Aesthetics and Cosmetic Surgery for Darker Skin Types

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Dedication

To Ephriam and Ruby Grimes, my parents, educators, and visionaries. Through them I have learned focus, dedication, resilience, and tenacity. To my loving daughter, Ashley, who is always there with endless love, support, and encouragement. To the late John A. Kenney Jr., MD, my mentor, eminent dermatologist extraordinaire, and "godfather" of ethnic dermatology. To the late Harold Pierce, MD, my mentor and trailblazer in ethnic cosmetic surgery. And lastly, to all the unsung heroes and pioneers of aesthetics and cosmetic surgery in darker racial ethnic groups.

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Foreword

"We are of course a nation of differences. Those differences don't make us weak. They're the source of our strength."

When presidential candidate Jimmy Carter said those words in 1976, he was thinking of many kinds of differences, but those differences, which are most immediately obvious, are those related to facial appearance. This wonderful book, produced by our friend Dr. Pearl Grimes and her associate editors and authors, addresses, highlights, and analyzes those similarities and differences using the concepts of balance and harmony. While there is a focus on color as in "darker skin types," in this book and in its title, the book contains valuable information which is independent of skin color or ethnicity. There are other highly relevant physical distinctions in the structure and function of eyelids with the chapter on "Blepharoplasty in Asian Eyes" as a wonderful example. The chapters on the surgical approaches best suited to management of the nasal area, face tightening, body contouring, hair restoration and removal are some of the practical backbone of this new text.

Having emphasized the broad perspectives of this book, we must commend Dr. Grimes on the wonderful wealth of material and information included that is specific to darker skin types, especially of African origin. This type of skin presents very specific problems from disorders of pigmentation, the problems associated with resurfacing, and the aging processes which are quite different from those seen in paler skin. Of course tumors, such as keloids, are a more severe problem in types V and VI skin.

Interestingly, despite the well-described differences in facial appearance between ethnic groups, anthropological and social analysis of the canons of facial beauty shows similarities throughout cultures—even in groups not even remotely communicating with other broader cultures. Dr. Grimes points out also that many African Americans are triracial descendants of African, Native American, and Northern Europeans, and many Hispanics are racial mixtures of Northern Europeans, Spaniards, and Native Americans. Their individual facial features are a blend of their particular heredities. We must be aware that despite an individual's perceived racial background (individual skin color may vary from pale to dark) there may be potential difficulties if the resurfacing physician does not recognize an individual's underlying skin type and look for this information prior to treatment. With the increasing integration of our culture, greater understanding of skin types and their variations and nuances are essential to the physician attempting to do the very best for all patients.

There is a narrow line between problems that are considered medical and those that are considered cosmetic. This book treats both with equal seriousness that we think is appropriate. There are chapters that are clearly cosmetic in focus and others that have no cosmetic material as well as some that straddle the boundary comfortably. All are absolutely relevant to the scope of this text. As in other areas, it is the very obvious comfort level which Dr. Grimes and her co-authors have achieved in addressing this large and important area of knowledge which is so impressive.

We are all indebted to Dr. Grimes for her research on topical treatments to restore normal tone and texture to darker skin types. She has worked hard for many years to help us understand the challenges inherent in darker skin types and the differences from paler skin. This new book is an expansion of her initial focus as well as a broadening, which helps us to expand our view of skin. Rather than regarding paler skin as "normal," we should now be regarding all skin as individual and managing it as such. The many factors involved in the assessment of the skin, including but not limited to pigmentation, should all be considered equally. This is the triumph of this book. Dr. Grimes and her co-authors are to be congratulated.

Wherever and whatever your practice in medicine, this book has lessons for all physicians to the benefit of all our patients and students.

ALASTAIR AND JEAN CARRUTHERS

Preface

Aesthetics and Cosmetic Surgery for Darker Skin Types has been a labor of love, passion, history, and expanding scientific knowledge. As a teacher, researcher, clinician, and mentor in dermatology and dermatologic surgery for more than 25 years, I have observed, participated, and contributed to the evolving field of cosmetic surgery in darker-racial ethnic groups.

Such individuals constitute the majority of the global population. They include Hispanics, Latinos, Africans, African Americans, Caribbeans, Native Americans, Pacific Islanders, East Indians, Pakistanis, Eskimos, Koreans, Chinese, Vietnamese, Filipinos, Japanese, Thai, Cambodians, Malaysians, Indonesians, and Aleuts. Darker racial ethnic groups are often classified as Fitzpatrick's Skin Types IV through VI and constitute a third of the United States population. Twenty percent of cosmetic procedures in the United States are performed in darker races. Current data suggest that the popularity and interest in cosmetic surgery in this group is expanding at a rapid pace.

Multiple studies have documented the unique structural and functional differences in the skin of darker skin types as compared to Caucasians. These differences can impact the choice of topical pharmacologic agents and cosmetic surgical procedures used in pigmented skin. The efficacy and outcomes of procedures vary in different racial groups. Some procedures may be extremely well tolerated in Caucasians or fair-skinned individuals but may cause myriad complications including scarring in dark skin.

There has been an explosion in new surgical techniques and technologies since the late 1990s. Despite this rapid growth, there is a dearth of published knowledge regarding cosmetic surgery in darker skin types. In addition, few textbooks have exclusively addressed this subject. To our knowledge, none have been published since W. Earle Matory Jr's "Ethnic Considerations in Facial Aesthetic Surgery" published by Lippincott in 1998.

John F. Kennedy stated: "The greater our knowledge increases the more our ignorance unfolds."

As we expand our knouledge of cosmetic surgery, it is clear that we must learn substantially more regarding techniques, outcomes, and complications of cosmetic surgery in darker racial ethnic groups.

Aesthetics and Cosmetic Surgery for Darker Skin Types was written to fill a tremendous scientific void. The intent was to provide cutting edge data, procedures, protocols, outcomes, and complications of cosmetic surgery in darker-racial ethnic groups. It was written for dermatologists, dermasurgeons, plastic surgeons, primary care physicians, medical students, interns, residents, and fellows.

This textbook is a compendium of the latest information addressing many aspects of aesthetics and cosmetic surgery, encompassing nine sections and 36 chapters by esteemed authors from around the globe. Hence, it represents and reflects a global treatise of current scientific knowledge.

Many topics of interest are addressed for the student and teacher of cosmetic surgery. The introductory chapter on beauty provides the reader with historical and societal constructs of beauty for darker skin types as compared to Caucasians. The following chapter reviews structural and physiologic differences in the skin of darker racial ethnic groups. The authors establish a paradigm for therapeutic options presented in subsequent chapters. The general textbook sections include: General considerations for cosmetic surgery; cosmeceutical and pharmaceutical agents; therapies for dyschromias; resurfacing procedures; facial tightening procedures; noninvasive wrinkle correction; correction of specific anatomic imperfections; surgical approaches for hair disorders; and benign and malignant skin tumors.

I hope that this treatise will serve as a foundation, bridge, and ladder of knowledge for any student, clinician, or scientist interested in aesthetics and cosmetic surgery in darker skin types.

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I would like to thank my associate editors, Teresa Soriano, MD, Doris Hexsel, MD, and Jenny Kim, MD, for their dedication and hard work. In addition, I am indebted to all of my distinguished authors who worked tirelessly, contributing extraordinary and unique chapters to bring this scientific venture to fruition. I sincerely thank all of you. I would also like to give a very special acknowledgment of gratitude to George Rudkin, MD, Matthew Kaufman, MD, and William Rassman, MD.

This textbook would not have been possible without the relentless efforts and work of my staff, Kali Ghazali and Michael Gonzalez, and the support of my family and dearest friends. Finally, I am deeply indebted to the vision and profound commitment of the Lippincott editorial staff. Many thanks to Nancy Winter, Managing Editor; Susan Rhyner, Editor, Division of Dermatology; Franny Murphy, Development Editor; Alicia Jackson, Project Manager; and Wendy Druck, Project Manager for Aptara, Inc.

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PART

1

General Considerations for Cosmetic Surgery

1

Beauty: An Historical and Societal Perspective

Pearl E. Grimes

HISTORICAL PERSPECTIVE

Beautiful faces are those that wear
It matters little if dark or fair
Whole-souled honesty printed there.

—"Beautiful Things" ELLEN ATHERTON

Historical definitions of beauty

If you ask patients to define "beautiful people," they will probably cite modern-day icons or historical legends renowned for their beauty. Such examples include Cleopatra, Angelina Jolie, or Halle Berry. But what do their answers tell us? White or black, Asian or Hispanic, beautiful people brought to mind probably share key attributes. For instance, virtually every culture has celebrated smooth skin, albeit a surface that is sometimes painted, tattooed, or pierced for extra appeal. Symmetry of features has long been a lure, if only subconsciously. Proportion, which represents the ratio of facial features relative to attraction, has held surprisingly steady over the centuries. Is there a recognized definition of beauty and, if so, where does it originate?

The accepted definition of beauty is based on ancient methods of quantifying beauty and applying those principles to all forms of nature. The ancient Egyptians may have been among the first to describe facial characteristics relative to beauty during the fourth and fifth centuries, but the ancient Greeks were the ones who appear to have quantified it. The artist Polykleitos, in the fifth century B.C., laid down recommended ratios for the ideal proportions in figures.[1] Those recommendations were later modified and refined. The Romans adapted the Greek canon, which developed and became known as the Golden Proportion. This ideal highlighted the connection between harmony, order, and proportion. This theme of defining beauty continued through the Middle Ages and was adapted during the Renaissance. In 1741, Père André described beauty as the balance of "Unity, order, proportion and symmetry."[2] No doubt many people would say the same today, even if they can't articulate their attraction to certain objects.

Studies have shown that few people fit the historical canons of beauty.[3] In the 19th century, a group of anthropologists in Frankfort agreed on standard cranial measurements that have since been used to measure attractiveness in addition to the earlier canons. History has shown that certain ideals are found attractive in most societies. Certain characteristics and proportions can be seen as universal. However, different methodologies, genetic algorithms, and modern digital facial manipulations that identify and define beauty have shown that there is no clear answer to the question "What is beauty?"[4,5]

Beautiful women in society: historical icons

Beautiful women have been etched onto cave walls, carved in stone, painted on canvas, and paid homage to in song, poetry, and prose. They have been with us since the beginning of time. The Greeks had the mythology of Aphrodite; the Norse had Freya. Hindu mythology reveres Lakshmi as the goddess of beauty. The Romans called their mythological goddess Venus.

The Venus of Willendorf is one of the oldest depictions of a human woman, an icon of prehistoric art, created nearly 30,000 years ago (Fig. 1-1). She was almost certainly a celebration of procreation and nurturing. By today's Western standards, however, she would be unlikely to find herself on the cover of *Vogue, Elle,* or *Essence* magazines.

Throughout history, there are examples of mutual appreciation of beauty across ethnic divides. Nefertiti and the Queen of Sheba are renowned beauties believed to have been black Africans (Fig. 1-2). The Queen of Sheba was from present-day Ethiopia or Yemen and is well known in Jewish, Christian, and Islamic texts. In Greek mythology, there were the celebrated black figures Isis from the Nile Valley and Diana of Attica from Ethiopia.

Pocahontas, the daughter of Chief Powhatan, was reportedly a beautiful and intelligent woman who was treated as royalty. The most well-known, idealized painting of her, *The Baptism of Pocahontas,*[5] depicts her as a lighter-skinned, virginal beauty compared with the other Indians in the picture.

Figure 1-1 The Venus of Willendorf. (The Natural History Museum, Vienna.)

Figure 1-2 Bust of Queen Nefertiti. (Altes Museum, Berlin.)

As stated by Margaret Hungerford in 1878, "Beauty is in the eye of the beholder and David Hume in 1757, "Beauty is no quality in things themselves: It exists merely in the mind which contemplates them; and each mind perceives a different beauty." But is this true? Is everyone's idea of beauty distinctly individual, or is there a template laid down in our genes against which we measure it? How much does the ideal vary from race to race or from culture to culture? Can exposure to new ideals influence our perception of beauty?

In our multiracial, multicultural, and multimedia society, it is difficult to tease out the factors that define beauty. Instead, observation of historical or isolated populations provides clues about the perception of beauty and the way it changes over time.

GENETIC AND EVOLUTIONARY ASPECTS OF BEAUTY

From an evolutionary perspective, beauty is a gauge to measure fitness and suitability of a mate. Attractive facial features may signal sexual maturity and fertility, emotional expressiveness, or confer a cuteness that evokes a protective instinct.[6] As a "survival-of-the-fittest" instinct, avoidance of deformity and disease directs us toward mates who exude health and vitality. Symmetrical features, healthy bodies, and flawless skin are idealized. These parameters are commonly used to define physical beauty—but they also leave room for variability and interpretation.

There is clear agreement that attractiveness ratings are similar in a number of cross-cultural studies.[7,8] When considering the genetic angle of defined beauty, men are attracted to delicate jaws, large eyes, narrow waists, and full hips and lips, probably because these features signal youth and a high estrogen level, which in turn means fertility and fecundity. Women, on the other hand, are attracted to strong chins, height, broad shoulders and wide jaws, probably because they signal a high testosterone level and imply an ability to protect and feed a family.[9,10]

The pursuit of beauty is a basic instinct and a biological adaptation to help ensure the survival of our genes and, in a sense, ourselves. Research suggests that sensitivity to beauty is due to an instinct that has been shaped by natural selection.[11] For example, certain studies show that infants will stare significantly longer at faces deemed by adults to be attractive.[12] In addition, mothers of attractive newborns spend more time interacting with their babies. Studies have also shown a disproportionate number of abused children may not fit the standard canons for beauty.[12]

In other words, beautiful people are excused for everything from stupidity to serious crimes. People are more likely to help the good-looking (even if they dislike them) and are less likely to ask them for help.[13–15] A common theory even has it that beauty is the appearance of things and people that are good, meaning attractive people are judged more worthy simply because of their looks.

Beauty clearly brings ease. It is, as they say, its own reward.[14]

MEASUREMENTS FOR FACIAL AESTHETICS

Anatomical beauty is relatively easy to define and measure. Population surveys have identified the facial features that contribute to a generalized ideal. These include a full head of hair, smooth complexion, large eyes, small nose, full lips, slightly protrusive lower face, and high cheekbones. On the other hand, facial features that detract from beauty are disproportion, asymmetry, excessive size, convexity of profile, retrusion of the chin, skin laxity, thin lips, large nose, and irregular or discolored teeth.[16]

Historical tools or parameters used to measure facial aesthetics include the golden aesthetic proportions, neoclassical canons of facial proportion, the Frankfort horizontal plane, and facial shapes (Table 1-1).

The Greeks were fascinated by beauty as conveyed by the pursuit of godlike perfection in their statues. They also considered mathematics to be the unifying basis of life, art, the gods, and the universe. It is therefore no surprise that they tried to define beauty with mathematics. The divine proportion, or "golden section," was taken up by Plato as a mathematical relationship expressing universal harmony. Considered an ideal measure to govern the relationship of elements of the human body, it is expressed as 1:1.618, a ratio that occurs in many natural forms such as plants, shells, and snowflakes. Leonardo da Vinci later used the "golden section" in his portraits. The apparent importance of the ratio led Ricketts, an orthodontist, in 1982 to postulate a divine proportion for facial analysis.[17] This concept is believed to have originated with the sculptor Phidias, hence the expression *phi* in relation to the golden proportion, which has been used as an aesthetically pleasing relationship of vertical and/or horizontal structures. Ricketts indicated that this relationship seems to occur naturally in a variety of guises in the human face and body. However, in 1992, Davis and Jahnke disputed the relevance of the "golden section." They demonstrated a preference for internal facial divisions with a unitary value with bilateral symmetry.[18]

The neoclassical canons of facial proportions, described by scholars and artists of the Renaissance based on classical Greek canons, are still used for evaluation of facial features today (Table 1-1). Standard canons include the division of the face profile into thirds, with the height from the hairline to the eyebrow, from the brow to the lower edge of the nostril, and from the nostril to the chin being equal (Fig. 1-3). Other guidelines state that the height of the nose and the ear be the same, the width of the mouth be one and a half times the width of the nose, and the inclination of the nose bridge be parallel to the axis of the ear.

In 1985, Farkas et al. suggested that the facial canons did not work well when used to measure beauty in contemporary white subjects.[19] How would the canons perform

Table 1-1

Aesthetic parameters of the face

Aesthetic parameter	Measurements
Golden aesthetic proportions	The nasal height (A) is related to the maxillary height (B) as 1.000:0.618. The sum of nasal height and maxillary height (A + B) are related to the mandibular height (C) as 1.618:1.000 The mandibular height (C) is related to the maxillary height (B) as 1.000:0.618 The orofacial height (B + C) is related to the nasal height (A) as 1.618:1.000 Note that each ratio is 1.618
Neoclassical canons of facial proportion	Nine in total: three vertical profile, four horizontal facial, and two nasoaural canons
Frankfort horizontal	Glabellar, columellar, and incisal angles
Facial shapes	Oval, heart, rectangular, other

Data from Tweed CH. The Frankfort-mandibular plane angle in orthodontic diagnosis, classification, treatment planning and prognosis. *American Journal of Orthodontics and Oral Surgery* 1946;32:175; Farkas LG, Hreczko TA, Kolar JC, et al. Vertical and horizontal proportions of the face in young adult North American Caucasians: revision of neoclassical canons. *Plast Reconstr Surg* 1985;7(3):328–338.

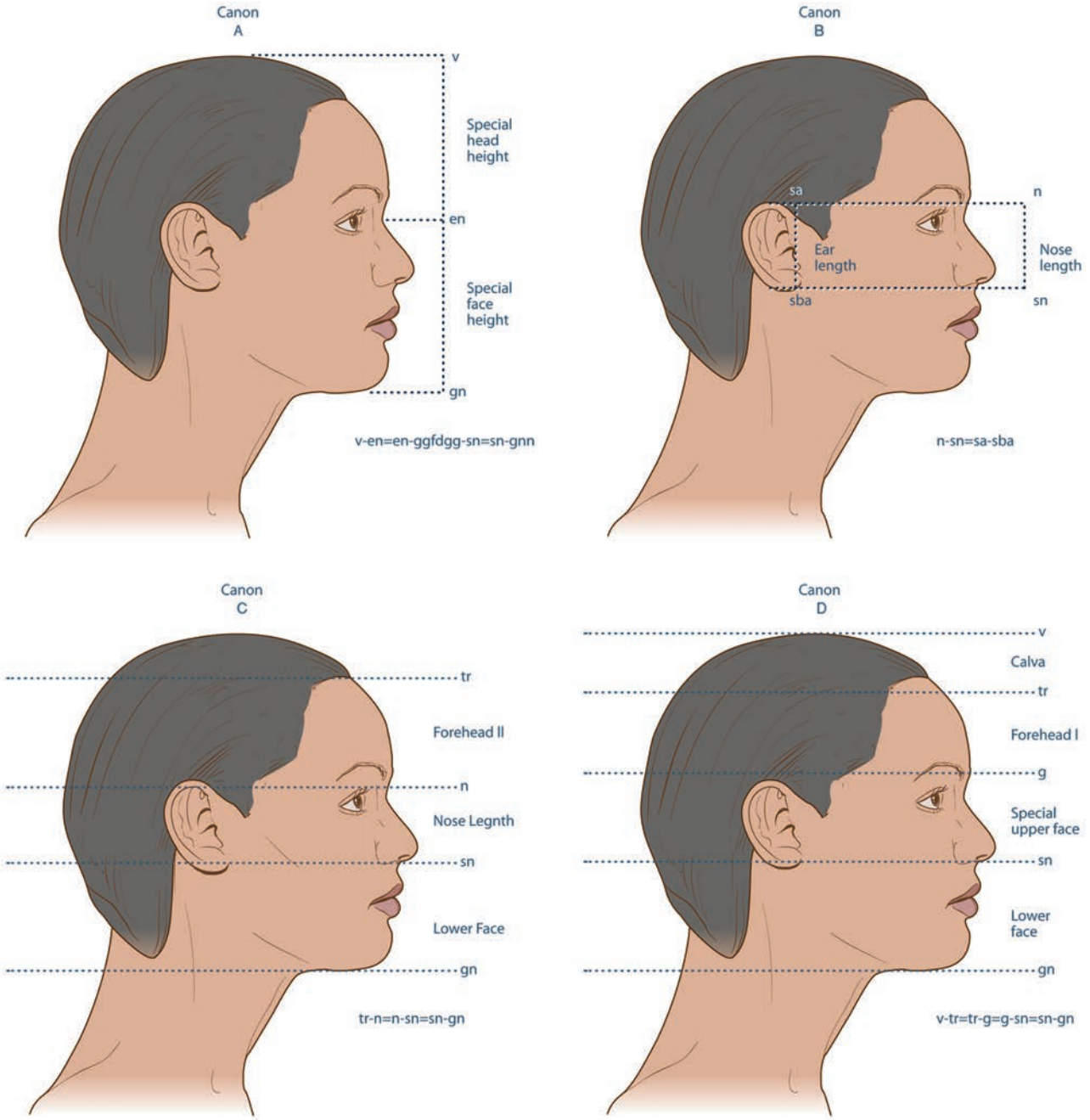


Figure 1-3 Golden Proportion and Neoclassical Canons. **A:** Two-section facial profile canon. The combined head-face height is divided into two equal parts: the special head height (vertex-endocanthion, v-en) and the special face height (endocanthion-menton, en-gn). **B:** Nasoaural proportion canon. The length of the nose (nasion-subnasale, n-sn) equals the length of the ear (supraaurale-subaurale, sa-sba). **C:** Three-section facial profile canon. The combined forehead-face height is divided into three equal parts: the forehead (trichion-nasion, tr-n), the nose (nasion-subnasale, n-sn), and the lower half of the face (subnasle-gnathion, sn-gn). **D:** Four-section facial profile canon. The combined head-face height is divided into four equal parts: the height of the calva (vertex-trichion, v-tr), the height of the forehead (trichion-glabella, tr-g), the special upper face height (glabella-subnasale, g-sn), and the height of the lower face (subnasale-gnathion, sn-gn). (Modified from Farkas LG, Hrecko TA, Kolar JC, et al. Vertical and horizontal proportions of the face in young adult North American Caucasians: revision of neoclassical canons. *Plast Reconstr Surg* 1985;75(3):328–337. Farkas LG, Forrest CR, Litsas L. Revision of neoclassical facial canons in young adult Afro-Americans. *Aest Plast Surg*. 2000;24:179–184.)

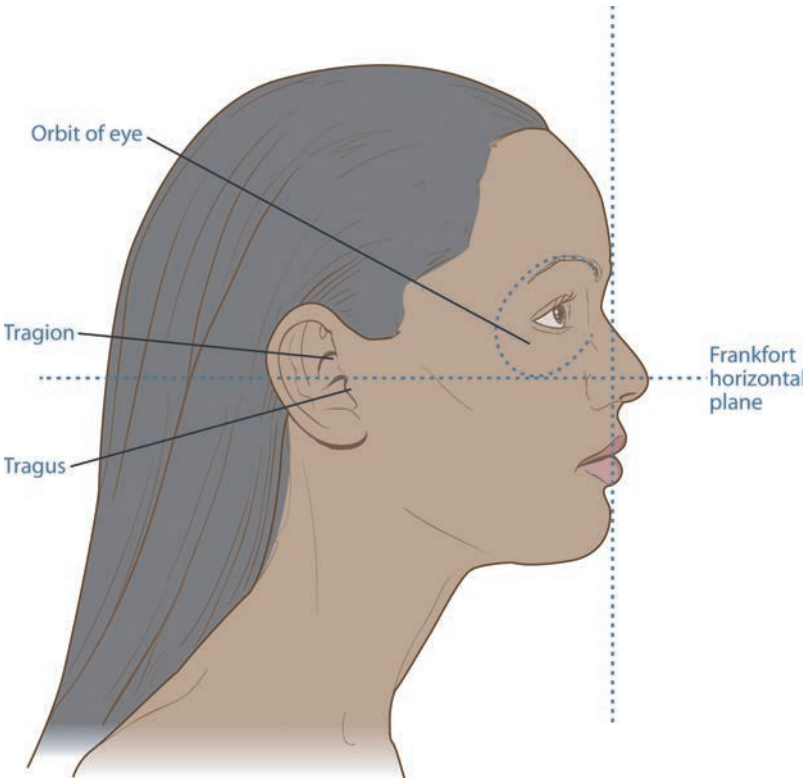


Figure 1-4 Frankfort horizontal scale. Standard craniometric reference used for facial surgery evaluation and photography. The position of the Frankfort horizontal line is determined by taking a lateral photograph and drawing a vertical line from just in front of the glabella to the front of the chin. A line is then drawn horizontally from right at the supratip to above the auricular canal, right above the tragus.

across ethnic boundaries? Matory assessed the applicability of various parameters of attractiveness in 400 "attractive" subjects representing different ethnic and racial groups: black Americans, Hispanic, Asian, Middle Eastern, and Caucasian.[20] The neoclassical canons were inconsistent in each of the ethnic categories. The face could be divided into three equal parts, and the face and cranium into four equal parts, in fewer than 9% and 4% of individuals, respectively.

In later work, Farkas et al. compared the validity of seven neoclassical canons in African Americans and Caucasian Americans.[3] They found that the three sections of the facial profile were not equal in either population. In the African American population, there was commonly a longer lower face height in relation to the height of the forehead and greater nose width. Farkas et al. concluded that the frequency of valid canons was greatly surpassed by their variations. In a similar study, Wang et al. compared horizontal neoclassical facial canons in Chinese and North American Caucasian populations.[21] They found that the nose corresponded to one quarter of the face in about half of Chinese subjects and approximately one third of Caucasian subjects. The Chinese mouth was significantly more often narrower than 1.5 times the nose width (71.8% of subjects), whereas the Caucasian mouth was significantly more frequently wider (60.2% of subjects).

The Frankfort horizontal plane, named in 1884, is the standard craniometric reference used for facial surgery evaluation and photography. The position of the Frankfort horizontal line is determined by taking a lateral photograph and drawing a vertical line from just in front of the glabella to the front of the chin (Fig. 1-4). Ideally, this line would be perfectly vertical, although some facial cosmetic surgeons believe the chin can be slightly behind this line in women and still look feminine and proportionate. A line is then drawn horizontally from right at the supratip to above the auricular canal, right above the tragus. Matory reported that the Frankfort horizontal was a common characteristic in African Americans with narrow and moderate features (98% and 65% of female subjects, respectively) but was less common in individuals with wide facial features (33.2% of female subjects).[20] He obtained similar results in male subjects.

In contrast to his results with neoclassical canons and the Frankfort horizontal plane, Matory found a dramatic consistency in the applicability of "golden aesthetic" proportions to the ethnic face (Table 1-1). The phi ratio of 1:1.618, as measured by the Ricketts caliper, correlated well with a number of facial relationships, including nose/eye/lip and nose/lip/chin relationships. In addition, he reported that among African Americans, the most attractive female faces are oval, diamond, or square shaped. In men, heart-shaped faces were more common. Oval faces when noted in men were considered feminizing.

Today, facial cosmetic surgeons rely on universally accepted guidelines and measurements of facial proportions to aid them in modifying facial structures and relationships.

A basic knowledge of standard reference points and their normative values is essential for computer imaging, record keeping, photography, and communication with patients and colleagues. However, these represent only basic standards for facial evaluation and analysis; there must also be an acceptance of their limitations in the clinical setting, because rigid adherence to calculated proportions may limit success in achieving a "natural" appearance.

DEFINING ETHNIC BEAUTY

The definition of a beautiful face will differ by ethnic group. Characteristic global defining features of people include skin color, hair texture, and morphologic differences in eyes, nose, and lips. Albeit there are diverse differences in the facial appearance of darker racial ethnic groups, several studies have indeed elucidated some defining features in facial structure of African Americans, Asians, and Hispanics.[3,22–25]

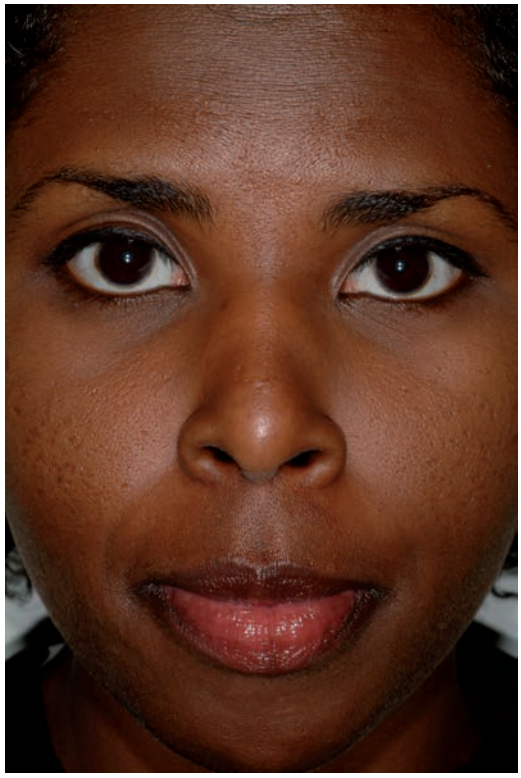
Most African Americans are triracial descendants of African, Native American, and Northern Europeans. Their facial features often reflect a multiracial heritage. African American skin tone can range in color from olive to light brown to brown to black. African American faces are characterized by a decreased nasal projection, broader nasal base, bimaxillary protrusion, and increased soft tissue thickness of the midface, lips, chin, orbital proptosis, and increased facial convexity (Table 1-2, Fig. 1-5).[23,26–28]

Asian populations include East Indians, Chinese, Japanese, Koreans, Vietnamese, Cambodians, Thai, Malay, Indonesians, Polynesians, and Filipinos. Some characteristic features of Asians include a wider intercanthal distance in relation to a shorter palpable fissure and a broad prominent forehead with nonptotic brows, lack of upper eyelid crease, broader nasal base, and a small mouth. Asians typically have a wider lower face with a recessed chin. In addition, wide mandibular angles and square-shaped faces are common (Table 1-3, Fig. 1-6).[23]

Many Hispanics living in North, Central, and South America are racial mixtures of Europeans, Spaniards, and Native Americans. African migration to the Americas—as well as migration of Asians and Central and Northern Europeans—has resulted in further miscegenation and given rise to the current-day Hispanic or Latino population. Variation depends on racial makeup.[29] Skin color may be white, olive, or brown. Many South American Latinos of Spanish and European ancestry have typical Caucasian facial features, whereas many Latinos in the Caribbean are of African ancestry. Common features of the Hispanic face include an increased bizygomatic distance,

Table 1-2

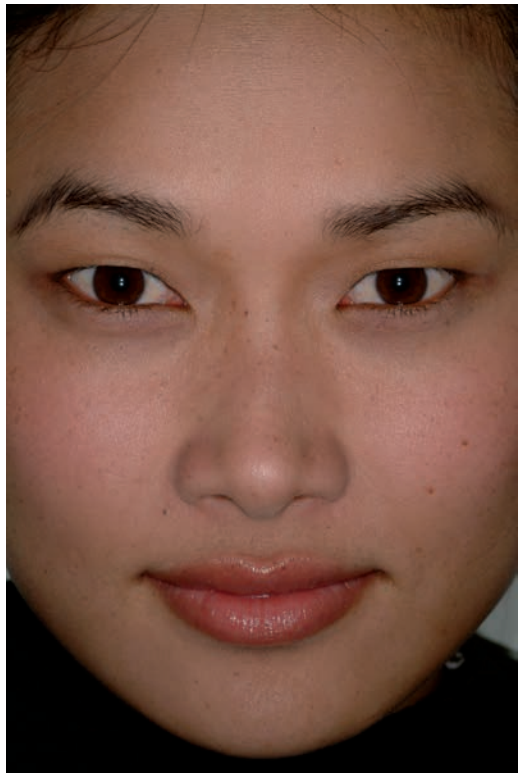
Features of the African American face



- Bimaxillary protrusion
- Broad nasal base
- Decreased nasal projection
- Orbital proptosis
- Increased soft tissue of the midface
- Prominent lips
- Increased facial convexity

Table 1-3

Features of the Asian face



Broad prominent forehead

Lack of upper eyelid crease

Wide intercanthal distance

Short palpebral fissure

Broad nasal base

Wide mandibular angles

Square-shaped face

bimaxillary protrusion, and higher convexity angle, giving it a broad appearance and somewhat rounded profile. Mexican American women are characterized as having more protrusive maxillary areas compared with Caucasians (Table 1-4, Fig. 1-7).[29]

In women of European descent, an oval-shaped face is considered the most aesthetically pleasing. However, in Asians and African Americans, a fuller, more rounded face is considered more attractive. Likewise, a pointed, upturned nose is often regarded as attractive in a Caucasian. In darker racial ethnic groups, a wider and longer nose is more appealing.[20] The absence of an upper eyelid crease, although characteristic in about half of Asians, is the most commonly requested cosmetic alteration among Asian Americans.[30] Attractive Hispanic features are more typically characterized by an increased bizygomatic distance, bimaxillary protrusion, and higher convexity angle compared with the Caucasian.[30] Such observations have served as a template for understanding the impact of diverse facial morphologies in the perception of beauty (Table 1-5, Fig. 1-8).

However, as societies become more integrated, many concepts of beauty are changing. The most important point for all ethnic groups is that each feature of the face should be in proportion to yield facial balance and harmony.[31]

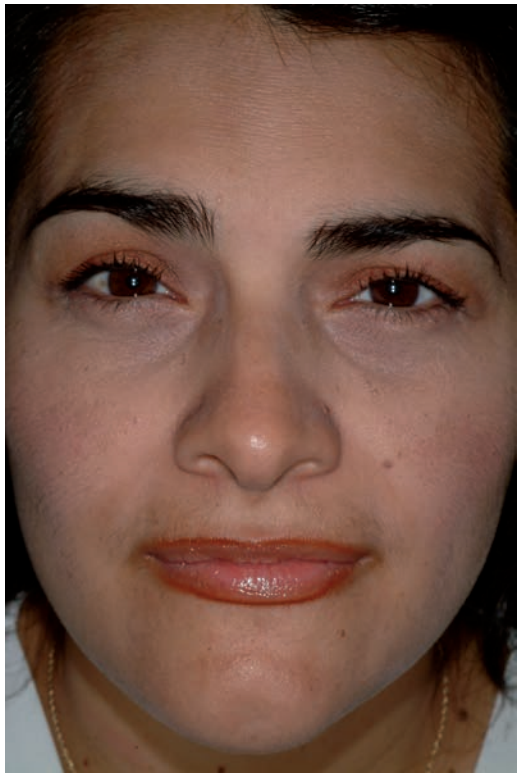
PERCEPTIONS OF BEAUTY FROM CULTURE TO CULTURE

Reverence for beauty is a fundamental cultural norm throughout the world. Still, within a given community, there is considerable agreement about what or who is beautiful. Without previous exposure to people of different ethnicity, individuals will demonstrate a preference for features that reflect their own. Despite this, there are clear cross-cultural preferences and commonalities that define beauty. In perhaps the most far-reaching study on the influence of race and culture on judgments of beauty, the anthropologists Jones and Hill compared preferences of the isolated Hiwi tribe in Venezuela and the Ache Indians of Paraguay with the preferences of subjects at three Western locations. The Indian tribe members had very little contact with Westerners, but all five groups had similar perceptions of beauty.[32] Numerous cross-cultural studies have confirmed a commonality in the recognition of beauty, although preferences are generally stronger for faces of the same race.

One can speculate that increasing globalization and exposure to varied cultures via the media and travel should have influenced and broadened concepts of ideal beauty in recent years. However, in todays mega-information age,

Table 1-4

Features of the Hispanic/Latino face



- Bimaxillary protrusion
- Increased bizygomatic distance
- Higher convexity angle
- Broader nose
- Broad, rounded face
- Receding chin
- Prognathic dental arches

the overwhelming influence of Eurocentric fashion and beauty industries further validates the persistence of Eurocentric standards of beauty. Such standards are indeed regarded as beauty norms to gage attractiveness and self-worth.

It is clear that Westernized, and generally lighter-skinned, ideals of beauty have had a complex historical and social foundation. Historically, Europeans colonized every corner of the world and become dominant figures in the social and political hierarchy of many nations. As they colonized globally, miscegenation was the endpoint. With cultural mixing, a broader cultural attitude evolved that superseded cultural and ethnic prejudices producing what has been called a *pigmentocracy*.[33,34]

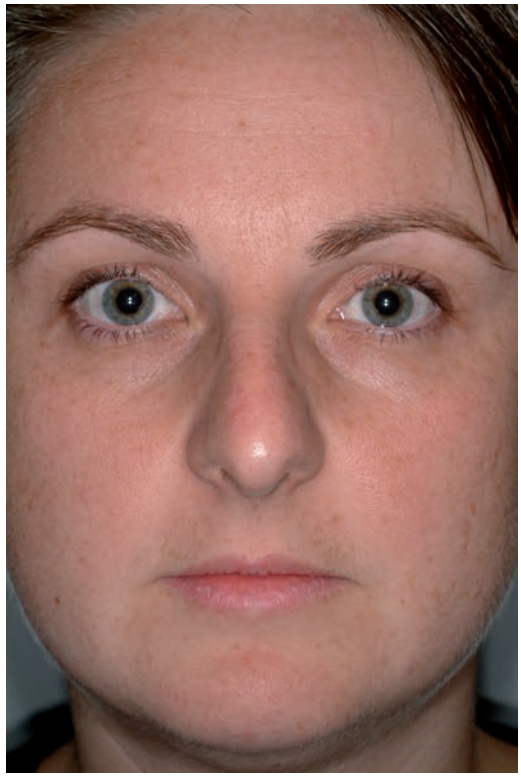
For thousands of years, foreign, usually lighter-skinned invaders, ruled many countries, including Egypt, South America, Africa, and India. The gradual mixing and lightening of people of different ethnic groups has resulted in an interesting variation on racism in certain countries that has been called *shadism*, in which social and political influence is determined by the particular shade of an individual's skin.[35] Shadism is a global phenomenon; it is apparent in the United States as well as in South America, Africa, the Caribbean, and India. In Brazil, as elsewhere, marrying 'light' is seen as a form of social advancement. This culturally perceived notion of the superiority and benefits of lighter skin is often reflected and reinforced in families, media, schools, and businesses.[36]

BEAUTY AND ADORNMENT

Biological beauty is determined by our anatomy. However, uniquely among the animal kingdom, we demonstrate the ability to alter and decorate our biological features to accentuate and enhance our appearance. Self-decoration is an ancient human trait seen at its earliest in cave paintings that depict ceremonial necklaces, bracelets, and masks. Cosmetic substances have also been found in Neolithic caves. In many primitive societies, those with wealth and time spent it "improving" the beauty of their bodies—a normal practice today. Decoration to enhance appearance is only limited by imagination and the availability of materials. Hence, a multitude of decorative approaches have evolved from the earliest times and in the farthest-flung populations. The importance of adornment as a contributor to beauty is readily apparent when children are asked

Table 1-5

Features of the Caucasian face



Oval face

Prominent cheekbones

Tapered jawline

Tall, slender nose

Narrow nasal base

Thin lips

to describe a beautiful woman or a handsome man. They will enthusiastically relate the clothes, the hair and decoration but much less frequently mention anatomical features.[37]

Early European explorers of the southern oceans noted in their travels that the people they came across, even those in cooler climates, often wore few clothes. However, a common feature was some form of self-adornment, whether jewelry, piercings, tattoos, paint, or decorative scars. In some cases, piercings and binding would prevent them from being able to work, which in itself declared a sign of their status.

There are many reasons why individuals choose to decorate themselves. It can set them apart from the natural world. It may be used to attract members of the opposite sex, as a mark of rank, or as a rite of passage. It may provide protection against evil spirits.[38,39] In addition, the act of self-decoration can have a psychologically therapeutic benefit as an expression of self-control. This has been confirmed in studies of hospitalized women for whom a visit to the hospital hairdresser or the act of applying makeup has a beneficial effect.[40] This is because it meets a need for personal control that may be lost while in the hospital. By chance or hindsight, some forms of self-decoration also have a specific medical benefit. The repeated cutting required to achieve decorative scarring exposes the body to pathogens and promotes the production of antibodies that can later give protection to the individual. Facial and body painting is another decorative custom that affirms tribal identity. It can be an important symbol of attractiveness and status within the community (Fig. 1-9).

THE CHANGING PERCEPTION OF BEAUTY

In 1992, C. Olds, in a review of Western art, argued that facial aesthetic ideals have remained constant for several thousand years as depicted in classical and modern art.[41] In contrast, Farkas et al.[19] found a large discrepancy between the aesthetic profile in art and that in the mass media. Certainly comparison of a well-rounded Rubenesque female nude with one of today's supermodels, or indeed a Classic Greek portrait, would suggest that society's representation of a beautiful body can change over time. Even within the short period of a century, preferences have been seen to change. Sutter,[26] Auger and Turley,[42] and Nguyen and Turley[43]

Figure 1-9 Unmarried Surma girl, Ethiopia, with distinctive face painting and stretched earlobes. (Photograph by Carol Beckwith and Angela Fisher, photokunst, Friday Harbor, WA.)

measured the profiles of white men and women from fashion magazines at different times during the 20th century. They found a significant trend for fuller and more anteriorly positioned lips in white female models, and a trend for a generally fuller profile in white male models. A similar trend was found when profiles of African American women were analyzed in the same way.[44]

Polynesia is renowned for its well-proportioned inhabitants. Large body size was traditionally seen as a primary requisite for beauty and happiness. Has exposure to a slimmer Western ideal of beauty influenced this perception?[45] Craig et al. recorded body-size perceptions in men and women in the Cook Islands and compared these with matched controls in Australia. He found that the preferred body size of the Cook islanders was in fact the same as the Australians in both men and women. Only the older Cook islanders chose a larger ideal body size.

CURRENT PARAMETERS FOR BEAUTY IN DARKER RACIAL ETHNIC GROUPS

Features that define a dominant or successful group within a society will tend to be imitated by others. The primary parameters by which darker racial ethnic groups in the United States define their beauty could be said to arise from comparisons with a white ideal. For African American, Hispanic, and Asian women in the United States, those features are skin color, hair texture and length, nose width, lip thickness, eye color, and the size of the hips and buttocks.[46]

For many Asian Americans, a porcelainlike white face remains the feminine ideal, reflecting a long-held belief that pale skin is associated with success and a comfortable life. An old Chinese proverb says, "White skin can cover 1,000 uglinesses." In a society in which beauty is represented by a white ideal, the ambition for paler skin is accentuated further. As a consequence, many Asian Americans go to great lengths to maintain a lighter skin.

The influence of the media in creating a stereotype for success is of course not limited to facial features, but also encompasses body shape. Body-size perception begins young. In a survey of Hispanic subjects, 6- to 7-year-old girls were already exhibiting a preference for a body thinner than their own. Dissatisfaction grew with age in girls but not boys. Previous studies have shown that Hispanics are generally more satisfied with their body shape than whites.[47] Historically, African American women also have a more positive perception of their bodies than white women, perhaps because of a greater tolerance of body type and shape in their community.[48]

AESTHETIC CHALLENGES IN COSMETIC AND RECONSTRUCTIVE SURGERY IN DARKER RACIAL ETHNIC GROUPS

A model of beauty based on Caucasian aesthetics may not be appropriate for a non-Caucasian individual. The challenge for cosmetic surgeons working with darker racial ethnic groups is to achieve an aesthetic relationship between facial structures without losing the individual's ethnicity. Reliance on guidelines based on white norms may result in dissonant facial proportions. Even within different ethnic groups, there will be different facial aesthetics that need to be recognized. However, in a multicultural environment, aesthetics may be changing in response to fashion and the influence of Western notions of beauty.

THE FUTURE

White Europeans and their descendants are unlikely to remain the dominant ethnic group in the United States. The U.S. Census Bureau has predicted that the proportion of white, non-Hispanic population will fall to 50% by 2050 from 69.4% in 2000. Similarly, Blacks will comprise 15% of the general population in 2050 from 13% in 2000. The Asian proportion will increase from 4% in 2000 to 8% in 2050, while Hispanic proportion will increase from 13% to

24% in the same period. The number of interracial marriages will also increase. According to *Newsweek* magazine, 67% of Asian Americans in their 20s married outside their race in 1990.

Lester B. Pearson, the Canadian statesman (1897–1972), said that "We are all descendants of Adam, and we are all products of racial miscegenation."[50] It may be that with the growing influence of intermarriage of different racial ethnic groups, the Eurocentric beauty standard may give way to more diverse standards of beauty.

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2

Structural and Physiologic Differences in the Skin of Darker Racial Ethnic Groups

Pearl E. Grimes and Quyn Sherrod

The color of skin is intriguing, for it evokes a multitude of societal emotions, interactions, inclusions, and exclusions. Descriptive terminologies for skin pigmentation are influenced by mythology, history, religion, anthropology, and geopolitical philosophies.[1] Individuals with deeply pigmented skin comprise myriad racial and ethnic global populations. Skin color, among other defining physical traits, is the key determinant of race. According to John Hope Franklin, ". . . the specter of color and race haunts every nook and corner of the world, consuming an inordinate amount of mankind's energies and attention that are so desperately needed to solve the major problems of peace and survival."[2]

Humans (*Homo sapiens*) have been divided into five geographical groups as a basis for racial categorizations, including Caucasian, Mongoloid, Australoid, Congoid (or Negroid), and Capoid. Caucasoid includes Europeans, Middle Easterners, Pakistanis, and Indians. Mongoloid includes East Asians, Indonesians, Polynesians, Micronesians, American Indians, and Eskimos. Australoid includes the Australian Aborigines, Melanesians, and Papuans. Congoid includes Africans and descendants of Africans (African Americans and African Caribbean). Migration and consequent miscegenation make this historical system of classification somewhat obsolete. Recent studies have investigated genetic markers for categorization of racial ancestry. Genetic categorization clusters humans based on allelic heterogeneity and the resulting phenotypic differences.[3] Variation in pigmentary phenotypes is attributed to the sequence diversity of the MC1R coding region.[4]

Ethnicity is a defined social construct based on national origin and phenotypic pigmentation (or skin color). Phrases commonly used when describing skin traits of darker racial ethnic groups include ethnic, dark, black, skin of color, and pigmented. The key unifying feature is skin with darker shades of pigmentation (tan, olive, brown, and black). Darker-skinned populations constitute the majority of the global population. They include Hispanics, Latinos, Africans, African Americans, Caribbeans, Native Americans, Pacific Islanders, East Indians, Pakistanis, Eskimos, Koreans, Chinese, Vietnamese, Filipinos, Japanese, Thai, Cambodians, Malaysians, Indonesians, and Aleuts.

In 2000, the United States Census Bureau estimated that the total resident population included 33 million Hispanic Americans (12%), 34 million African Americans (13%), 11 million Asians and Pacific Islanders (4%), and 2 million Native Americans, Eskimos, and Aleuts (1%). Statistical projections suggest continuing major growth of the nonwhite U.S. population, with Hispanics having the most significant growth rate. By 2050, at least 50% of Americans will represent darker racial ethnic groups.[5]

The popularity of cosmetic procedures is increasing substantially in the United States and globally. In the United States, patients are bombarded with cosmetic surgery images from television shows, newspapers, beauty magazines and books, the Internet, and infomercials. Media sources often present the most cutting-edge cosmetic procedures to the lay public. Patients today are more informed than ever.

All racial ethnic populations show keen interest in procedures to enhance one's aesthetic appeal. Data from the American Society for Aesthetic and Plastic Surgery for 2005 revealed that the overall number of cosmetic surgical procedures increased 544% since 1997. The five most popular cosmetic surgical procedures in 2005 were liposuction, breast augmentation, blepharoplasty, rhinoplasty, and abdominoplasty. The top five nonsurgical cosmetic procedures were botulinum toxin injections, laser hair removal, hyaluronic acid filler injections, and chemical peels. Darker racial ethnic groups accounted for 20% of all cosmetic surgery procedures. Hispanics accounted for 9% of this group, African Americans 6%, Asians 4%, and other groups 1%.[6]

Cosmetic procedures commonly performed in darker racial ethnic groups include chemical peels, microdermabrasion, injectable fillers, laser hair removal, botulinum toxin injections, liposuction, and breast augmentation. Nonablative resurfacing procedures, including intense

pulsed light as well as radiofrequency procedures, are also increasing in popularity (see Chapters 16 to 19).

When considering cosmetic procedures in darker racial ethnic groups, clinicians should be cognizant of the special structural and physiologic differences in the skin of such individuals. These differences can significantly affect and influence surgical and cosmetic surgery outcomes. This chapter will review the structural and physiologic features of the skin of darker racial ethnic groups.

SUBJECTIVE AND OBJECTIVE ASSESSMENT OF SKIN COLOR

In the late 19th century, Felix von Luschan developed a chromatic scale to classify skin color.[7] The von Luschan scale consisted of 36 opaque glass tiles that could be compared with a subject's skin, typically in a non–sun-exposed area. This scale was commonly used throughout the early part of the 20th century to classify skin types. Because of its subjective nature, it was considered highly problematic and was abandoned in the mid-20th century. However, von Luschan's global depiction of regions largely populated by darker racial ethnic groups remains relatively accurate today (Fig. 2-1).

The assessment of skin color and the ability to monitor color changes over time or during treatment of skin conditions is no doubt an important tool in dermatology and cosmetic surgery. The perception of skin color, however, is highly subjective, being influenced by many factors. These include pigmentation, desquamation, cutaneous blood flow, physical exertion, anatomic site, and variation in ambient lighting.[8]

The Fitzpatrick skin type classification was developed in 1975 by dermatologist Dr. Thomas Fitzpatrick as a sun-reactive skin typing system to classify persons with white skin to select appropriate doses of ultraviolet-A (UVA) for phototherapy patients.[9] The classification was subsequently modified to measure responses in various skin types to sunlight and ultraviolet radiation. It correlates the color of skin with its ability to tan or burn with ultraviolet light exposure. It is based on six categories, which include:

- Type I (very white or freckled): Always burn
- Type II (white): Usually burn
- Type III (white to olive): Sometimes burn
- Type IV (brown): Rarely burn
- Type V (dark brown): Very rarely burn
- Type VI (black): Never burn

Darker racial ethnic groups are often classified as Fitzpatrick skin types IV through VI. Despite the fact that it was never designed for cosmetic purposes, the Fitzpatrick classification is often used as a criterion to determine the safety of a variety of cosmetic procedures in individuals with white, olive, brown, or black skin. As the American and global populations become increasingly diverse, the Fitzpatrick classi-

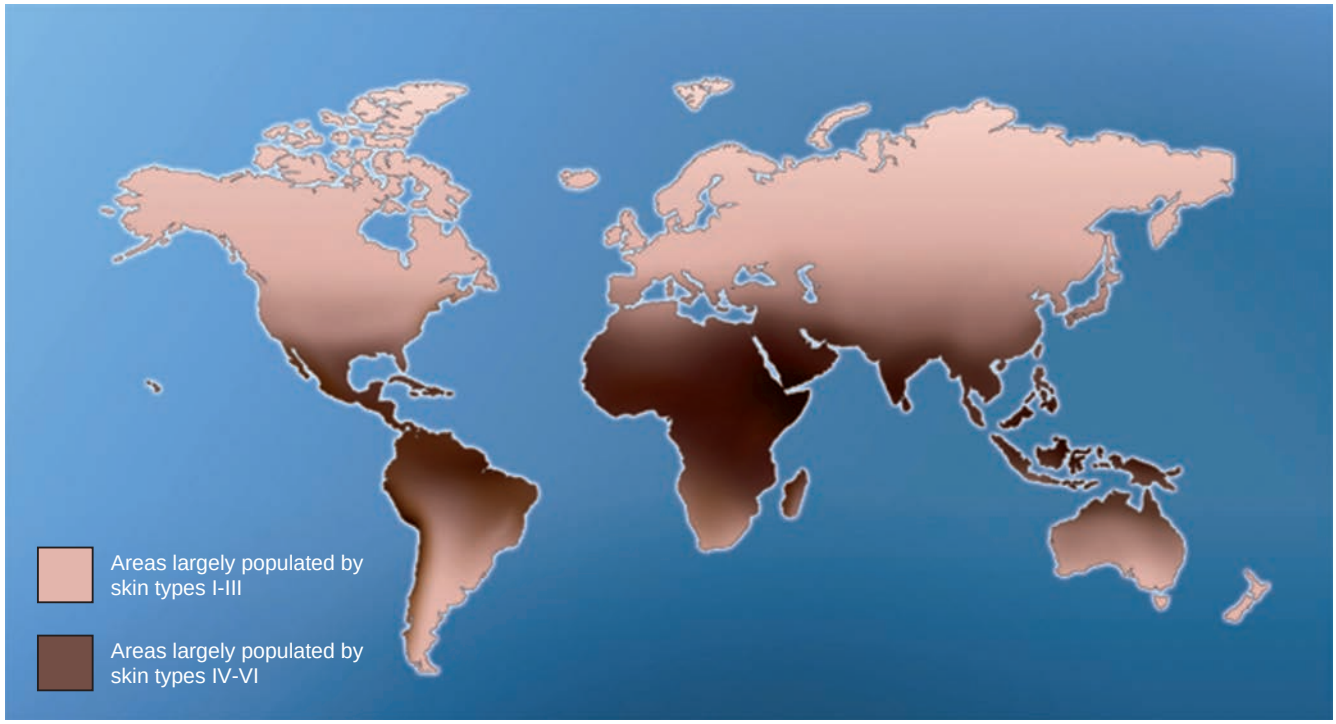

Figure 2-1 Global map depicting areas largely populated by individuals of darker racial ethnic heritage. Darker shaded areas of the global map represent areas largely populated by individuals of darker racial ethnic heritage.

fication has come under increasing scrutiny in its lack of ability to predict minimal erythema dosing (MED), minimum melanogenic dosing (MMD) to tanning, or even constitutive skin color. Multiple investigators are examining new scales to assess ultraviolet responses as well as scales that more accurately predict cosmetic surgery outcomes.[10]

New objective technologies have evolved that facilitate objective and reproducible quantitative measures of skin color and erythema. A variety of color-measuring instruments have evolved based on two different principles of color physics. These include reflectance spectrophotometry and tristimulus colorimetry.[11] Spectrophotometer instruments use broad bands or selected wavelengths of light in the visible range and measure absorbance and reflectance. Tristimulus analysis of blue, red, and green light measures light reflection from skin structures. Convenient instruments using these principles include the Minolta Chromameter, the DermaSpectrometer, the Photovolt ColorWalk Colorimeter, the Mexameter, the DermaSpectrophotometer, and the Erythema Meter.

Grimes et al.[12] measured the ranges of skin color and erythema by reflectance spectrophotometry in a multiracial population of 160 subjects including African Americans, Caucasians, Hispanics, Asians, and East Indians. Measurements were taken during the months of November through January, when summer tans had likely faded. There was a statistically significant correlation between reflectance spectrophotometry measurements using the Meximeter MX 16 (Courage Khazaka, Electronics, GMbH) and race and Fitzpatrick's skin types (Fig. 2-2A,B). As the intensity of cutaneous pigmentation increased, measurements for melanin and erythema increased. There was no statistically significant correlation with age or sex. Additional studies are indeed warranted to further validate the reliability of bioinstrumentation as a tool for skin typing.

MELANOCYTES, MELANIN, AND PIGMENTATION

The key feature defining races is the color of an individual's skin. Although skin color is influenced by melanin, hemoglobin in blood vessels, and dietary carotenoids, the predominant chromophore is melanin produced by melanocytes. The biologic differences observed in melanocytes and epidermal melanin have been well defined in black skin and white skin. Melanocytes are dendritic cells located in the basal layer of the epidermis (Fig. 2-3A,B). There are approximately 36 keratinocytes interfacing with 1 melanocyte, forming what is called an epidermal-melanin unit.[13] The distribution of these cells varies in different regions of the body (Fig. 2-4). Melanocytes are more numerous on the head and neck, scrotum, foreskin, and dorsal feet.

The content of melanin within keratinocytes determines skin color, with deeply pigmented skin having the highest content of epidermal melanin (Fig. 2-5). Melanin is a dense, relatively insoluble polymer of high molecular weight. It exists in two forms: eumelanin and pheomelanin. Eumelanin is a highly cross-linked dark brown to black pigment predominantly responsible for skin pigmentation. Pheomelanin is a yellow-red alkali soluble pigment derived from tyrosine, in which dopaquinone combines with glutathione or cysteine to form cysteinyl-dopa. Pheomelanin is predominantly found in auburn or red-haired fair skinned individuals.

Melanin is synthesized on melanosomes via the Raper-Mason pathway (Fig. 2-6).[14] The rate-limiting

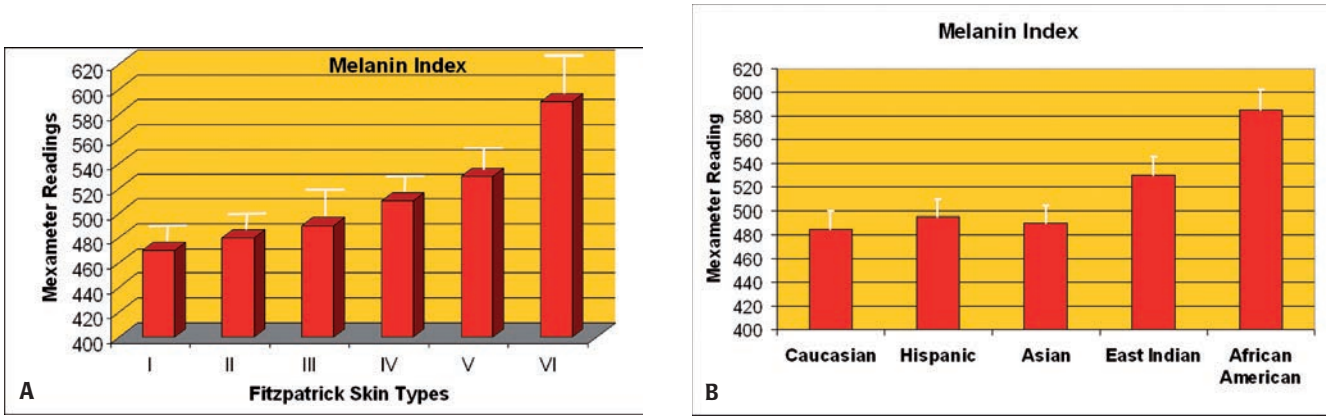

Figure 2-2 **A:** Reflectance spectrophotometry using the Mexameter MX16: correlation of melanin index with Fitzpatrick's skin types. There was a statistically significant correlation ($p = 0.01$) between intensity of pigmentation (melanin index readings) and Fitzpatrick's skin types. **B:** Reflectance spectrophotometery utilizing the Mexameter MX16: correlation of melanin index with race/ethnicity. There was a statistically significant correlation ($p<0.05$) between intensity of pigmentation (melanin index readings) and race.

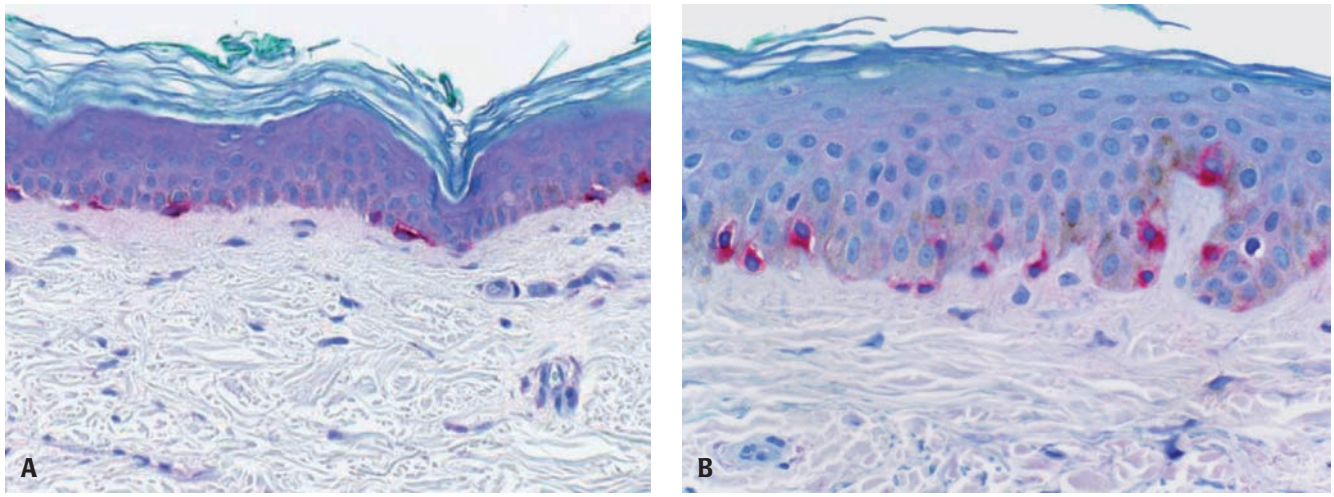

Figure 2-3 Immunohistochemical staining for melanocytes using an alkaline phosphatase detection kit and a 1:5 dilution of MEL-5 antibody after predigestion for 4 minutes with protease in **(A)** white skin and **(B)** black skin.

enzyme for this process is tyrosine. Although the precise mechanism of transfer of melanosomes to keratinocytes is unknown, suggested mechanisms include (a) fusion of melanocyte and keratinocyte plasma membranes, (b) melanosome secretion into the intercellular space followed by keratinocyte endocytosis, and (c) phagocytosis of melanocyte dendritic tips by keratinocytes.[15,16]

Melanosomes can occur as large, single membrane–bound mature melanosomes or as aggregates of smaller melanosomes. Although there are no quantitative differences

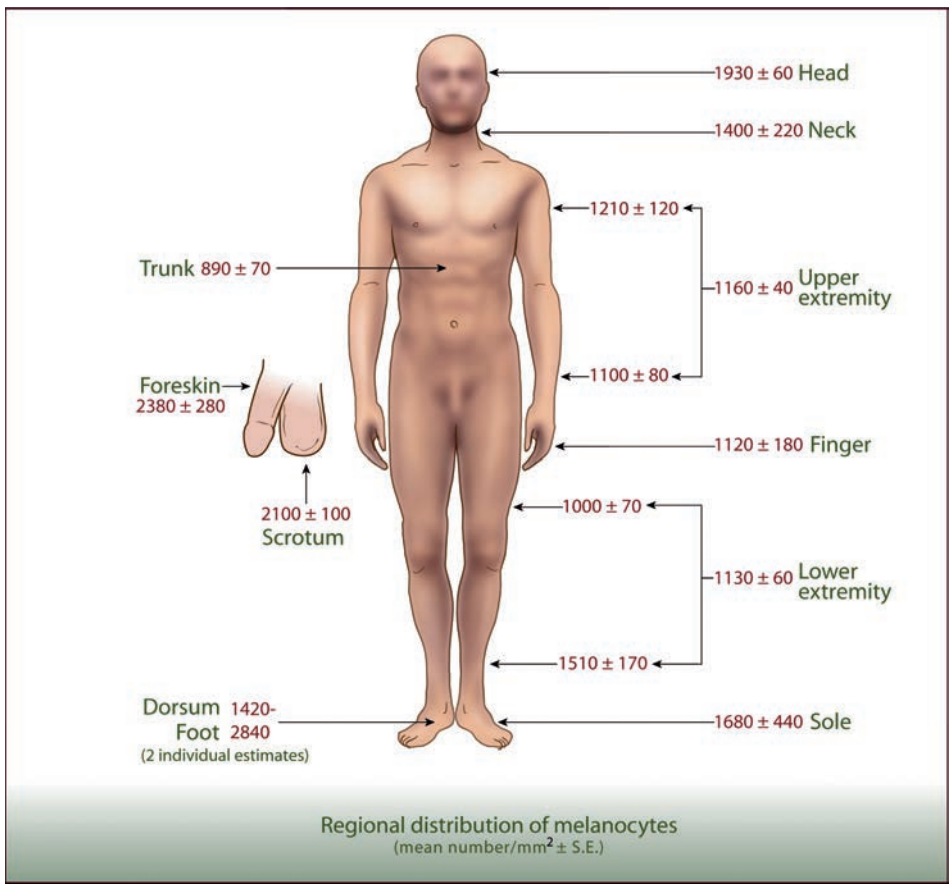

Figure 2-4 Anatomic distribution of melanocytes. (Modified from Fitzpatrick TB, Szabo G, Wick MM. Biochemistry and physiology of melanin pigment. In: Goldsmith LA, ed. *Biochemistry and Physiology of the Skin.* New York: Oxford Univ Press; 1983:112.

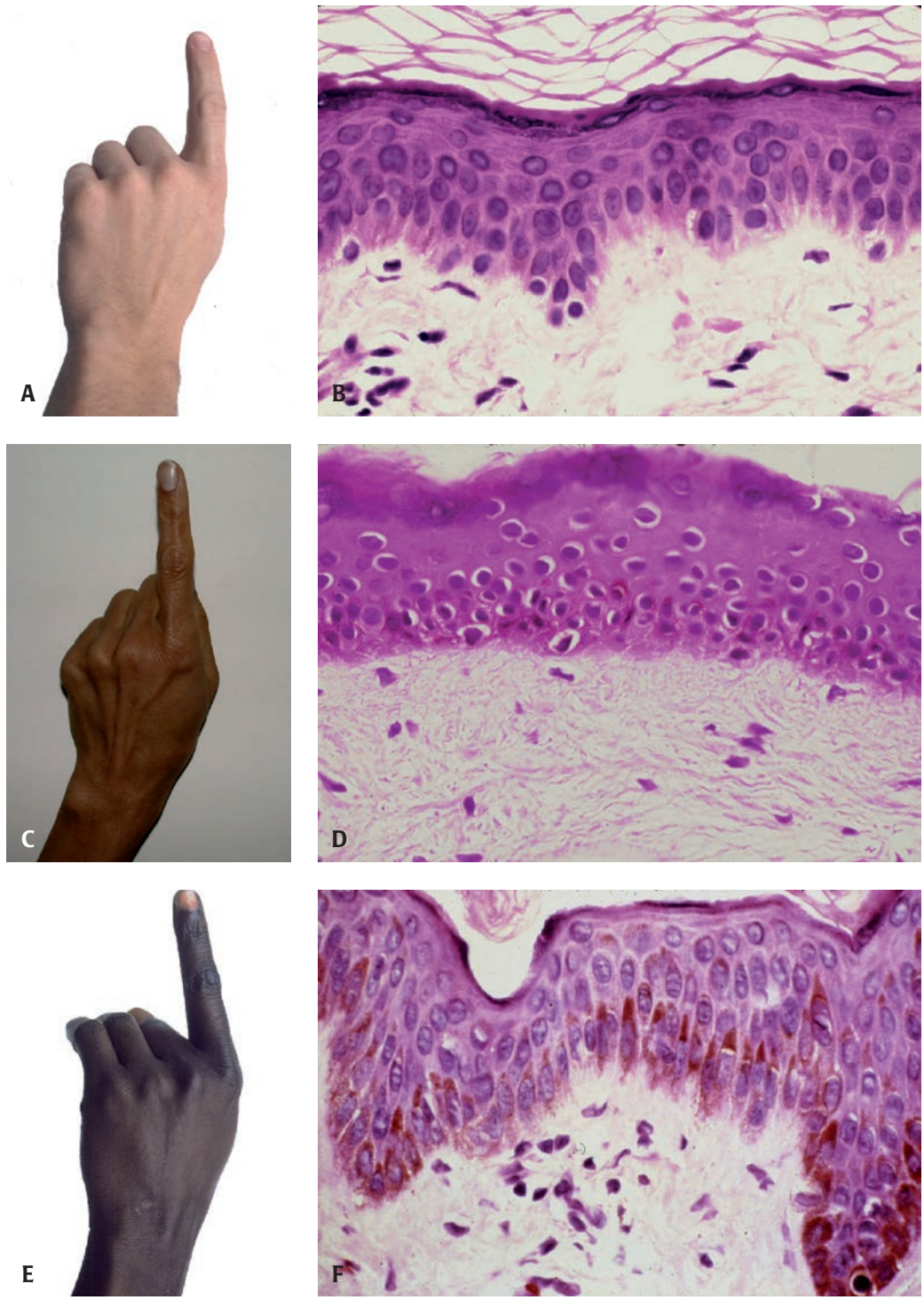

Figure 2-5 Photos and biopsies (40X magnification) taken from the hand of **(A)** and **(B)** Caucasians, **(C)** and **(D)** East Indians, and **(E)** and **(F)** African Americans. Note the progressive increase in melanin as skin pigmentation darkens. Courtesy of Jag Bhawan, MD.

in melanocytes amongst various racial/ethnic groups, the skin of blacks has an increased content of epidermal melanin and large singly dispersed melanosomes within melanocytes and keratinocytes.[17,18] Melanosomes have been identified in the entire epidermis, including the stratum granulosum, stratum lucidum, and stratum corneum. Pigmented skin in particular black skin has more stage IV melanosomes. In contrast, in very pale white skin, few melanosomes are seen in the basal keratinocytes and malpighian layer.[19] However, darker-skinned Caucasians, upon skin exposure to sun, have

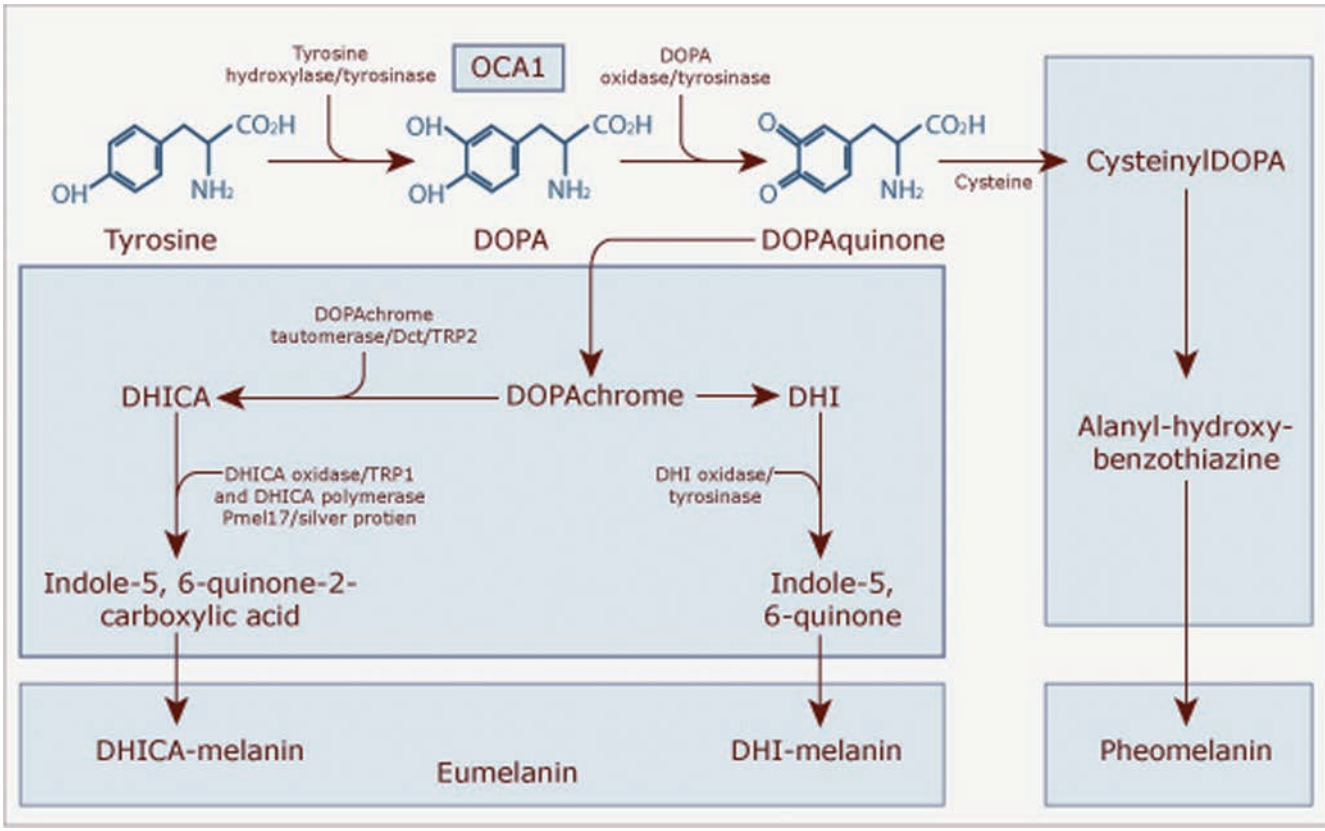

Figure 2-6 Melanin Biosynthetic Pathway.

larger nonaggregated melanosomes. Lighter-complexioned blacks have a combination of large nonaggregated and smaller aggregated melanosome.[19] In Asians, non–sun-exposed areas of skin have aggregated melanosomes, whereas sun-exposed areas have predominantly nonaggregated melanosomes.[20] Such observations support the concept of significant intraracial and interracial variations in pigmentation.

Recent work suggests that the expression and activation of protease-activated receptor-2 (PAR-2) correlates with skin color and may influence ethnic skin color phenotypes. PAR-2 receptors are expressed on keratinocytes. They have been shown to play a role in controlling melanosome ingestion and phagocytosis by keratinocytes.[21,22] In addition, PAR-2 may play a regulatory role in skin pigmentation.[23,24] Babiarz-Magee et al.[21] examined the expression of PAR-2 and its activator trypsin in human skin from individuals with different shades of pigmentation. These findings suggest PAR-2 and trypsin were expressed in higher levels in darker compared with lighter skin. In addition, darker skin showed an increase in PAR-2 specific protease cleavage ability. These findings suggested that PAR-2 expression and activity may play an important role in ethnic skin color phenotypes.

A study comparing the transmission of ultraviolet radiation (UVA and UVB) through skin samples of blacks and whites using both biologic and spectroscopic techniques found that, on average, five times as much ultraviolet light reached the upper dermis of white skin as compared with black skin.[25] Differences in transmission between the stratum corneum of blacks and of whites were far less striking. The main site of UV filtration in whites was the stratum corneum, whereas in blacks, it was the malpighian layers of the epidermis. The main UV protective factor for black epidermis was 13.14 compared with 3.4 for white skin.[25]

Rijken et al.[26] investigated the responses of black and white skin to solar-simulating radiation. In subjects with skin types I to III, 12,000 to 18,000 mJ per cm^2 of solar-simulating radiation (SSR) induced DNA damage in epidermal and dermal cells, an influx of neutrophils, active proteolytic enzymes, and diffuse keratinocyte activation. In addition, IL-10 positive neutrophils were found to infiltrate the epidermis. Except for DNA damage in the suprabasal epidermis, none of these changes was found in subjects with skin types IV to VI exposed to comparable doses of SSR. Increased skin pigmentation appeared to be the primary source of these observed differences. Hence, the increased epidermal melanin content of black skin serves as a major filter for blocking ultraviolet light transmission, further substantiating melanin's role in lowering the susceptibility to sunburn, photoaging, and skin cancer.[27,28]

In a study assessing the relationship between constitutive skin color and UV light sensitivity in Koreans, darker skin color conferred photoprotection in younger patients.[29] Similarly, an assessment of physiologic factors

affecting skin susceptibility to ultraviolet radiation in Japanese women showed that darker-skinned Japanese women had less severe reactions to sun exposure.[30]

The melanocytes of darker-skinned individuals show labile, exaggerated responses to cutaneous injury.[31] A major consequence of this phenomenon is the high frequency of dyschromias, in particular melasma and postinflammatory hyperpigmentation.

EPIDERMAL STRUCTURE AND FUNCTION

Stratum corneum

There are some differences described in the epidermis in lighter compared with darker racial ethnic groups. Differences include variations in stratum corneum thickness, water content, lipid production, and melanin (Table 2-1).

Corneocytes are key in determining cutaneous water loss and percutaneous absorption of topically applied products. Some differences have been reported in the stratum corneum of darker racial ethnic groups. Despite a scarcity of data, some of these differences are generally accepted. Weigand et al.[32] assessed cell layers and density of the stratum corneum in 25 white and 21 black subjects. The authors reported that the stratum corneum of black and white skin was of equal thickness. However, in blacks, it contains more cell layers and requires more cellophane tape strippings to remove the stratum corneum.

Corcuff et al.[33] assessed corneocyte surface area and spontaneous desquamation in blacks, whites, and Asians

Table 2-1

Comparison of epidermis of different racial groups

	White	Black	Asians*
Stratum corneum thickness	7.2 μm	6.5 μm	
Stratum corneum layers	17 layers	22 layers	
Stratum lucidum	1–2 layers; on exposure to sun becomes swollen and distinctly cellular	Remains compact and unaltered with sun exposure	
Water barrier	High	Low	
Melanosomes	Small. Grouped melanosomes in keratinocytes less dense, more numerous in stratum corneum than basal layer	Larger. Individually dispersed melanosomes in keratinocytes more numerous in basal layer	Mainly aggregated melanosomes; nonaggregated in sunlight-exposed areas
Stratum corneum lipids	Low	High	
Vitamin D production	High	Low	
Minimal Erythema Dosing	Low	High	
Photodamage	Significant changes in the epidermis	Marginal changes in the epidermis	Significant changes in the epidermis
Melanin	Has greater protective capability in the stratum corneum	Has less protective capability in the stratum corneum	
Mast cell morphology	Smaller granules. Less cathepsin G	Larger granules. More cathepsin G	

From Halder RM. *Dermatology and Dermatological Therapy of Pigmented Skins.* Boca Raton, FL: Publisher; 2006:5. With permission from CRC Press, Taylor & Francis Group.

*There is minimal published data on Asians.

of Chinese ancestry with 18 to 25 subjects in each group. They found no evidence of differences in corneocyte surface area among black, white, and Asian skin. However, black subjects were noted to have increased spontaneous desquamation compared with whites and Asians. They suggested this difference might be due to differences in the lipid composition of the intercellular cement. Other studies have also failed to show differences in stratum corneum thickness among darker skin types compared with Caucasians.[34]

Barrier function

The epidermal barrier provides an effective covering that prevents loss of body fluids while controlling absorption of infectious, toxic, or other externally applied substances. The results of studies assessing barrier function including transepidermal water loss (TEWL), conductance, sodium lauryl sulfate irritation, and pericutaneous absorption of chemicals have shown variable results among different racial-ethnic groups. Multiple investigations, including Berardesca and Maibach,[35] Wilson et al.,[36] Reed et al.,[37] Kompaore et al.,[38] Grimes et al.,[39] and others have assessed TEWL in darker-racial ethnic groups. Sample size, methodologies, and testing sites have varied.

An initial study by Berardesca and Maibach showed greater TEWL in blacks compared with whites after sodium lauryl sulfate (SLS) challenge to preoccluded, predelipidized skin of the back.[35] Subsequent studies by these investigators showed varying results.[40,41] When testing the upper back after SLS stress in seven Hispanic men and nine white men, TEWL was greater in Hispanic men but not statistically significant. A volar and dorsal forearm study in 15 blacks, 12 whites, and 12 Hispanics showed no difference between site or race at baseline. Grimes et al.[39] recently assessed TEWL from the inner forearm in 18 African American and 19 Caucasian women. No differences in TEWL were observed in baseline assessments. A subset of three African Americans and five Caucasians underwent testing after SLS challenge. No statistically significant differences were observed at 30 minutes, 24 hours, or 48 hours. In addition, Goh and Chia[42] reported no differences in TEWL at baseline and after irritation with SLS in Chinese, Malays, and Indians.

In contrast, other studies have shown increased TEWL at baseline and/or after irritation. Kampaore et al.[38] assessed TEWL after application of a vasodilator, methyl nicotinate, and after tape stripping. The study population included seven blacks, eight Caucasians, and six Asians. TEWL was greater in blacks and Asians compared with Caucasians. After tape stripping, Asians showed the most significant TEWL, followed by blacks.

Additional studies have reported a more resistant barrier in deeply pigmented skin with enhanced TEWL after tape stripping compared with lighter skin types.[43]

The differences in skin irritation were assessed in 22 Japanese and 22 German women.[44] Tests performed included forearm patch testing with SLS, measurement of TEWL, stratum corneum hydration, sebum secretion, laser Doppler flowmetry, melanin content, and erythema. No significant differences in barrier function of the stratum corneum were found between these two groups. However, stronger clinical sensory differences were evident among Japanese women.

In general, investigations assessing hydration and skin biomechanics showed variable results. Water content measured by capacitance after topical administration of the irritant sodium lauryl sulfate was compared in blacks and whites, and in Hispanics and whites.[34] There were no significant differences. Concrete variations were not observed using other methods, such as resistance, conductance, and impedance to quantify variations in hydration. However, after topical application of the vasodilator methyl nicotinate, black and Asian skin was reported to be more permeable to water than white skin measured using laser Doppler velocimetry (LDV). Studies assessing blood vessel reactivity in darker racial ethnic groups have been difficult to interpret given that different vasoactive substances were used. However, some differences in blood vessel reactivity have been noted.[45–47] Studies following well-defined protocols carried out on larger experimental and control groups are direly needed to further assess the definitive differences in water content, blood reactivity, and elastic recovery between racial groups.

Irritation

Marshall et al.[48] reported an increased frequency of irritation as assessed by erythema from 1% dichloroethyl sulfide in blacks compared with whites. A subsequent study by Weigand et al.[49] reported that after removal of the stratum corneum, there were no differences in irritation as assessed by the induction of erythema. Recent clinical studies report an increase in irritant reactions in darker racial ethnic groups when treated with retinoids.[50,51] However, an exhaustive review of this subject found little evidence supporting differences in the irritant response between Caucasians, blacks, and Asians.[52]

Differences in barrier function assume increasing importance when assessing irritant dermatitis, contact dermatitis, and tolerance to cosmetic formulations. Aggressive anti-aging regimens incorporating the use of retinoids, retinols, and alpha hydroxy acids can induce irritant dermatitis in some darker-skinned patients. Hence, gradual titration to more aggressive formulations is always prudent. Barrier integrity and differences in barrier function are also important considerations when performing chemical peels, microdermabrasion, cosmetic laser resurfacing, and hair removal procedures.

Lipid content

Several studies, albeit with small sample sizes, have measured stratum corneum lipids and ceramide levels in darker

racial ethnic groups. Reinertson and Wheatley in 1959 measured lipids and sterols in living and cadaver skin of black and white men. Lipid content and sterols were higher in black skin compared with white.[53] Since then, two other studies have assessed lipids. In contrast to the later studies, Sugino et al. reported 50% lower levels of ceramides in blacks compared with Hispanics and Caucasians.[54] However a study of stratum corneum lipid content in 41 subjects from the United Kingdom and 62 subjects from Thailand showed no differences in scalp lipid levels.[55]

Lipid levels may significantly influence and/or determine epidermal water content, an important variable in evaluating or considering the response to topical cosmeceutical and pharmaceutical agents.

DERMAL STRUCTURE

Fibroblasts, mast cells, and blood vessels

Very few studies have assessed basic dermal differences in darker racial ethnic groups. Dermal changes associated with chronologic aging and photoaging are discussed in Chapter 3. Black skin has a thick and compact dermis in which the distinction between the papillary and reticular layers is less clear compared with Caucasian skin. The dermis of blacks contains many fiber fragments composed of collagen fibrils and glycoproteins.[56] In addition, there is close stacking of the collagen fiber bundles, which run parallel to the surface of the epidermis. In general, the dermis of blacks shows minimal evidence of photodamage. Table 2-2 compares differences in the dermis of black and white skin.

Table 2-2

Comparison of dermal structure between black and white skin

	White	Black
Dermis	Thinner and less compact	Thick and compact
Papillary and reticular layer	More distinct	Less distinct
Collagen fiber bundles	Bigger	Smaller. Close stacking and surrounded by ground substance
Fiber fragments	Sparse	Prominent and numerous
Melanophages (macrophages that phagocytize). Melanosomes that spill into the dermis	Many	Numerous and larger
Lymphatic vessels	Moderate, dilated	Many dilated, empty lymph channels, usually surrounded by masses of elastic fibers
Fibroblasts	Not as numerous. Some binucleated cells	Numerous and large. Many binucleated and multinucleated cells
Elastic fibers	More. In photodamage, only fibers in papillary and reticular dermis stain pink; the others stain lilac or deep blue	Less. All dermal elastic fibers stain pink, as found in sun-protected skin. Elastosis is uncommon
Superficial blood vessels	Sparse to moderate	More numerous, mostly dilated
Glycoprotein molecules	Variable	Numerous in the dermis

From Halder RM. *Dermatology and Dermatological Therapy of Pigmented Skins.* Boca Raton, FL: Publisher; 2006:8. With permission from CRC Press, Taylor & Francis Group.

Fibroblasts are large and numerous on black skin, suggesting active biosynthesis, degradation, and turnover. These cells have been shown to be hypertrophic and contain extensive rough endoplasmic reticulum, Golgi bodies, and vesicles. In blacks, this heightened activity could affect keloid and hypertrophic scar formation, common conditions in individuals of African ancestry. Keloids are also more common in Asians, particularly Chinese people, compared with Caucasians.[56]

Montagna and Carlisle[57] reported an equal number of mast cells in black and white skin and found no differences in the staining properties of mast cell granules. In contrast, Sueki et al.[58] performed biopsies on four black and four white subjects and found that mast cells in black skin contained larger granules. Fusion of granules seemed to account for the larger sizes. Proteases, tryptase, and cathepsin G also differed in mast cells of black and white skin. Mast cell mediators include histamine, fibroblast growth factor, and tryptase. Mast cells also have been implicated in the pathogenesis of keloids and hypertrophic scars.[59,60]

Superficial subepidermal blood vessels are reported to be more numerous in black skin.[61] Compared with white dermis, the dermis of blacks has been reported to have many dilated, empty lymph channels. The significance of these dilated lymph channels is unknown.

Skin thickness/facial tissue thickness

There are few comparative studies assessing skin or tissue thickness in lighter versus darker racial ethnic groups.[62–65] No statistically significant differences in skin thickness were observed in non–sun-exposed forearm skin of white and black women.[65] Facial measurements were not taken.

Measurements of facial soft-tissue thickness have been conducted in men and women in American blacks and whites,[62] Japanese,[63] and a mixed South African racial population.[64] Notable differences exist between men and women, with men having increased thickness of facial tissue. Comparison between the results of facial soft-tissue measurements in American blacks, whites, Japanese, and a mixed South African population show that facial tissues of blacks are thicker in the upper and lower face. Measurements in the aforementioned groups of black, white, and Japanese were conducted on cadaver specimens, whereas measurements in the mixed racial population were taken with computerized tomography. Given the popularity of resurfacing procedures, botulinum toxin injections, and injectable filler substances, these data may be of use to the cosmetic surgeon in defining the choice of resurfacing procedure, depth of treatment, and appropriate dosing of denervating agents.

Appendages

Few definitive differences in eccrine and apocrine glands have been reported among darker racial ethnic groups compared with lighter skin types. However, Montagna and Carlisle[57] reported that apocrine glands are more often found in the facial skin of black women compared with Caucasians.

Results of investigations of sebaceous glands and sebaceous gland activity have shown some differences. Several studies have reported larger sebaceous glands in blacks compared with whites,[66,67] Kligman and Shelly[68] reported an increase in sebum production in blacks, and others have reported no differences among different racial/ethnic groups. Grimes et al.[39] assessed sebum production on the forehead of 18 African American women and 19 white women using a sebumeter. No statistically significant differences in sebum production were found. Sebum production was also measured via a sebumeter and sebutape in 20 blacks, 20 Asians, and 20 whites.[69] No significant differences in sebum production were observed. Sebum production and oily skin are key issues of consideration when selecting the appropriate cosmeceutical and pharmaceutical products. Patients with oily skin necessitate special products to combat oil production. In addition, increased sebum production may be a consideration when selecting appropriate resurfacing procedures for darker skin types.

Hair follicles

The hair features of individuals of African ancestry are indeed different as compared with other racial-ethnic groups. Unprocessed virgin hair is characteristically fragile, tightly curled, dry, and brittle. In contrast to other races, the follicles are flat and elliptical. The hair also has a longer axis. Lindelof et al.[70] assessed the structure of the hair shaft in blacks and reported that the black hair follicle has a helical form. In contrast, the Asian follicle is straight, and the Caucasian follicle is a variation of the two. Compared with other groups, the hair of blacks has the smallest mean cross-sectional area. The cross-sectional area is largest in Asians and smallest in Caucasians; however, hair characteristics are becoming increasingly varied because of miscegenation and genetic diversity. An ultrastructural study of hair differences in blacks and whites found fewer elastic fibers anchoring the hair follicles in the dermis in blacks. In addition, the total hair density and total number of terminal hair follicles appears to be significantly lower in African Americans compared with Caucasians.[71] Because of these inherent structural features, the hair is predisposed to breakage. Special grooming procedures are often necessary to straighten the hair. Pressing the hair and chemical relaxing further aggravate hair fragility (see Chapter 30). In addition, the curved follicle predisposes black men and women to pseudofolliculitis barbae.[72] Hair follicle morphology assumes increasing importance in laser hair removal as well as hair transplantation surgery.

CONCLUSION

Statistical projections suggest continued major growth of darker racial populations globally.[5] The unique structural

and physiologic differences of the skin of darker racial ethnic groups are paramount considerations in selecting appropriate aesthetic and cosmetic surgical procedures. Cosmetic surgeons must be cognizant of these differences to provide optimal patient care, patient satisfaction, and enhanced quality of life.

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3

The Aging Face in Darker Racial Ethnic Groups

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The aging face is an amalgam of many elements of time. It is a canvas of photodamage (extrinsic aging) and the imitable changes of time (intrinsic aging), including volumetric loss (fat atrophy) and gravitational soft-tissue movement. It is characterized by the appearance of coarse and fine wrinkles, skin laxity, jowls, mottled pigmentary changes, textural changes, redundancies, and loose skin. The aforementioned signs are unique to each individual, so that in aging, each person presents a greatly variable number of skin and soft-tissue alterations determined by genetic factors and environmental influences, such as sun exposure, smoking, and lifestyle.

Common signs of aging in fair-skinned patients result from photodamage as evidenced by wrinkles, skin laxity, dyschromia, and textural alterations; these tend to appear as early as the second and third decade of life. Darker racial ethnic groups have a higher content of epidermal melanin (see Chapter 2). In addition, fibroblasts are large and active, often giving rise to a thicker dermis. The photoprotective effects of melanin in darker racial ethnic groups retard many of the early telltale signs of aging, such as crow's feet and periorbital wrinkles. Hence, photoaging changes are often minimized in deeply pigmented skin. Instead, soft tissue and gravitational changes may dominate cutaneous aging in darker skin types.

This chapter will review photodamage, intrinsic aging, and soft-tissue gravitational aspects of the intrinsic aging process in darker racial ethnic groups.

PHOTODAMAGE

Photodamage results from the long-term deleterious effects of sun exposure. Clinically, photodamaged skin is characterized by coarse and fine wrinkling, mottled pigmentary changes, sallowness, textural roughness, and telangiectasias (Table 3-1). Histopathological features of photodamaged skin include significant epidermal and dermal alterations.[1] The epidermal thickness may be increased or decreased, corresponding to areas of hyperplasia or atrophy. There is loss of polarity of epidermal cells and keratinocyte atypia. Dermal features include elastosis, degeneration of collagen, and anchoring fibrils. Blood vessels become dilated and twisted. Ultraviolet light exposure activates matrix-degrading metalloproteinase enzymes, including collagenase. Cytokines are released from keratinocytes. The cumulative effect is chronic dermal inflammation.[2–4]

Photoaging affects all races and skin types. Signs of photoaging may begin at an early age, as evidenced by freckles following ultraviolet light exposure. However, the clinical manifestations of photodamage may differ in lighter compared with darker skin types. In individuals with Fitzpatrick's skin types I to III, or lighter-complexioned races, the clinical signs of photoaging—including wrinkles, laxity, dyschromia, and sallowness—may also be accompanied by an increased occurrence of premalignant and malignant skin lesions, including actinic keratoses, basal cell carcinoma, squamous cell carcinoma, and melanoma.

Glogau classified the severity of photodamage based on the extent of epidermal and dermal degenerative changes. Severity of photodamage is categorized from I through IV, ranging from mild to moderate to advanced or severely photodamaged skin (Table 3-2). The Glogau classification often facilitates the selection of appropriate treatment options in the aging Caucasian face.[5] For instance, patients with mild photodamage often respond to topical anti-aging regimens and superficial resurfacing procedures, whereas patients who have moderate to severe photodamage require more aggressive resurfacing procedures or rhytidectomies.

In deeply pigmented skin, photodamage may be characterized by mottled facial pigmentation, texturally rough skin, and fine wrinkles. In contrast to Glogau's scale, advanced and severe photodamage are uncommon in deeply pigmented skin, in particular in African Americans (Fig. 3-2A–D). In a study by Grimes,[6] 100 women of color were surveyed regarding their concern about wrinkles, and the resulting data were compared with results from an age-matched population of 143 white women. Mean age of the white comparison group was 43 years. Sixty-five percent of the women of color—compared with only 20% of the white women—reported that their skin was not wrinkled. Only 2% of the women of color—compared with

Table 3-1

Clinical and histological features of intrinsic and extrinsic aging

Feature	Intrinsic aging (chronological)	Extrinsic aging (photoaging)
Clinical	Smooth, atrophic	Fine and coarse wrinkles
	Finely wrinkled Laxity, unblemished	Sallowness, laxity, mottled pigmentation, textural roughness, telangiectasias
Epidermis	Stratum corneum normal thickness (basket weave pattern), epidermis thinned, atrophic, flattened rete ridges	Basket weave or compact stratum corneum, acanthosis and/or atrophy, keratinocyte atypia, flattened rete ridges
Dermis	Absent Grenz zone, loss of elastic fibers, elastogenesis, decreased thickness, microvasculature normal, no evidence of inflammation	Grenz zone prominent, elastogenesis, elastosis, collagen degeneration, loss of anchoring fibrils
		Microvasculature abnormal:
		Blood vessels dilated, twisted;
		Later stages: Sparse, perivenular lymphohistiocytic infiltrates

Modified from Gilchrest BA. A review of skin aging and its medical therapy. *Br J Dermatol* 1996;135:867–875; and Lavker RM. Cutaneous aging: chronologic versus photoaging. In: Gilchrest BA, ed. *Photodamage*. Cambridge, MA: Blackwell Science;1995:123–135 (34).

20% of the white women—considered their skin moderately wrinkled. These results show a marked difference in perceived photoaging between women of color and white women. Montagna and Carlisle[7] compared the morphology of facial skin of 19 black and 19 white women between the ages of 22 and 50 who had lived in Tucson, Arizona, for 2 or more years. Four-mm punch biopsies were taken from the malar eminence of each subject and processed for light and electron microscopy. These investigators reported that the stratum lucidum of black skin was not altered by ultraviolet light exposure. Black skin rarely showed areas of epidermal atrophy, and there was minimal evidence of elastosis. Overall, compared with white skin, black skin showed minimal evidence of photodamage. Two-mm punch biopsies of six women ages 45 to 50 with skin types V to VI from the Vitiligo and Pigmentation Institute corroborated Montagna's findings.[8] Biopsies were taken from the lateral periorbital region of each subject. There was no evidence of elastosis or epidermal atrophy. These women did, however, manifest mottled facial pigmentation and texturally rough skin, and in some instances, enlarged pores, which had worsened over time (Fig. 3-3A,B).

In contrast to the Montagna and Carlisle study, Whitmore and Sago[9] measured the thickness of the epidermis and dermis on the non–sun-exposed forearm in 86 white women and 40 black women. They reported no statistically significant difference in skin thickness. Controlling for confounding variables—such as age, menopause, oral contraceptive use, hormone replacement therapy, cigarette smoking, and exercise—there was no relationship between race and skin thickness of black (1.39 ± 0.02 mm) and white (1.41 ± 0.01 mm) women. These findings suggest that the sun-exposed skin of whites is far more susceptible to the deleterious effects of ultraviolet light than is black skin.

The clinical features of photoaging in Asian skin differ from Caucasian skin. Asians tend to develop mottled pigmentation, solar lentigo, and seborrheic keratoses. In addition, Asians develop thicker, deeper wrinkles on the forehead, periorbital, and crow's feet area compared with finer wrinkles in the aforementioned areas in Caucasians.[10] Mild solar elastosis has been observed at 20 years of age in sun-exposed facial skin of Korean patients. Severe accumulation of elastotic material was evident in the dermis of Koreans older than 40 years of age. However, in sun-protected skin, solar elastosis was not present.[11]

Goh assessed photoaging in 1,500 Asians of skin types III and IV.[12] The study included subjects of Indonesian,

Table 3-2
Glogau classification of the aging face

Group	Clinical features
I (Mild)	Age: 20s–30s
	Early photoaging
	Mild dyschromia
	No keratoses
	Minimal wrinkling
	Minimal/no makeup
	Minimal/no scarring
II (Moderate)	Age: Late 30s–40s
	Early senile lentigines
	Dyschromia
	Early actinic keratoses
	Parallel smile lines
	Early wrinkling
	Some foundation worn
	Mild acne scarring
III (Advanced)	Age: Usually 50–65
	Dyschromia, telangiectasias
	Visible keratoses
	Wrinkling at rest
	Always wears makeup
	Moderate acne scarring
IV (Severe)	Age: 60–75
	Actinic keratoses
	Prior skin cancers
	Wrinkling throughout
	Makeup cakes and cracks
	Severe acne scarring

Modified from Glogau RG. Chemical peeling and aging skin. *J Geriatr Dermatol* 1994;2:30–35.

Malaysian, and Chinese ancestry. Clinical manifestations of photodamage in this study included hypopigmentation, coarse and fine wrinkles, and tactile roughness.

In a study of photodamage in 407 Koreans, standardized facial photographs were taken and evaluated by independent investigators to assess the severity of wrinkles and dyspigmentation.[13] Wrinkling and pigmentation changes were a major feature of photoaging in Koreans. Women tended to have more severe wrinkles; seborrheic keratoses were the major pigmentary lesions in men, whereas hyperpigmented macules were prominent features in women. The number of hyperpigmented lesions and seborrheic keratoses increased with each decade of age. Cigarette smoking was an independent risk factor for wrinkles, but not for dyspigmentation, and caused additive detrimental effects to wrinkles induced by aging and sun exposure.

Toyoda and Morohashi[14] assessed morphological alterations of epidermal melanocytes in photoaging in 15 Japanese women between the ages of 58 and 81. The investigators compared skin taken from the exposed crow's feet area with the sun protected postauricular regions. Compared with sun-protected skin, the sun-exposed sites showed a statistically significant increase in melanocyte number, marked nuclear heterogeneity, and signs of cell activation. In addition, melanocytes were in close opposition to photodamaged, degenerated keratinocytes. Melanocytes in the sun-exposed areas also contained large intracytoplasmic vacuolar structures.

Photodamage was assessed in 61 Thai patients. Eighty percent of the Thai subjects were women. Biopsies were taken from the cheek. The majority of subjects were classified as Fitzpatrick skin type IV. All subjects were older than 60 years. Baseline biopsies of these subjects revealed significant evidence of photodamage, including atrophy of the epidermis, atypical epidermal cells, hyperpigmentation, elastosis, and collagen degeneration.[15] Many of these patients had a long-term history of intense sun exposure without photo protection.

There is a dearth of information regarding photoaging in Hispanics. Sanchez[16] reported photoaging as the third most common dermatologic concern in 1,000 Hispanics, accounting for 16.8% of visits in a private practice. Given the diverse background of Hispanic populations, fair-skinned Hispanics may have substantial photodamage similar to Caucasians, whereas deeply pigmented Hispanics may have minimal photodamage, as evidenced in African Americans and darker-skinned Asians.

In light of the above findings, there is a spectrum of photodamage in individuals with skin types IV through VI. Clinical manifestations of photodamage in deeply pigmented skin includes mild wrinkling, dyschromias, textural alterations, seborrheic keratoses, and even dermatosis papulosa nigra. Histologic changes may be minimal, as evidenced by biopsies in African Americans; however, more significant photodamage is reported in Asian skin.[6] The biological basis for these observations correlates with many of the well-documented morphological and physiological skin differences in dark as opposed to white skin.[17]

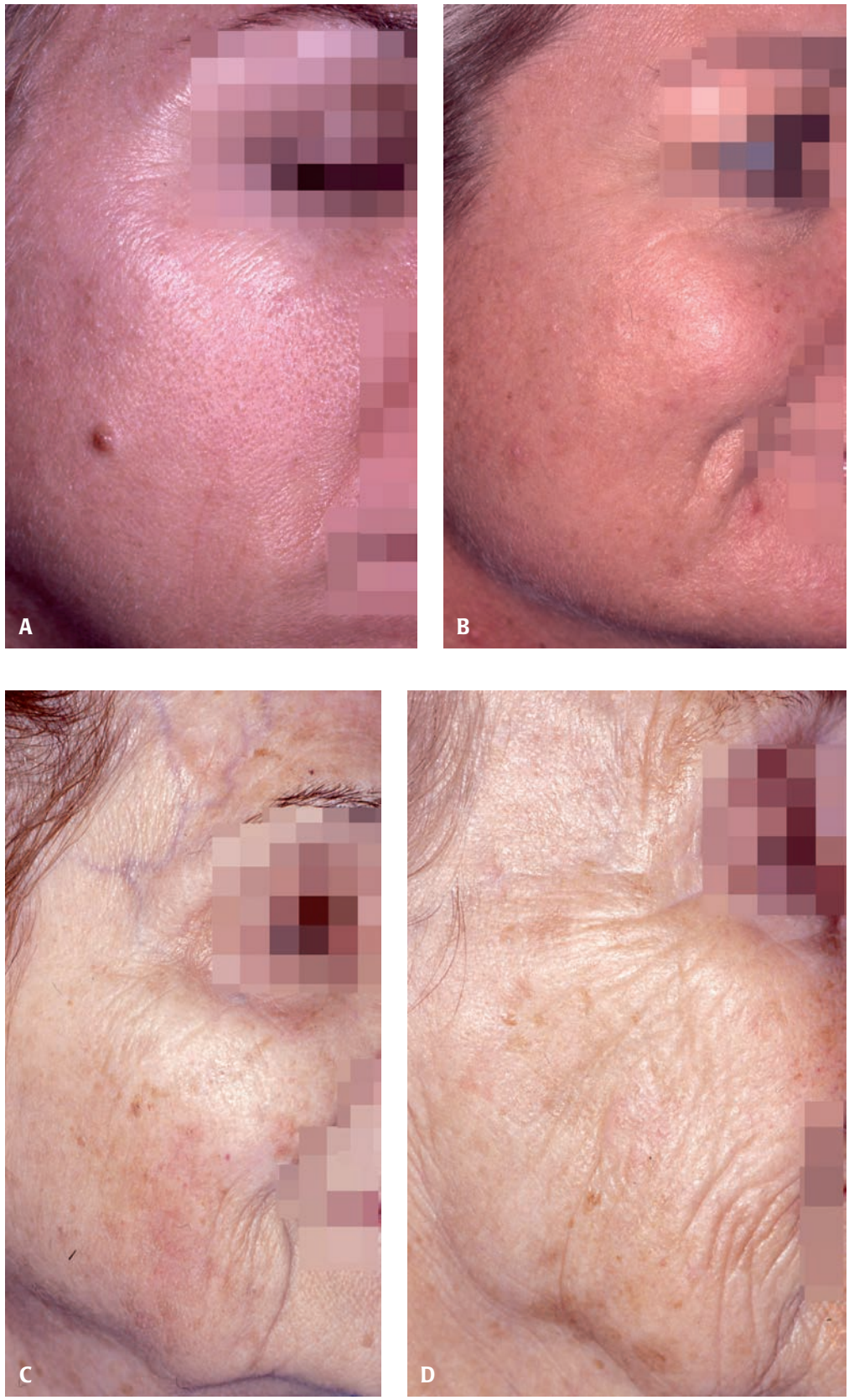


Figure 3-1A–D Glogau classification of the aging face: **(A)** I (mild); **(B)** II (moderate); **(C)** III (advanced); **(D)** IV (severe).

Figure 3-2 **A** and **B:** A 52-year-old African American woman shows no clinical evidence of photodamage. **C** and **D:** The 82-year-old mother of the patient shown in A and B shows hyperpigmentation, fine wrinkles, laxity, textural changes, and intrinsic aging.

INTRINSIC AGING

All humans experience intrinsic aging. Typically, it is characterized by smooth, relatively atrophic, finely wrinkled or lax skin. Histologically, the stratum corneum is normal. However, the epidermis is atrophic and there is flattening of the dermoepidermal function. Dermal features include decreased thickness, loss of elastic fibers, and a decrease in the biosynthetic capacity of fibroblasts (Table 3-1).

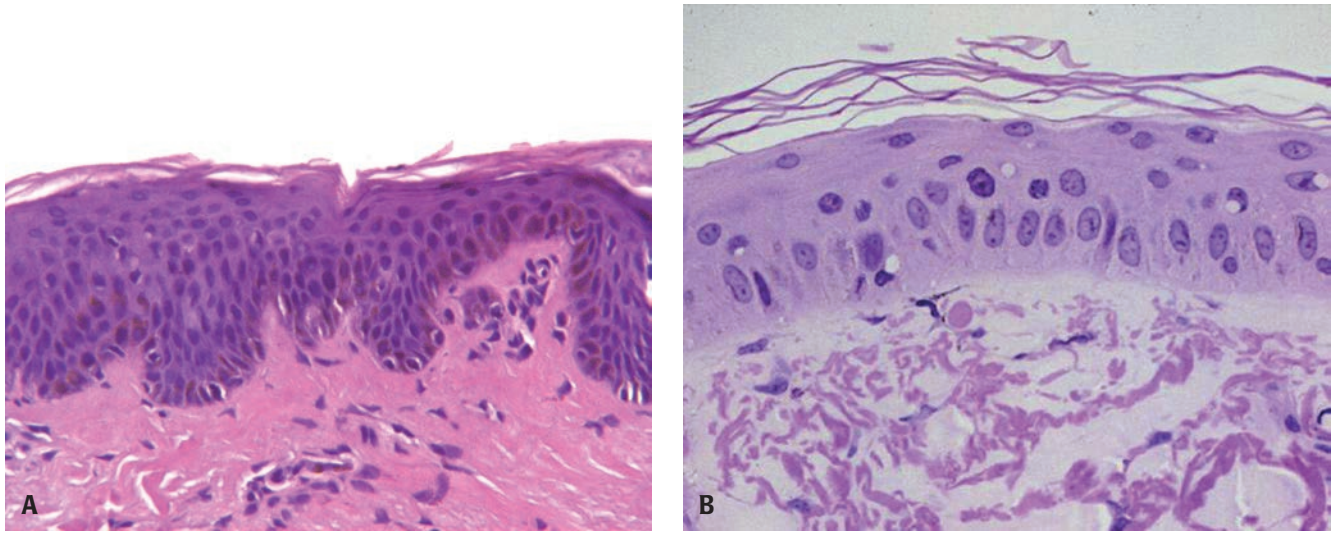


Figure 3-3 Hemotoxylin and eosin stain sections from **(A)** a 50-year-old African American and **(B)** a 50-year-old Caucasian. *Note:* There is minimal histologic evidence of photodamage in the 50-year-old African American. There is severe collagen degeneration in the 50-year-old Caucasian.

There is a scarcity of data regarding the histologic features of chronologic aging in darker racial ethnic groups. Herzberg and Dinehart[18] examined the features of sun-protected skin from six African Americans 6 weeks to 75 years of age with light and electron microscopy.

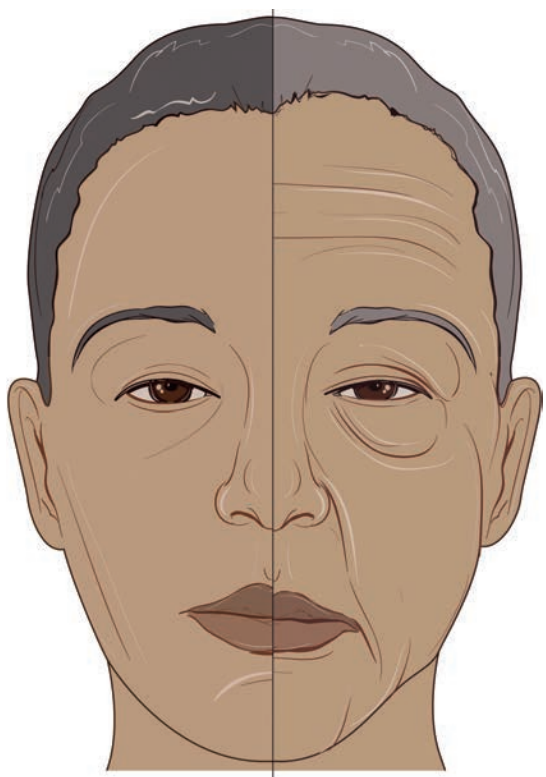


Figure 3-4 Illustration showing intrinsic aging of the upper, mid-, and lower face, including brow furrows, eyelid ptosis and laxity, nasolabial lines, and jowl formation.

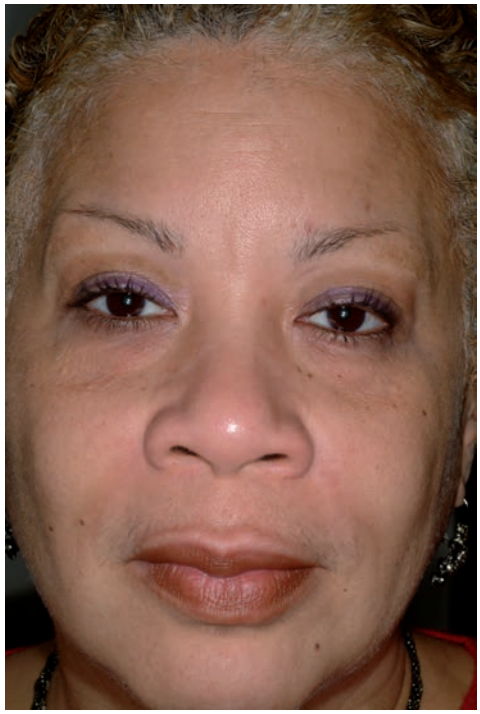
With aging, the dermoepidermal junction was flattened with multiple zones of basal lamina and anchoring fibril reduplication. Microfibrils in the papillary dermis became irregularly oriented. Compact elastic fibers showed cystic changes and separation of skeleton fibers with age. The area occupied by the superficial vascular plexus in specimens of equal epidermal surface length decreased from the infant to young adult (21–29 years old) to adult (39–52 years old) age groups, then increased in the aged adult (73–75 years old) age groups. With the exception of the vascularity in the aged adult group, the above features were similar to those seen in aging white skin. In addition, there was a decrease in the number of melanocytes with age. Basal keratinocyte melanin granule density increased with age to age 52 and remained dense in the aged adult group, whereas the number of melanocytes decreased. The findings suggest that there are no differences in chronologic aging in black and white skin.

The skin is also a target for various hormones, and sex steroids have a profound influence on the aging process. A decrease in sex steroids thus induces a reduction of those skin functions that are under hormonal control. Sex steroids manifest their effects by two different mechanisms: Genomic and nongenomic effects. Estrogen alone or together with progesterone prevents or reverses skin atrophy, dryness, and wrinkles associated with chronological or photoaging.[19] Estrogen and progesterone stimulate proliferation of keratinocytes, whereas estrogen suppresses apoptosis and thus prevents epidermal atrophy. Estrogen also enhances collagen synthesis, and estrogen and progesterone suppress collagenolysis by reducing matrix metalloproteinase activity in fibroblasts, thereby maintaining skin thickness. Estrogen maintains skin moisture by increasing acid mucopolysaccharide or hyaluronic acid levels in the dermis, whereas progesterone increases sebum secretion.[20]

Table 3-3

The aging African American face

The aging African American face



Malar flattening

Prominent nasolabial folds

Nasal lengthening

Recessive chin

Submental skin laxity

Temporal hair loss

Brow ptosis

Furrows: Frontal, glabella

Eyelid:
Upper moderate laxity
Lower minimal laxity
Scleral show

Prominent jowls

Few rhytides

Marionette lines

Modified from Matory WE. Aging in people of color. In: Matory WE, ed. *Ethnic Considerations in Facial Aesthetic Surgery.* Philadelphia: Lippincott-Raven;1998:151–170 (153).

Studies of postmenopausal women reveal that the effects of estrogen deficiency on the skin include wrinkling, dryness, atrophy, laxity, hot flashes, and vulvar atrophy. Subjects using hormone replacement therapy (HRT) demonstrated an improvement in skin moisture, thickness, wound healing, and collagen content.[20–27] However, there is still much debate on the merits of HRT for aging skin. Although a large number of publications have documented the effects of sex hormones on the aging process, it is obvious that HRT should not be administered as an independent treatment for aging skin.

There are few studies available on the influence of testosterone in the male sex. This hormone shows an age-dependent decrease in androgenous tissues like the pubic region, but it remains normal in the regions such as the scrotal and thigh skin.[28] However, there are no studies showing differences in hormonal action between distinct races. Other signs of cutaneous aging are classified as secondary, including reduced sebum production, the number and function of apocrine glands, and slowed hair growth. These signs may represent a reduction in the concentration of androgens in the tissues that occurs with aging.[18,29] These data suggest that sex steroid hormones also influence the aging process.

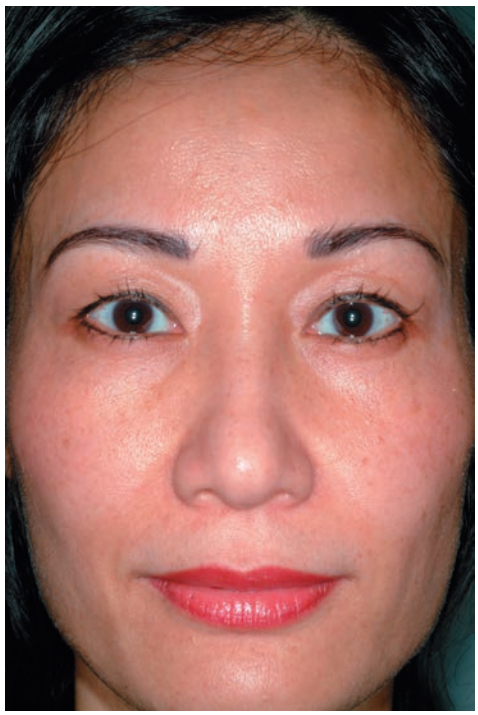
Tissue alterations related to intrinsic aging

Facial aging also occurs as a result of loss of hard and soft tissues, including bone remodeling, fat atrophy, and the gravitational redistribution of the skin and subcutaneous tissue. Dark-skinned individuals have a tendency to age prematurely in some areas and late in others because of adipose-tissue atrophy, bone remodeling, and gravitational redistribution of soft tissue.[30] Patients with darker skin, particularly African Americans, tend to manifest signs of aging in the deeper muscular layers of the face, with sagging of the malar fat pads toward the nasolabial folds (Fig. 3-4).

Regarding the upper third of the face, one of the first signs of facial aging in deeply pigmented skin occurs in the periorbital area. Ptosis of the upper eyelid tends to appear around the fourth decade, whereas in fair-skinned individuals, it becomes evident from the third decade.[31] In Hispanics, brows tend to be implanted at a lower level with respect to the supraorbital rim. Nasolabial folds are

Table 3-4

The aging Asian face



The aging Asian face
Weaker facial skeletal support
Gravitational descent of soft tissues
Malar fat pad ptosis
Tear trough deformity
Descent of thick juxtabrow tissues of the lower orbit
Prominent nasolabial folds
Accretion of submental adipose tissue
Platysmal descent/dehiscence
Few rhytides

Modified from Shirakabe Y, Suzuki Y, Lam SM. A new paradigm for the aging Asian face. *Aesthetic Plast Surg* 2003;27(5):397–402.

common. In addition, there is sagging of the cheeks. However, there are individual variations, such as individuals with hollowed eyes who tend to present drooping upper eyelids later. Some darker-skinned patients have excess skin in the upper eyelids and dark circles. Lower eye bulging and wrinkles are often problems in darker-skinned patients older than 50 years (Tables 3-3, 3-4, and 3-5; Fig. 3-5A-C). As aging progresses, ptosis in black patients is commonly accompanied by the rounding of the outer corner of the eye, with exposure of the sclera.[30] In general, wrinkles in darker ethnic patients are the result of muscular or expression wrinkles, mainly on the upper third of the face, as well as "sleep wrinkles."

In the middle and lower face, the classic signs of aging include tear trough deformity, infraorbital hollowing, ptosis of the subcutaneous adipose tissue in the malar region; increasing nasojugal groove prominence and deepening of the nasolabial fold.[30] Bimaxillary protrusion in the presence of infraorbital hypoplasia is a common feature in individuals of Hispanic, Asian, and African ancestry.[32,33] Given the thicker dermis and subcutaneous tissues of some darker racial ethnic groups, combined with infraorbital hypoplasia, midface aging can occur at an earlier age and can be pronounced.

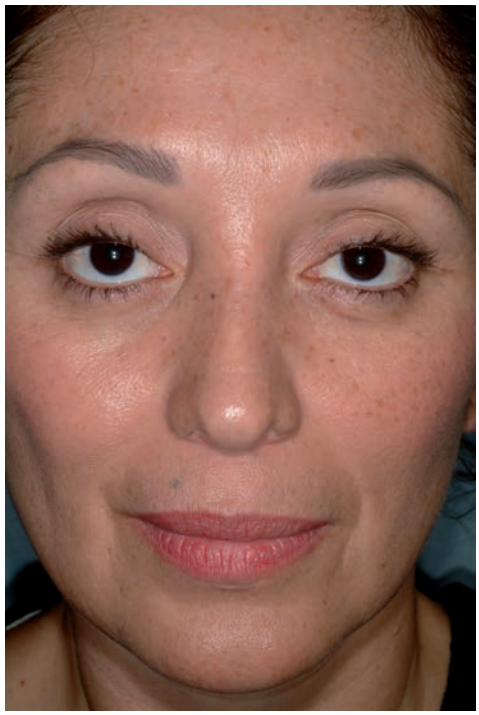
In the lower face, darker racial ethnic groups experience jowl formation and pronounced melomental lines. Lower face alterations also occur later in dark-skinned patients and are less pronounced than in the white races, with exception of the accumulation of fat in the mentum region. The mentum is an area in which darker-skinned patients present significant facial aging, where an accumulation of fat may occur in the submandibular region as a result of a lower projection of the chin, leading to a slight rounding of the jaw line in African Americans.[34] With age, the lips in general become thinner and flattened. The philtrum, often considered the key element of attractive lips, also diminishes with age. However, the characteristic voluminous lips of blacks prevent the appearance of perioral wrinkles. The loss of lip volume that occurs with aging is not usually a complaint among blacks, and there is little demand for fillers for lip augmentation.

HAIR SENESCENCE

Structural and morphologic differences in hair amongst different racial ethnic groups are described in Chapter 2.

Table 3-5

The aging Hispanic face



The aging Hispanic face
Minimal facial elastosis
Infraorbital shadowing
Jowl formation
Platysma banding
Few rhytids
Prominent nasolabial folds
Submental fullness
Marionette lines

Modified from Matory WE. The Hispanic patient. In: Matory WE, ed. *Ethnic Considerations in Facial Aesthetic Surgery.* Philadelphia: Lippincott-Raven;1998:303–306.

Whitening of the hair is the most obvious sign of human aging, though its mechanism is, as yet, little understood.[35] Recent studies suggest that the whitening is caused by a defect in the maintenance of the melanocytic stem cells and that this process is dramatically accelerated by deficiency of the Bc12 gene, which causes selective apoptosis in melanocytic stem cells.[35,36] However, there are no studies on the differences in the whitening process between individuals of different skin color.

CONCLUSION

Current concepts regarding facial aging include an interactive relationship between photodamage and intrinsic aging factors, including adipose tissue atrophy, gravitational redistribution of soft tissue, and bone remodeling. However, many facial aging-related alterations are linked to the acquired characteristics and habits of the individual. In darker-skinned patients, the higher content of epidermal melanin and a thicker dermis reduce the appearance of photodamage alterations, including coarse and fine wrinkles, sallowness, and telangiectasias. However, other age-related changes occur because of chronologic aging, including volumetric loss of fat and gravitational soft-tissue redistribution.

Cosmetic surgery in darker racial ethnic groups continues to grow at a rapid pace. Facial rejuvenation procedures for all skin types have become increasingly popular. As clinicians and cosmetic surgeons, we have much to learn regarding the aging face of darker racial ethnic groups. An expanded knowledge base of the characteristics and alterations of cutaneous aging in such patients will allow us to enhance and grow our armamentarium of appropriate facial rejuvenating procedures. As Francis Bacon said "Knowledge is power." Knowledge is indeed the purveyor of virtue; cosmetic surgical mishaps may arise from ignorance. – Francis Bacon (1561–1626) English Philosopher.

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4

Outcomes in Aesthetic Surgery: Patient Satisfaction

Pearl E. Grimes

Cosmetic procedures are generally performed with the aim of achieving one or more of the following objectives: *Enhanced appearance*, *enhanced perception of beauty by others,* and *delayed outward signs of aging*.[1] Despite the rapid growth in the number of cosmetic surgery procedures performed in recent years, however, the effects of aesthetic surgery on patients are not well characterized. The methods used to evaluate the impact of cosmetic surgery on the patient remain the subject of ongoing discussion and research. Although physicians regularly observe from their individual clinical cases that cosmetic procedures can yield important benefits in patients' functioning, quality of life, and well-being, measuring these parameters objectively poses a considerable challenge.

MEASURING OUTCOMES IN COSMETIC SURGERY

In part, the lack of knowledge about the impact of cosmetic surgery reflects the inherent difficulty in assigning objective measures to the improvement of appearance or to the "creation" of beauty. These measures are subjective, preference driven, and highly individual by nature. Conventional assessment of the success of medical procedures has focused on the more readily measurable parameters of mortality, morbidity, and physiologic function. Although these assessments are undoubtedly important for any surgical procedure, they do not provide a meaningful assessment of aesthetic outcomes. Against this background, a variety of methods for measuring the success of cosmetic procedures has been investigated, including anthropometric assessments, subjective assessments by patients and surgeons, and outcomes research.

Outcomes research may be defined as "the science of measuring patient experience."[2] It examines the end results of treatment, but in contrast to other methods, it focuses specifically on the patient's experience, perspective, and values.[3] Assessment of outcomes is particularly relevant following cosmetic procedures because it provides an objective evaluation of the success of treatment. More importantly, it permits quantification of patients' satisfaction with the results. This is a key measure; it is arguable whether a procedure that has been technically successful, but with which the patient remains dissatisfied, may be regarded as having achieved the objectives of treatment.

Outcomes research therefore seeks to identify and define standardized, validated instruments for objective evaluation of the changes achieved with cosmetic procedures. This chapter provides an overview of the importance of patient satisfaction as an outcome measure, examines some of the instruments used to assess this, and identifies ongoing challenges for the future, including the development of suitable instruments for assessing outcomes in patients of darker racial ethnic groups.

ASSESSING OUTCOMES IN COSMETIC SURGERY

Early studies in cosmetic surgery assessed the efficacy of treatment using a variety of physical measures. These included subjective evaluation of ***patient photographs*** documenting the time course, or results, of treatment or healing; comparisons of ***physical measurements*** taken before and after cosmetic procedures; and ***optical profilometry***, used to quantify the changes achieved by surgery. The drawback to these methods is that they do not take patient experience, attitudes, or values into account. A more recent review of patient satisfaction following surgical cosmetic procedures showed that in 36 studies, most patients were pleased with the outcomes of treatment and felt better about themselves, with improvements seen in self-worth, distress and shyness, and quality of life.[4]

Despite the enormous increase in cosmetic surgery procedures in the United States, there is a dearth of data in plastic surgery and cosmetic dermatologic surgery assessing patient satisfaction outcomes. A study of 30

patients who underwent botulinum toxin A injection demonstrated that more than 80% of individuals considered their treatment beneficial, and all patients would recommend treatment "completely" or "mostly." Outcomes were assessed using the Freiburg questionnaire on aesthetic dermatology and cosmetic surgery.[5] In addition, Augustin et al.[6] assessed patient satisfaction in a group of patients treated with tumescent liposuction. The Freiberg questions on aesthetic dermatology and cosmetic surgery were also used for this study. Of 300 patients, 159 (53%) returned their questionnaires. Satisfaction with tumescent liposuction was high in 85% of patients. Eighty percent regarded the procedure as nonstressful. Other studies of outcomes in facial procedures, including skin resurfacing, concluded that there are few well-designed studies using objective, validated assessment tools.[7]

WHY DO OUTCOMES MATTER?

Enhancing an individual's appearance using cosmetic procedures has important beneficial effects that extend far beyond the physical improvements achieved by treatment. During the past several decades, a number of studies have demonstrated that aesthetic surgery can have a positive impact on patients' self-confidence, body image, psychosocial well-being, and sexual function, as measured by a variety of methods.

It has been suggested that cosmetic surgery may best be regarded as "body image surgery,"[8] and it is clear that poor body image may be the impetus for patients to seek cosmetic surgery in the first instance.[9] Perhaps unsurprisingly, most patients appear to be satisfied with the results of aesthetic procedures and feel better about themselves afterward. It is well documented that patients report positive effects on self-image following a variety of cosmetic surgery procedures, as well as reduced dissatisfaction with body image and appearance. Such changes are manifested by improvement in negative thoughts, feelings, and behaviors relating to the specific body feature that has undergone alteration.[10–21] In addition, there is evidence to suggest that cosmetic surgery can lead to improvements in areas of psychological functioning, such as depressive symptoms[22] and quality of life.[21,22]

The impact of aesthetic procedures on sexual function is also well documented. As long ago as 1974, a study published by Baker et al. showed that many women reported enhanced self-confidence, psychosocial health, and sexual relations following breast augmentation.[23] Patients were more likely to alter their style of clothing to wear more provocative styles, to report more pleasure in sexual relationships, and to have an overall improved feeling of sexual adequacy.[23] These observations have been corroborated by a more recent study in which the authors concluded that cosmetic surgery patients "overwhelmingly" tend to feel better about their body following surgery, as well as experiencing striking improvements in their own and their partners' sex lives following elective cosmetic procedures, especially those involving the breasts, abdomen, or thighs.[24]

INCREASING THE LIKELIHOOD OF GOOD OUTCOMES AND SATISFIED PATIENTS

It is clear that cosmetic surgery can have a profound effect on patients' psychosocial well-being. In recent years, an increasing proportion of people reported dissatisfaction with their appearance. Given the fact that cosmetic procedures are increasingly acceptable, available, and affordable, it is likely that requests for interventions to enhance appearance will continue to increase. Some patients may be dissatisfied with the results of procedures that are deemed technically successful. Therefore, it is important to keep in mind the patient's perceptions, experiences, and feelings to outcomes of aesthetic procedures. These considerations will help optimize selection of suitable individuals for treatment and maximize successful outcomes and satisfied patients.

Factors influencing outcomes and patient satisfaction

Few studies have rigorously investigated which factors are specifically linked to unsatisfactory psychosocial outcomes following cosmetic surgery, but there is some evidence to suggest that unsatisfactory outcomes are more likely if the patient is of the male sex and a young age. Negative outcomes also increase if the patient suffers from a psychiatric condition such as depression, anxiety, or body dysmorphic disorder, or a personality disorder such as narcissism. Patients with unrealistic expectations about cosmetic surgery are more likely to express dissatisfaction with the results. For example, individuals who regard cosmetic surgery not simply as a means of improving their appearance, but as a way of improving relationships or of solving their life's problems, are more likely to experience poor outcomes.[25] Patients who have undergone multiple cosmetic procedures and have consulted many different practitioners may have a higher likelihood of dissatisfaction with the results (Table 4-1).

The ***nature and extent*** of the procedure being performed may also have an impact on reported outcomes. There is some evidence that more major interventions involving a significant change to body appearance ("type changes," such as rhinoplasty or breast augmentation) can result in more significant body-image disturbance than procedures resulting in less dramatic changes ("restorative" procedures, such as face lifts or botulinum toxin A injection).[9]

Table 4-1

Factors influencing unsatisfactory cosmetic outcomes

Male patient
Young age
Psychiatric disorders
Depression
Anxiety
Personality disorders (narcissism)
Body dysmorphic disorder
Unrealistic expectations
Patient undergoing multiple cosmetic procedures
Procedures causing a dramatic change in appearance
Potential complications high for chosen patient

Finally, the interplay between ***risks and benefits*** of cosmetic surgery can affect the success of reported outcomes. For example, procedures resulting in skin dyspigmentation, hypertrophic scarring, or the development of keloids may give rise to poorer patient satisfaction than other interventions. Given that the race or ethnicity of the patient can be an important predictor of such undesired effects of aesthetic procedures, careful patient selection and pretreatment counseling are vital to ensure that the patient's expectations of treatment are realistic and that information about possible side effects has been adequately conveyed.

Body dysmorphic disorder

A subset of patients who seek cosmetic surgery appear to have poor outcomes despite the apparent success of the procedure. Such patients may be suffering from body dysmorphic disorder (BDD), a psychiatric condition characterized by distorted body image and an obsessive and irrational preoccupation with minimal (or absent) physical defects, to the extent that the patient experiences clinically significant distress or impaired functioning (social, occupational, or other).[26] Patients may spend hours each day worrying about their appearance, constantly seeking reassurance from others, and repeatedly checking their appearance or attempting to disguise the perceived defect.

It is estimated that as many as 15% of patients seeking cosmetic surgery[27,28] and 12% of those consulting dermatologists may have BDD.[29] It is important to realize that cosmetic procedures rarely benefit individuals with BDD; following treatment, most such patients report that the results are unsatisfactory and that their appearance has not been improved.[30,31] Patients with BDD may be more likely to litigate against their cosmetic surgeon or dermatologist and may even threaten, or become violent toward, their physician.[32,33] It would therefore be wise to consider the following issues when deciding whether a patient is suitable for a cosmetic procedure, as answering these questions will help to clarify whether the patient may be suffering from BDD:[30–33]

- What is the ***patient's attitude*** toward his or her cosmetic problem? Is he/she preoccupied with it and convinced that it is serious even if it seems minor or nonexistent to others?
- What ***degree of distress or disability*** does the patient feel is associated with the problem? Does this seem proportionate to the nature and scale of the problem?
- How ***long does the patient spend each day worrying*** about the problem? Does thinking about it cause distress? Does the problem cause functional impairment, such as avoidance of social situations?
- What are the ***patient's expectations*** of the cosmetic intervention requested? Are these realistic?
- Has the patient consulted ***multiple practitioners*** or undergone ***multiple cosmetic procedures***? Does he/she report dissatisfaction with the results of prior treatment?
- Does the patient have a ***history of litigation*** against, or ***threatening or violent behavior*** toward, a cosmetic surgeon or dermatologist?
- Does the patient have a ***history of any psychiatric condition*** that may predispose him/her to a distorted body image?

OBJECTIVE TOOLS FOR MEASURING OUTCOMES

A large number of diverse studies in cosmetic surgery and dermatology have been performed to date, using varying methods for assessment of treatment success and patient satisfaction with outcomes. Although there is now a large body of useful data, no single means of assessing outcomes has been adopted, which creates a lack of consistency and makes comparisons between studies difficult. The development and adoption of validated, objective instruments for the evaluation of outcomes is clearly desirable, as this would permit comparison of aesthetic surgery techniques, quantification of the positive effects of treatment, and identification of patients most likely to benefit from cosmetic procedures.[1]

A major review of 43 studies using a total of 53 tools for measuring outcomes in cosmetic procedures[1] identified the following features as the key parameters for any useful instrument:

- **Feasibility:** The tool must be feasible to administer for the particular study to which it is applied.
- **Validity:** Does the instrument have appropriate validity with respect to aesthetic procedures?
- **Reliability:** Has the instrument demonstrated acceptable reliability?

Table 4–2

Validated outcome surveys

Multidimensional Body-States Relations Questionnaire (MBSRQ),[a] a psychological measure of body image

Facial Appearance Sorting Test (FAST),[b] for evaluation of the outcomes of rhinoplasty

Breast Chest Ratings Scale,[c] for assessment of breast surgery

Derriford Appearance Scale (DAS59),[d] for evaluation of appearance-related quality of life

[a]Cash TF. MBSRQ Users' Manual. Available at: www.body-images.com/assessments/mbsrq.html/. Accessed February 23, 2007
[b]Copas JB, Robin AA. The Facial Appearance Sorting Test (FAST): An aid to the selection of patients for rhinoplasty. *Br J Plast Surg* 1989;42:65.
[c]Thompson JK, Tantleff S. Female and male ratings of the upper torso: actual, ideal and stereotypical conceptions. *J Soc Behav Pers* 1992;7:345.
[d]Harris DL, Carr AT. The Derriford Appearance Scale (DAS59): a new psychometric scale for the evaluation of patients with disfigurements and aesthetic problems of appearance. *Br J Plast Surg* 2001;54:216.

- **Sensitivity to change:** Does the scale have the ability to detect changes resulting from cosmetic procedures?

The review concluded that the measures of greatest value in determining outcomes of aesthetic surgery were ***body image*** and ***quality of life***, and identified key instruments as being particularly useful or worthy of further study (Table 4-2).[1] In addition, it was recommended that a generic, utility-based quality-of-life instrument, such as the **Health Utilities Index** (HUI)[34] or the **EuroQol** (EQ 5D),[35] should be used.[1]

A more recent study has constructed a simple, validated numerical rating scale of 1 to 100 points for assessment of the quality of cosmetic dermatologic procedures.[36] The scale rates the associated cost, risk, time (procedure and recovery), discomfort, results, and longevity of benefit, with the only identified limitation of the instrument being that patient preferences outside of the rating scale may appear to increase or decrease the suitability of particular cosmetic interventions. When the scale was used by 15 expert cosmetic dermatologists to rate 23 common procedures—including microdermabrasion, glycolic acid peels, cryosurgery, laser resurfacing, blepharoplasty, botulinum toxin A injection, liposuction, and laser hair removal—it was found that the experts assigned similar ratings to the same procedures but that mean ratings were different across procedures. This instrument may be useful in the future for the assessment of novel procedures in cosmetic dermatology and to help cosmetic surgeons choose between alternative procedures.[36]

CONCLUSION

The assessment of outcomes for cosmetic procedures is a complex and challenging field with great scope for improved standardization. It is clear that outcomes research, with its patient-focused evaluations, represents a more valid approach than reliance on simple clinical outcomes of treatment. A major challenge for the future remains the development of objective, validated, and widely adopted instruments for assessments that permit valid comparisons between studies and between different procedures to be made. In addition, it must be recognized that to date, little attention has been paid to the development of rating scales for use across all racial and ethnic groups; most have been used only for Caucasians, and the special considerations of patients of color have not been addressed. It is hoped that this will change in future.

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5

Evaluation and Design of Cosmetic Research Studies

Amit G. Pandya

In making decisions regarding the diagnosis and treatment of skin diseases, clinicians are faced with a confusing array of data from various sources to help them make correct choices. A variety of questions may come to mind during this process. What procedures and tests need to be performed to make the right diagnosis? Is a biopsy necessary before embarking on a treatment course? Is there good evidence that preoperative labs and medications are useful for a particular procedure? What is the evidence that a particular treatment or cosmetic procedure is effective? What is my own experience in this situation? Can I rely on the data that is being presented? Am I giving the correct choices and advice to my patient?

As always, the first rule of professionalism is paramount: The needs of the patient supersede the needs of the professional. We want to do what is best for the patient, but how do we evaluate the large volumes of data that we are given at meetings, in journals, by colleagues, and by the lay press and advertisements? Fortunately, there is a substantial amount of material available on the use of evidence-based medicine for clinical practice.

Evidence-based medicine is the use of the best current evidence in making decisions about the care of individual patients.[1] The strength of the evidence is based on a hierarchy of evidence, which consists of, in descending order, results of systematic reviews of well-designed studies, results of one or more well-designed studies, results of large case series, expert opinion, and personal experience. There is a large body of evidence available for the care of patients with skin disease. However, there is a dearth of evidence-based data on aesthetics and cosmetic surgical procedures in darker racial ethnic groups. It is important to be familiar with the evidence that does exist for a diagnostic or therapeutic intervention that one might be considering. The clinician must be equipped to critically review such data to do what is best for the patient. By reviewing this information and remembering some guidelines, one can evaluate data critically and determine the correct diagnostic and treatment options for any clinical situation. Use of MEDLINE and other databases can be useful in locating the best evidence for a particular clinical circumstance.

In general, well-designed, randomized controlled trials give the best evidence for the efficacy of a particular therapeutic intervention. Trials of agents and procedures for cosmetic indications have often been performed without controls, randomization, or blinding. Bias can occur in poorly designed trials, which can mislead clinicians into making the wrong decisions and cause unnecessary treatment for patients.[2] Recently, the CONSORT (Consolidated Standards of Reporting Trials) recommendations on items to include when reporting a randomized clinical trial have been published (Table 5-1).[3] These guidelines are helpful in evaluating any study to determine its validity.

The CONSORT guidelines were developed in 1996 to improve the suboptimal reporting of randomized control trials. The goal of the CONSORT guidelines is to assist health-care providers in making informed decisions about the validity of the studies on which they base their clinical practice. Eleven key methodological factors important in reporting a randomized control trial were initially identified. Several journals accepted these recommendations, with the exception of the *New England Journal of Medicine*. The second edition of CONSORT established a 22-item checklist, which emphasized the need for the word "randomized" to appear in the title to allow literature searches to identify the paper.[3] The CONSORT statement is an important research tool that takes an evidence-based approach to improve the quality of reports of randomized trials and is available in several languages. One can assume a certain degree of validity when reading trials that have been conducted using these guidelines.

Although the randomized controlled trial provides medicine with its main source of evidence for supporting the use of a particular therapy or medical practice, there may be problems in the conduct and reporting of such trials.[4] Many clinical situations, such as cardiac arrest and

Table 5-1

CONSORT guidelines on items to include when reporting a randomized clinical trial

Manuscript SECTION and topic	Item	Description
TITLE and ABSTRACT	1	How participants were allocated to interventions (e.g., "random allocation," "randomized," or "randomly assigned")
INTRODUCTION Background	2	Scientific background and explanation of rationale
METHODS Participants	3	Eligibility criteria for participants and the settings and locations where the data were collected
Interventions	4	Precise details of the interventions intended for each group and how and when they were actually administered
Objectives	5	Specific objectives and hypotheses
Outcomes	6	Clearly defined primary and secondary outcome measures and, when applicable, any methods used to enhance the quality of measurements (e.g., multiple observations, training of assessors)
Sample size	7	How sample size was determined and, when applicable, explanation of any interim analyses and stopping rules
Randomization: Sequence generation	8	Method used to implement the random allocation sequence (e.g., numbered containers or central telephone), clarifying whether the sequence was concealed until interventions were assigned
Randomization: Allocation concealment	9	Method used to implement the random allocation sequence (e.g., numbered containers or central telephone), clarifying whether the sequence was concealed until interventions were assigned
Randomization: Implementation	10	Who generated the allocation sequence, who enrolled participants, and who assigned participants to their groups
Blinding (masking)	11	Whether or not participants, those administering the interventions, and those assessing the outcomes were blinded to group assignment. When relevant, how the success of blinding was evaluated
Statistical methods	12	Statistical methods used to compare groups for primary outcome(s); methods for additional analyses, such as subgroup analyses and adjusted analyses
RESULTS Participant flow	13	Flow of participants through each stage (a diagram is strongly recommended). Specifically, for each group report the numbers of participants randomly assigned, receiving intended treatment, completing the study protocol, and analyzed for the primary outcome. Describe protocol deviations from study as planned, together with reasons
Recruitment	14	Dates defining the periods of recruitment and follow-up
Baseline data	15	Baseline demographic and clinical characteristics of each group

(*continued*)

Table 5-1

CONSORT guidelines on items to include when reporting a randomized clinical trial (*Continued*)

Manuscript SECTION and topic	Item	Description
Numbers analyzed	16	Number of participants (denominator) in each group included in each analysis and whether the analysis was by "intention-to-treat." State the results in absolute numbers when feasible (e.g., 10/20, not 50%)
Outcomes and estimation	17	For each primary and secondary outcome, a summary of results for each group and the estimated effect size and its precision (e.g., 95% confidence interval)
Ancillary analyses	18	Address multiplicity by reporting any other analyses performed, including subgroup analyses and adjusted analyses, indicating those prespecified and those exploratory
Adverse events	19	All important adverse events or side effects in each intervention group
DISCUSSION Interpretation	20	Interpretation of the results, taking into account study hypotheses, sources of potential bias or imprecision, and the dangers associated with multiplicity of analyses and outcomes
Generalizability	21	Generalizability (external validity) of the trial findings
Overall evidence	22	General interpretation of the results in the context of current evidence

From Altman DG, Schulz KF, Moher D, et al., for the CONSORT Group. The revised CONSORT statement for reporting randomized trials: explanation and elaboration. *Ann Intern Med* 2001;134:663–694.

pain relief, do not lend themselves to randomization. In addition, trials seldom study the effects seen in different subgroups of patients, nor can the results from a small group of study patients always be extrapolated to larger populations. Clinical trials performed in limited groups of patients of the same age, race, education, socioeconomic background, or skin type may not apply to a broader population. Short-term outcomes do not always translate into long-term outcomes for any particular treatment, necessitating specific clinical trials conducted over long periods of time.

Despite these problems, the randomized, controlled blinded trial and the CONSORT guidelines represent significant advances in standardizing clinical trials, and future trials in patients with cosmetic dermatologic disorders should be designed according to these guidelines. Although all of the recommendations may not be applicable to a particular study in the field of cosmetic dermatology, the concepts presented in the CONSORT statement are useful guidelines for all clinicians. Several studies regarding the efficacy and safety of cosmetic procedures in darker racial ethnic groups using these guidelines have been performed. These include studies on depigmenting agents,[5,6] glycolic acid peels,[7] and laser therapy[8] for melasma.

COMPONENTS OF A GOOD STUDY

Rationale and objectives

The study should state its rationale. Why is it important to perform the study? What is the scientific background that led to the development of the study? What other trials have been performed for this disease in the past, and what are their limitations? The objectives of the trial—i.e., efficacy, local and general safety, or remission—should be clearly stated.

Selection of participants and study size

In selecting the study population, inclusion and exclusion criteria should be carefully considered. What were the eligibility criteria for participants? Were there standardized inclusion and exclusion criteria? Were patients with confounding diseases or recent treatments for the studied disease excluded? Does my patient have the same diagnosis as those in the study?

As much as possible, statistical methods should be used to determine the sample size. Pilot proof-of-concept studies on a few patients can be done first to predict the response to a particular therapy. The results of these pilot studies must be interpreted with caution until larger trials are performed. The predicted difference between the study

and control populations can then be used to calculate the number of patients who will be needed in a randomized controlled trial to demonstrate a difference between the two groups. This "powering" of a study is a useful and crucial exercise before starting a therapeutic trial. Once a study has begun, any patients who withdraw from the study should not be substituted for and should be included in the final results, the so-called "intent-to-treat analysis."

Clinical trial design

Trial design is a key element in obtaining clinically relevant results. Three key elements of good clinical trial design can be identified: Randomization of patients, inclusion of a control group, and blinding.[5] In principle, parallel group, double-blind, vehicle and active comparator controlled studies provide the best evidence for the efficacy of a given treatment. Trials aiming to demonstrate the superiority of a new therapy to a known active and effective treatment are acceptable if the efficacy of the active comparator is well established. Optimal frequency and concentration of topical medications should be established in pilot studies.

Randomization of patients

Randomization of patients overcomes bias in patient selection and avoids the necessity to analyze outcome on a patient-by-patient basis. Randomized numbers generated from a coin toss or from a computer-assisted randomization program can be used, along with sealed envelopes. If a washout period is needed, the patient should not be randomized until this period is over.

Control

A number of options can be considered when designing a control for a trial of a new therapy. The treatment under study can be compared with a vehicle control, with an active comparator, or with the untreated opposite side of the face (split-face trial). The use of historical controls is inferior to prospective trials, because the same conditions did not apply to both treated and control groups. If an active comparator is used, it should be an intervention with well-documented clinical efficacy. The active comparator should be given at the most optimal dose. The advantage of using a split-face trial design is that it is usually the only way to evaluate accurately treatment outcome with a study drug compared with vehicle in a small number of patients. The split-face design may also be useful for comparisons between two active products when the test drug is compared with a known standard therapy, either approved for use or with established efficacy. There may be ethical issues in continuing such a trial if the difference between the treated and control sides is significant.

A number of variables may need to be controlled in designing a good trial. For example, a single phototype may need to be enrolled, because outcome has been shown to vary among different phototypes. Caucasian patients may have very different responses to cosmetic treatments compared with African or Asians. The time of the year during which the clinical trial is conducted also has to be taken into account to allow for the degree of sun exposure. One method would be to have an internal control whereby the sun-exposed suprasternal notch is assessed with objective evaluations but not treated. Another option would be to include a patient-completed questionnaire that focuses on length of sun exposure during a study so that one can determine if there was a significant difference between groups.

The educational and socioeconomic class of the patients within the study should be considered with regard to compliance; understanding instructions; affordability of sunscreens, cleansers, etc; and inability to avoid sun exposure, such as in the case of outdoor workers. Language and cultural practices must also be taken into account when using consent forms and providing instructions on medication. Cultural practices are also important, as home remedies might conflict with the study medication.

Blinding

Blinding of the investigator and patient (double-blinding) is the optimal choice in trial design, but patient blinding may not be possible with certain interventions, such as chemical peels and laser therapy. Bias may occur in open trials because of the innate desire for many investigators and patients to demonstrate a positive treatment effect of any intervention. If the caring physician cannot be blinded, then evaluation of improvement should be done by an independent blinded observer.

METHODS OF EVALUATION

Evaluation of improvement is one of the most crucial aspects of any good study. Optimally, the outcome measure should have been tested before its use in a study.[9] Does it really measure what it purports to measure? Is there good correlation with the gold standard and clinical exam? Has there been a gold standard established? Is it reproducible, showing both interrater and intrarater reliability? Is it responsive and sensitive to detecting clinical change? Is the method feasible, inexpensive, practical, and widely available? Have the evaluation methods been standardized and validated? Are these methods accepted as valid, reproducible, and reliable in measuring change in disease as a result of an intervention? Of course, many interventions in the field of cosmetic dermatology do not have established methods of evaluation. However, outcome measures are important in the assessment of the reliability of any intervention and should be developed further. Evaluation of the outcome of a clinical trial can be divided into subjective and objective evaluation techniques.

Subjective evaluation techniques

Although inferior to objective evaluation techniques, subjective evaluation, particularly the physician's global assessment, is often the primary efficacy end point by which a new treatment is evaluated. A crucial aspect of evaluation techniques in multicenter trials is agreement on rating systems by all investigators before beginning a study. This avoids large differences in outcomes between investigational sites. Optimally, grading systems should be standardized and validated. This can be done with a test group of patients or photographs presented to blinded observers. For example, a 50% improvement in telangiectasias after laser surgery may be defined very differently by different evaluators. Some kind of uniformity should be established before conducting the study.

Established, validated evaluation techniques are superior to nonvalidated techniques. Unfortunately, few subjective evaluation techniques have been validated in dermatology, particularly for cosmetic disorders. The scoring systems vary based on the disorder being studied. For example, subjective scoring systems that have been employed in pigmentation studies include the physician's global assessment, patient global assessment, melasma area and severity index (MASI), melasma severity scale ([0–3], much worse [−2] to much improved [+2]), Munsell color chart, hyperpigmentation scale (1–10), improvement scale (total, partial, failure), target lesion assessment compared with surrounding skin, and linear analog scale. Which of these methods is the best to use? Without validation, this question remains unanswered.

Like the MASI score for melasma, the Vancouver Scar Scale uses several parameters, including pigmentation, vascularity, pliability, and height to help standardize the subjective evaluation of a scar.[10] Evaluating improvement in the number of vessels or pigmentation using a grid system and counting the number of affected boxes in the grid is a way of determining the degree of involvement in an area of skin and quantifying improvement, but still relies to some degree on subjective assessment.[11] Global methods, which take into account several variables, such as the physician's global assessment, are the most commonly used scoring systems, but there is great interrater variability with such methods, and they should rarely be the sole method of evaluating improvement.

One important aspect of the physician's global assessment is the clinical relevance of this evaluation method. Does the treatment make a significant overall improvement in the patient's appearance? Although objective evaluation methods are more reproducible and reliable, they may not be relevant when the general appearance of the patient is taken into account. For example, what difference does a 20% improvement in pigmentation using a chromameter make if it is not noticed by a blinded observer? Including both subjective and objective assessments can help overcome this problem.

Table 5-2

Objective evaluation techniques

Narrow-band reflectance spectroscopy (Mexameter, Dermaspectrometer): Pigmentation and erythema
Handheld tristimulus reflectance meter (Minolta Chromameter): Pigmentation and erythema
Corneomelametry: Pigmentation
Fluorescent video recording: Pigmentation
Photospectrometer: Dermal erythema
Computer-based objective analysis: Wrinkles
Three-dimensional topographical evaluation: Wrinkles
Ultrasound: Thickness of skin and subcutaneous tissue
Histology: Multiple parameters

Objective evaluation techniques

A variety of objective evaluation techniques have been used in trials for cosmetic treatments. Table 5-2 lists some of the techniques used to objectively evaluate cosmetic disorders. A common feature of these techniques is the use of instrumentation to minimize investigator or patient bias. Clinical studies using objective methods of evaluation are more difficult but superior to trials that only rely on subjective evaluation techniques. Although more difficult than subjective techniques, objective evaluation usually offers greater reliability, reproducibility, and credibility to any study. Thus, pigmentation, erythema, skin thickness, and durability can be measured using various devices with reproducible results.

Although patients are often reluctant to consent to a biopsy of the skin, histological evaluation of the skin before and after an intervention can be very useful in determining efficacy of a cosmetic treatment.

Photography

Images are one of the most important forms of evidence to evaluate when reviewing cosmetic studies. Uniformity in multiple aspects of photography must be achieved if images are to be credible as evidence of an improvement, particularly if the images will be used in measuring outcome. To draw a meaningful conclusion about the effect of a cosmetic treatment, images must be standardized and reproducible.[12] A small change in positioning or facial expression can cause images to be misleading. Neutral facial expression and neutral gaze must be used to evaluate the surface characteristics of the skin, particularly wrinkles.

There is a delicate balance between aperture, lighting, and shutter speed. All of these should be kept constant when taking before and after photographs. The patient should be placed in a fixed position at a fixed distance

from the camera. Even small changes in the position of the chin can cause distortion of the skin. The camera should have a fixed flash position, F-stop, focal length, and lens. Through-the-lens metering, as used in single-lens-reflex cameras, should be used, as it gives the photographer the ability to compose the image through the same lens with which the picture will be taken. Standardization of image timing is another important factor when performing photography for cosmetic procedures. Posttreatment edema may temporarily reduce wrinkles and improve tone. Images should be taken after edema and erythema has subsided.

Polarized light photography is useful in the assessment of dermal changes, particularly vascular changes and skin surface changes. In studies for disorders of pigmentation, it is primarily used to reduce glare. Ultraviolet (UV) light examination can be used to distinguish between skin color changes that are related to pigmentation and changes that result from other causes, such as collagen deposition, scarring, or vascularity. UV photography is excellent in capturing fine lines as well as pigmentary changes and is 10 times more sensitive than visible light in detecting epidermal melanin. Because most current studies use digital cameras to capture images, it is important to use a resolution of at least 3.0 megapixels to maximize image clarity.[12]

DURATION OF TREATMENT

The duration of any study should be sufficient to allow time for an accurate assessment of efficacy. This may vary depending on the intervention. For example, improvement of telangiectasias with laser surgery can be seen within days, whereas scar therapy with topical agents may require months to demonstrate a difference. Without follow-up, however, it is impossible to assess the overall effect of the intervention. Evaluation of the patient several months or more after treatment establishes the ability of a particular procedure to produce a durable improvement.

COMPLIANCE

The issue of compliance should be addressed in a clinical trial with an assessment made of the amount of study drug used per patient, i.e., number of tubes, weight of drug, and timely attendance of the patients for follow-up visits.

MAINTENANCE TREATMENT

Studies that show improvement of a disorder may need to be prolonged to demonstrate maintenance of improvement. A given therapy may be useless if the effects are not lasting. Good studies usually include follow-up evaluations to document improvement.

Table 5-3

Side effects of therapy from the perspective of the patient and the physician

Patient	Physician
Stinging/burning	Erythema
Pain	Scaling
Tenderness	Erosions
Itching	Crusting
Redness	Inflammation
Scaling/dryness	Irritation
	Hypopigmentation
	Confettilike pigmentation
	Hyperpigmentation
	Postinflammatory hyperpigmentation
	Scarring

SAFETY

The safety of a trial medication should be assessed in terms of local and systemic tolerance, adverse events, and cosmetic appearance. Some examples of safety measures are shown in Table 5-3.

QUALITY OF LIFE

In view of the considerable effect cosmetic disorders have on the health-related quality of life (HRQoL) in affected patients, attempts have been made to assess the benefit of therapy on this important parameter. The existing Dermatology Life Quality Index (DLQI) and SKINDEX-16 are general measures of the impact of skin disease on the HRQoL of patients with various skin disorders; they put equal weight on the physical and psychological effects of a dermatological condition. A new HRQoL instrument for women with melasma, MELASQOL, has been developed.[13] The MELASQOL uses items from the SKINDEX-16 as well as the skin discoloration questionnaire that focus on items that would be more relevant to melasma-specific HRQoL. In the future, cosmetic dermatology studies should include HRQoL measurements to determine the full impact of skin disorders on the patient. To this end, new questionnaires and other QOL instruments that are specifically aimed at cosmetic disorders will need to be developed.

CONCLUSION

Few well-controlled trials have been conducted in patients with cosmetic disorders, and further effort is required to standardize such trials in the future. This will allow clinicians to better compare outcomes of different therapeutic modalities. By using some of the guidelines presented in this chapter, researchers can design well-controlled, randomized trials that will serve the important goal of better care for all patients.

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6

Cosmetic Issues of Concern for Potential Surgical Patients

Chang-Keun Oh, H. Ray Jalian, Stephanie R. Young, and Seong-Jin Kim

Darker-skinned individuals (Fitzpatrick skin type IV through VI) represent 30% of the population, U.S. population and the majority of the global population (see Chapter 2), thus physicians are more likely to encounter such patients in their clinics and practices, and therefore must know how to treat diverse skin types. Until recently, training programs have paid little attention to ethnic skin, focusing instead on procedures and treatments relating to fair-skinned individuals. Today's rapidly increasing population of darker skin types requires that cosmetic surgeons recognize the need for safe, effective treatments for people of color.

Several studies have assessed the incidence of skin diseases in patients of color. Halder et al.[1] assessed the incidence of common dermatoses in 2,000 patients in a predominantly black dermatologic practice. The four most common skin diseases, in order of incidence, were acne vulgaris (27.7% of patients), eczema (23.3.%), pigmentary disorders other than vitiligo (9%), and alopecias (5.3%). Alopecias were predominantly chemical and traction alopecia. Pigmentary disorders were predominantly postinflammatory hyperpigmentation (PIH) and melasma.

Child et al.,[2] assessing the spectrum of skin disease in a predominantly black population in southeast London, recorded diagnoses in 461 consecutive African, Afro-Caribbean, and mixed-race patients. The most common diagnoses in the 274 adults included in the study were acne vulgaris (13.7%), eczema (9%), psoriasis (4.8%), and keloidal scars (4.1%). Several of the aforementioned conditions are considered "cosmetic."

The cosmetic surgeon should have an in-depth understanding of the physiological and functional differences that exist between fair-skinned individuals and their dark-skinned counterparts. Data, however, relating to these primary differences remain limited.[3–5] Despite this, surgeons who keep diversity of skin in mind in their practices will do a great benefit to their patients by allowing their postoperative experience to be predictable and without complications.

This chapter will provide an introductory overview for cosmetic issues of concern in darker racial ethnic groups. These issues include pigmentation disorders, skin laxity, wrinkles, sensitivity, oily skin and acne, and scarring.[6] Many of these disorders will be discussed in depth in other chapters (Table 6-1).

Table 6-1

Cosmetic issues of concern for darker ethnic groups

Pigmentation disorders
Melasma
Postinflammatory hyperpigmentation
Hori's nevus
Solar lentigo
Vitiligo
Irritant contact dermatitis
Wrinkles/photodamage
Oily skin
Acne vulgaris
Hypertophic scars
Pseudofolliculitis barbae

PIGMENTARY DISORDERS

Variation of skin color is believed to have evolved as a result of selective pressures present in particular environments, mainly extremes in light and temperature. The most apparent and important morphological difference in darker racial groups involves pigmentation. The reactivity of melanocytes and the profound tendency toward hyperpigmentation are unique characteristics of darker-skinned individuals.

It is well established that there are no racial differences in the number of melanocytes[7] in darker compared with lighter skin types. Differences in melanocytes and melanin production have been discussed in Chapter 2. The increased epidermal melanin content of darker-skinned individuals provides greater intrinsic photoprotection, perhaps explaining why problems such as photodamage, actinic keratoses, rhytides, and skin malignancies are less common in deeply pigmented skin. However, the increase in epidermal melanin and the often capricious response of melanocytes to inflammation or injury can lead to distressing dyschromias characterized by hyperpigmentation or hypopigmentation.

Melasma is a troublesome acquired hypermelanosis, usually occurring symmetrically on the face (Fig. 6-1). Although melasma can affect all people, Asian, Hispanic, and black women are most commonly affected.[8] Although the precise cause of melasma is unknown, multiple factors have been implicated in the etiopathogenesis of this condition. These include genetic influences, sunlight

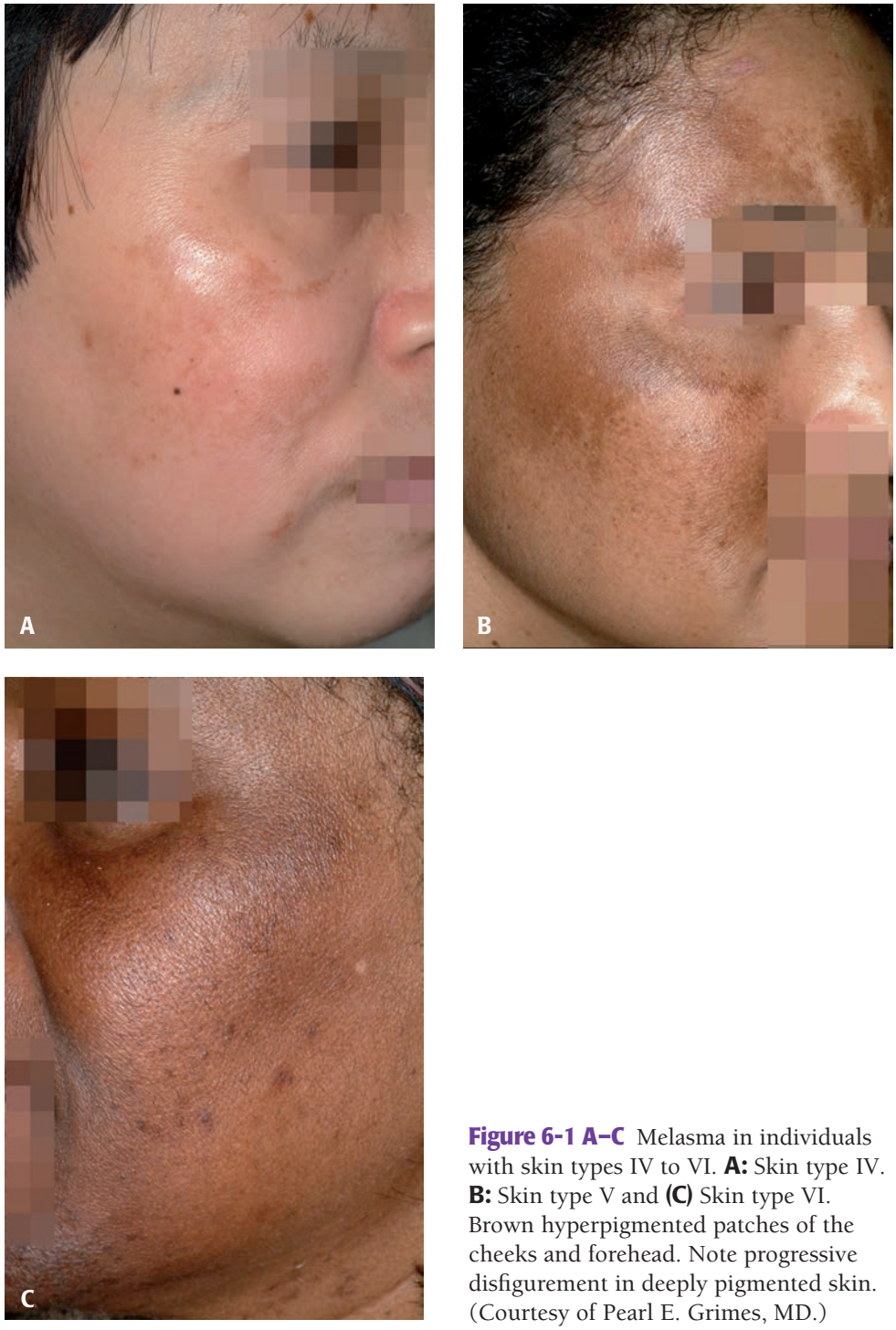

Figure 6-1 A–C Melasma in individuals with skin types IV to VI. **A:** Skin type IV. **B:** Skin type V and **(C)** Skin type VI. Brown hyperpigmented patches of the cheeks and forehead. Note progressive disfigurement in deeply pigmented skin. (Courtesy of Pearl E. Grimes, MD.)

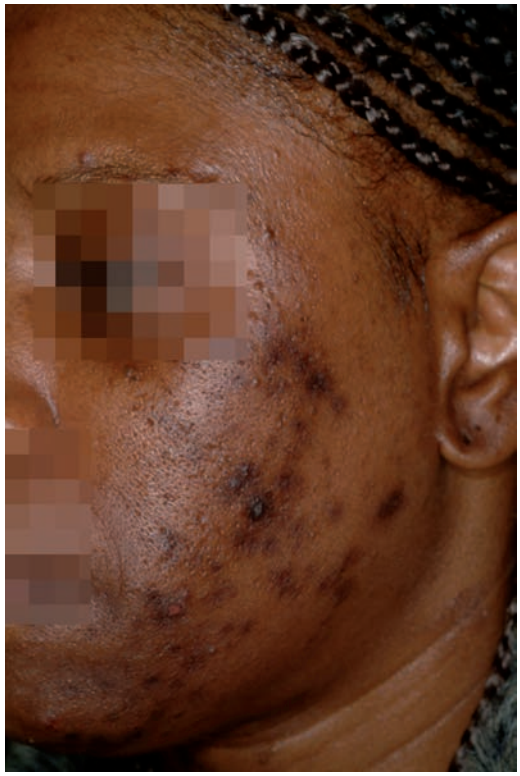

Figure 6-2 Postinflammatory hyperpigmentation. Note hyperpigmented macules and patches of the face. (Courtesy of Pearl E. Grimes, MD.)

exposure, pregnancy, oral contraceptive use, hormone replacement therapy, cosmetics, and medications, such as phototoxic and antiseizure medications. Recently, Grimes et al. reported hyperactive melanocytes and increased epidermal melanin in the affected skin of patients with melasma.[9] Electron microscopy studies showed enlarged melanocytes with increased numbers of melanosomes and prominent dendrites. This study suggested that melasma may be a consequence of hyperactive and hyperfunctional melanocytes causing excessive melanin deposition in the epidermis and dermis.

Another important cosmetic pigmentation issue is PIH (Fig. 6-2). PIH is characterized by an acquired increase in cutaneous pigmentation secondary to an inflammatory process. Excess pigment deposition may occur in the epidermis or in both epidermis and dermis. The condition occurs in all racial and ethnic groups; however, it has a higher incidence in people with darker complexions. Previous studies have suggested that inflammatory reactions that cause a release of arachidonic acid from cell membranes may be a cause of PIH. Mediators implicated in PIH include endothelin 1, prostaglandins, interleukin-1, and stem cell factor.[10,11]

LENTIGINES

Solar lentigo (Fig. 6-3) are common light brown to brown lesions occurring as discrete hyperpigmented macules on

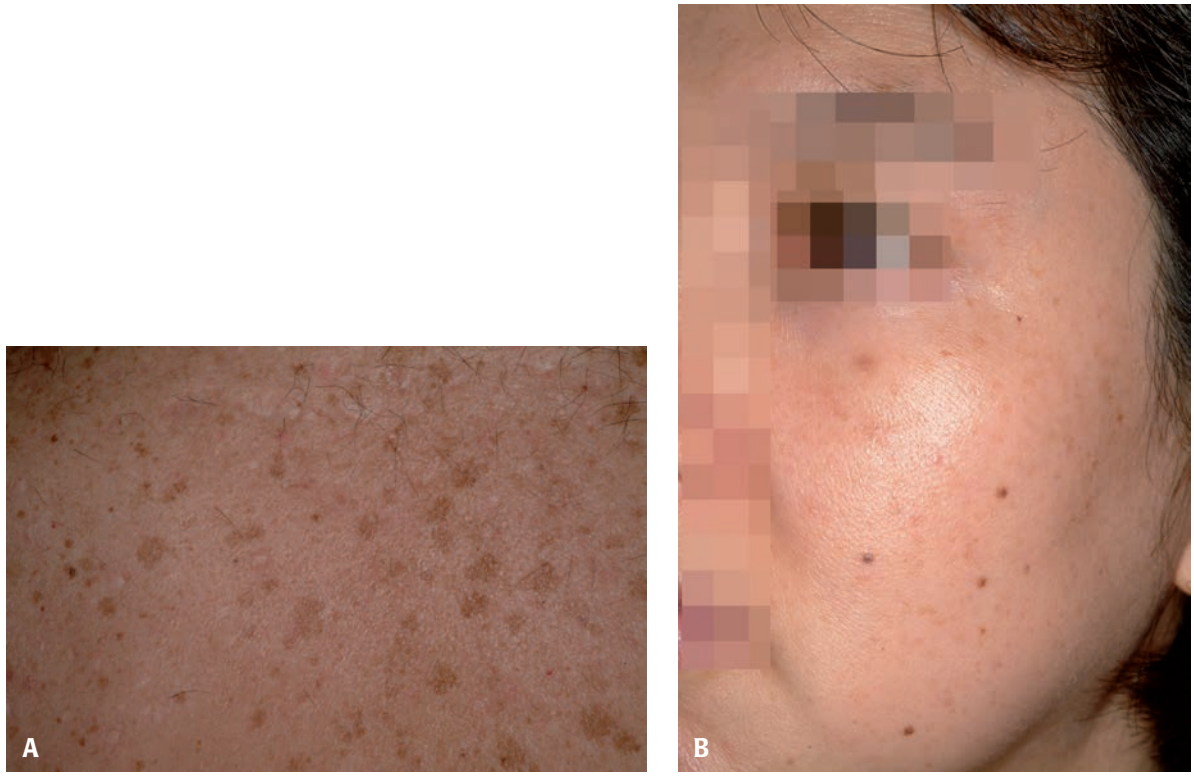

Figure 6-3 Solar lentigo characterized by brown macules of the **(A)** back and **(B)** face. (Courtesy of Pearl E. Grimes, MD.)

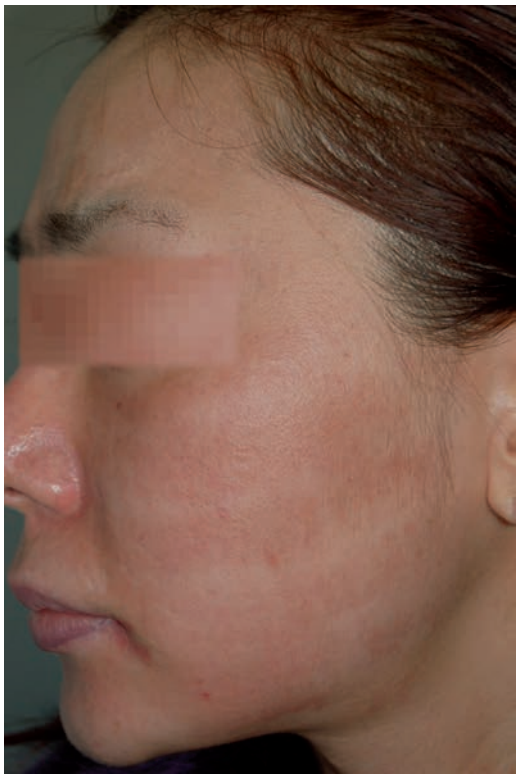

Figure 6-4 Postinflammatory hyperpigmentation after fractional resurfacing.

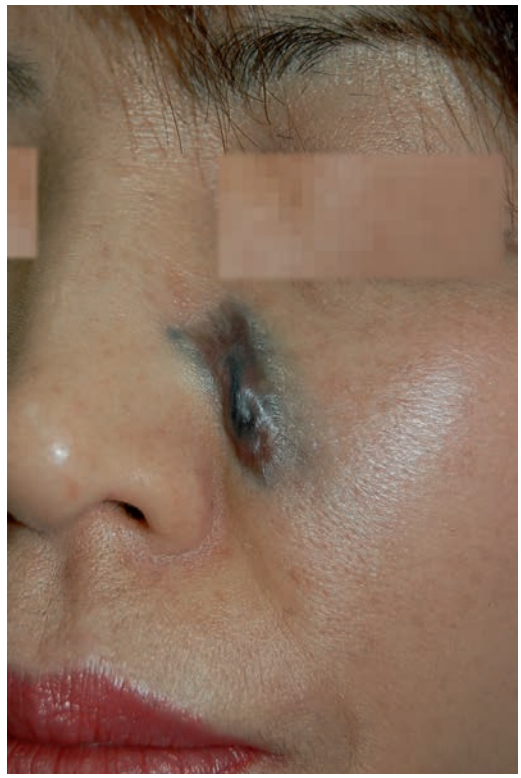

Figure 6-5 Scar after removal of congenital melanocytic nevus with CO_2 laser.

sun-exposed areas of skin, such as the face, arms, chest, and back. Solar lentigo is induced by natural or artificial ultraviolet light sources. Such lesions are common in skin type IV, in particular in Asians and Hispanics. They are less common in blacks. Histologically, they are characterized by elongated rete ridges, club-shaped extensions, and a proliferation of melanocytes, and keratinocytes.[12]

Hori's nevi are acquired bilateral nevus of Ota-like macules symmetrically located on the forehead, temples, eyelids, and malar regions. These often occur in young women with a family history for these lesions. They are also aggravated by sun exposure.[13] Histologically, the overlying epidermis is normal. In the papillary and upper reticular dermis, dendritic melanocytes are present and surrounded by a fibrous sheath.[14]

Treatment with laser light can create unwanted epidermal side effects, such as blistering, dyspigmentation, and scarring, because the higher epidermal melanin content acts as an additional chromophore (Figs. 6-4 and 6-5). A higher level of laser expertise and clinical experience in treating darker skin is mandatory to ensure that patients are treated safely and effectively. Test spots should always be performed as an aid to selecting the safest and most effective parameters of treatment, including determining the appropriate fluence, wavelength, and thermal relaxation time. Efficient cooling devices are essential to prevent the unwanted thermal damage that could potentially cause pigmentary complications. Transient hyperpigmentation can be prevented or relieved by the pre- and postoperative use of hypopigmenting agents.

Vitiligo is a relatively common pigmentary disorder characterized by patches of depigmentation. The disease affects 1% to 2% of the population and shows no racial or ethnic predilection. Vitiligo is indeed a disfiguring and psychologically devastating disease. The disorder may be imperceptible in individuals with skin types I and II. However, the condition is striking in darker racial ethnic groups (Fig. 6-6). Patients with vitiligo experience profound psychological trauma in light of the cosmetic deformity. Psychological profiles document perceived job discrimination, low self-esteem, suicidal ideations, and difficulties in interpersonal relationships.[15,16]. Quality-of-life studies document improvement with treatment of this disorder.[17,18]

Current therapies for dyschromias are reviewed in Chapters 13 through 15.

SKIN LAXITY AND WRINKLES

Darker skin is thought to be more resistant to the deleterious effects of ultraviolet radiation. A physician who has experience in ethnic variations of skin might say that a person with darker skin appears much younger than a fair-skinned person of the same actual age. Higher melanin content and a different pattern of melanosomal dispersion in the epidermis seem to be responsible for this effect.

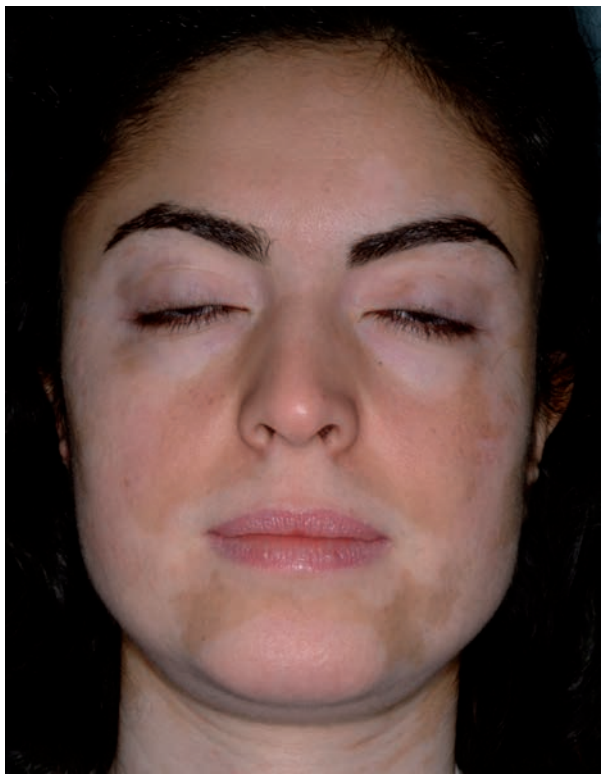

Figure 6-6 Facial vitiligo characterized by areas of depigmentation. (Courtesy of Pearl E. Grimes, MD.)

Recent experimental observations confirmed this hypothesis by measuring cytokines and DNA damage in black and white skin during the skin responses following exposure to solar-simulating radiation.[1,19] It was demonstrated that a dark-skinned individual's epidermis, on average, provided an intrinsic sun protection factor (SPF) of 13.4,[20] which provides the daily protection necessary to maintain "better aging" (see Chapter 3).

Many new products and techniques have arisen that are useful in the rejuvenation of facial skin. Treatment options include topical skin care products, microdermabrasion, chemical peels, and both ablative and nonablative laser/light/radiofrequency skin resurfacing. Surgical intervention, injectable fillers, and neurotoxins are also recommended. In the past, darker-skinned patients were much less likely to undergo facial cosmetic surgery not only because of pervasive cultural attitudes that facial plastic surgery conflicts with a healthy sense of racial identity, but also because of the increased risk of hypertrophic scarring and keloid formation. However, this trend appears to be changing rapidly. Many minimally invasive procedures, such as botulinum toxin injections, soft-tissue augmentation, and resurfacing modalities are well suited for the ethnic patient with midface aging who does not need more drastic lifting procedures. It is recommended to customize treatment plans for the patient, allowing him or her to voice their concerns in the most comprehensive manner possible.

SENSITIVE SKIN

Sensitive skin is generally defined as a reduced tolerance to frequent or prolonged use of cosmetics and toiletries.[21] This intolerance can manifest itself with symptoms that range from objective signs of irritation, such as erythema, dryness, and scaling, to subjective signs of irritation, such as stinging and burning. However, the high variability in the manifestation of sensitive skin makes investigating this issue very complicated. There are a wide variety of test protocols that are employed in an attempt to detect sensitive skin in patients and to assess the irritancy of products. In a recent publication, approximately 50% of women and 40% of men surveyed within a U.K. population regarded themselves as having sensitive skin.[22] Because there is huge variability in the presentation of sensitive skin, subjectively or objectively, some suggest that the perception of "sensitive skin" is possibly influenced by the media, as much published data showed no clear correlation between objective skin findings and patient reports about sensitive skin.[23] Objective findings demonstrating response to irritants, however, suggest that sensitive skin is in fact a real issue. The issue of sensitive skin in darker racial ethnic groups remains controversial.[13]

Jourdain et al.[24] studied ethnic variations in self-assessed sensitive skin by conducting 800 telephone surveys with four different ethnic groups (African Americans, Asians, Euro-Americans, Hispanics). Fifty-two percent of respondents reported sensitive facial skin. No statistically significant differences were identified in the incidence of sensitive skin among different groups, but differences in sensitive skin were identified between ethnic subgroups. African Americans had lower skin reactivity to most environmental factors and lower incidence of recurring facial redness. Euro-Americans had higher skin reactivity to wind and lower reactivity to cosmetics. Asians had higher skin reactivity to spicy food and temperature changes, whereas Hispanics had lower skin reactivity to alcohol. The issue of sensitive skin should be considered when prescribing pharmacologic agents and cosmetic regimens for patients with darker skin types.

Although other studies have suggested an increase in irritation and skin sensitivity in darker racial ethnic groups, a recent detailed review of the subject does not support this occurrence.[1,4,25]

The issue of sensitivity has to be dealt with on an individual basis. Clinical experience suggests that darker-skinned women often experience irritant contact dermatitis (Fig. 6-7) in response to topical products, including cosmetics. However, patch-test results showed a similar incidence of contact dermatitis between blacks and whites in test populations.[26] Studies have shown higher rates of sensitization to formaldehyde-releasing preservatives in whites, whereas African Americans showed higher sensitivity to para-phenylenediamine, cobalt chloride, and thioureas. Overall response rates indicated no significant differences

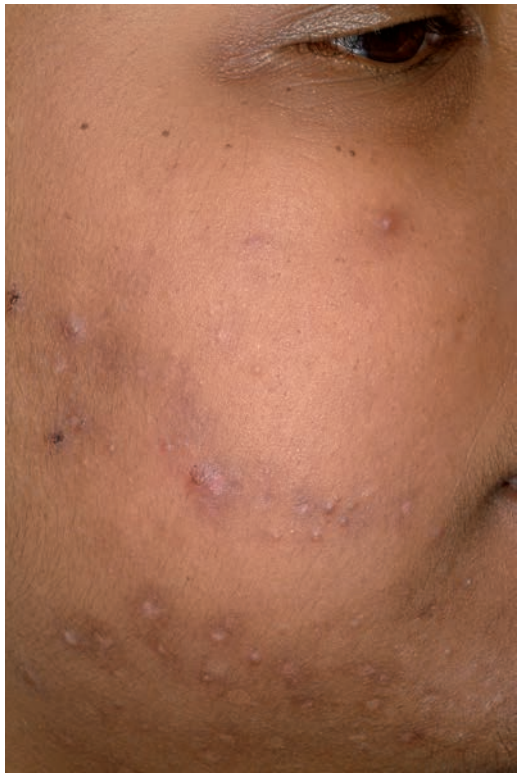

Figure 6-7 Irritant contact dermatitis. Scaly and erythematous patches of the cheeks surrounding hypopigmented acne scars in a patient treated with a benzoyl peroxide product. (Courtesy of Pearl E. Grimes, MD.)

between the two races. Thus, it is more likely related to differences in individual history of allergen exposure.

Commonly used topical irritants include tretinoin, benzoyl peroxide, alpha hydroxy acids, and salicylic acid. These products can be used safely and efficaciously in dark skin; however, they must be cautiously titrated, starting with lower concentrations. Interestingly, it is a consensus of the cosmetic industry in Korea that glycolic acid concentrations higher than 5% are intentionally avoided, because premarketing product safety tests showed a marked irritation response. In the United States, in contrast, glycolic acid is available in concentrations up to 8% over the counter.

Whether this difference in tolerability represents true ethnic differences in sensitivity or cultural differences, the therapeutic paradigm may vary to minimize adverse reactions in darker skin. Hypoallergenic cleansers and moisturizers are also recommended to maintain optimal barrier function with postoperative skin care. Maintaining an intact skin barrier is the best protection against irritants, infections, and harmful environmental stimuli.

SCARRING

Hypertrophic scars and keloids are common in darker racial ethnic groups, in particular blacks and Chinese. Keloids are well-demarcated overgrowths of scar tissue that occur in genetically predisposed individuals. Many cutaneous injuries, especially lacerations and surgical trauma, may precipitate keloids. Transforming growth factor beta 1, mast cells, melanocytes, the gli-1 oncogene, and integrins may play a major role in keloid formation. Therapies for keloids and hypertrophic scars are discussed in Chapter 34.

Many individuals avoid surgical procedures for fear of these unwanted scars. Keloids and hypertrophic scarring may indeed complicate surgical procedures in dark skin. Thus, considering whether a darker-skinned patient has a history of keloid or excessive scar formation is an important part of selecting patients for surgery. Also, a careful evaluation of a patient's personal and family history and close physical examination of the patient's skin may reveal any changes secondary to trauma. Even a completely negative evaluation, however, does not guarantee that the patient will be free from these adverse results. However, minimizing scarring and achieving proper wound healing can occur as long as the physician abides by the well-recognized principles of wound healing and care for scar formation in darker skin types (see Chapter 34).

OILY SKIN AND ACNE

Sebum, secreted by the sebaceous glands, is the major component of the lipid film that covers the face. Sebum secretions vary with age, sex, genetics, and topographic variations of the skin.[27–30] The amount of facial sebum secretion is an important consideration in facial skin care. Current studies show no significant differences between African Americans and Caucasians in instrumental measurements of sebum.[25] It is noted that in Asian women, there is a positive correlation between darker pigmentation and the amount of skin surface lipids.[31]

Facial skin types are commonly classified into three types: Oily, normal, or dry (based on the individual's subjective judgment).[32] Excessive skin oiliness can be present in varying degrees in both men and women and may range from being merely a cosmetic burden to a frank disease state, such as severe seborrhea and acne (Fig. 6-8A,B). Excessive seborrhea, characterized by coarse-pored skin, minimal acne, and oily scalp hair, is a well-known clinical entity. It causes considerable concern, has significant social impact, and affects the quality of life in some individuals. Typical treatments include topical tretinoin, glycolic acid, and azelaic acid to improve texture of skin to some degree. Recently, elubiol, a dichlorophenyl imidazoldioxolan, exhibited a clinically significant effect on oily skin.[33] Moreover, superficial chemical peels facilitate and expedite the responses to topical agents. An excellent improvement was observed in rough and oily skin when using a series of salicylic acid chemical peels in patients with skin types V and VI. Salicylic acid peels also improved the appearance of enlarged pores. Although other superficial peels induce similar responses, salicylic

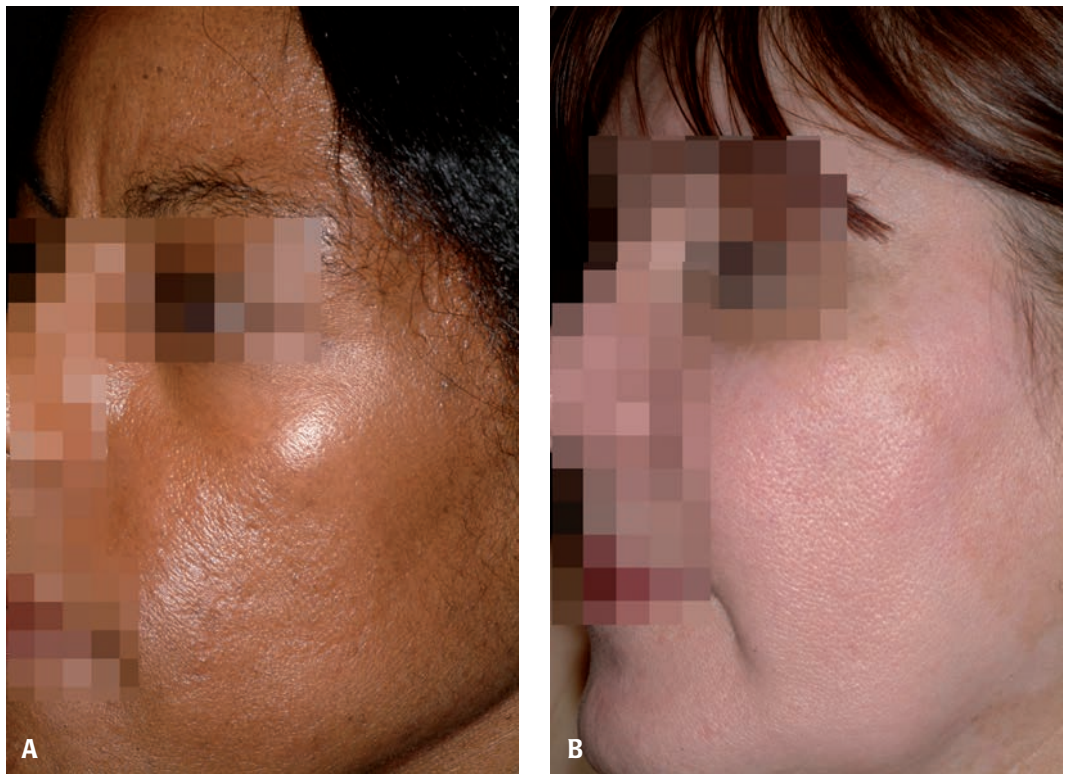

Figure 6-8 Oily and enlarged pores in an **(A)** African American and **(B)** Caucasian. (Courtesy of Pearl E. Grimes, MD.)

acid appears to have maximal efficacy for oily skin because of its lipophilic effects.[34] Recently, Geissler et al. reported that a very low dose of isotretinoin is effective in controlling seborrhea. Daily doses of 2.5 and 5 mg isotretinoin were effective in reducing sebum production.[35] Zileuton, a 5-lipoxygenase inhibitor, also directly inhibits sebum synthesis in a transient manner with the potency similar to low-dose isotretinoin.[36]

Acne vulgaris is common in people of all ethnic skin types (Fig. 6-9A,B,C). Overall, neither race nor ethnicity greatly influence acne prevalence, a disorder that consistently ranks as the top dermatologic diagnosis in populations of all skin types. Similarily, the basic pathophysiology of acne is most likely comparable in all skin phototypes. In dark skin as well as white skin, the well-known quartet of acne pathogenic factors includes excessive sebum production, abnormal follicular keratinization and plugging, proliferation of *Propionibacterium acnes*, and inflammation.[37] Increased sebum production stimulated by androgens is almost always the first listed pathogenic factor promoting acne. A correlation between the severity of acne and facial sebum secretion is generally accepted.

Although this classic pathophysiology is shared, the subsequent evolution of the acne lesion and the degree of inflammation at clinical presentation may vary among individuals according to their skin types. In particular, nodulocystic acne appears to be more common in Caucasians and Hispanics than in African Americans.[38] Patients with darker skin are at an increased risk for developing PIH and keloid scarring subsequent to acne lesions.

The major treatment options for acne itself are also similar for patients across the wide range of skin phototypes. All the approved topical and systemic medications can be considered in patients with ethnic skin. However, the selection, dosing, formulation, timing, and combination of these acne treatments will rely on clinical assessment of each patient's condition—including a careful consideration of the unique acne-related problems of ethnic skin.

The most critical issue related to acne in dark-skinned patients is the development of PIH. PIH can develop in response to the acne itself or to any overly aggressive acne treatment (e.g., thermal, chemical, or trauma) that disturbs the skin. Early and aggressive treatment is always best for avoiding PIH,[39] but the therapy must also be thoughtfully selected to achieve a balance to eliminate the acne without inducing the PIH. Keloid formation is also more common following acne in African American, Hispanic, and Asian patients versus white patients. These keloidal overgrowths of scar tissue are between five and 16 times more frequent in patients with skin of color. Although not as common as PIH, keloidal scarring is more permanent and disfiguring.

Pseudofolliculitis barbae is a common condition observed primarily in men of African descent who shave (Fig. 6-10). However, the condition can occur in other racial

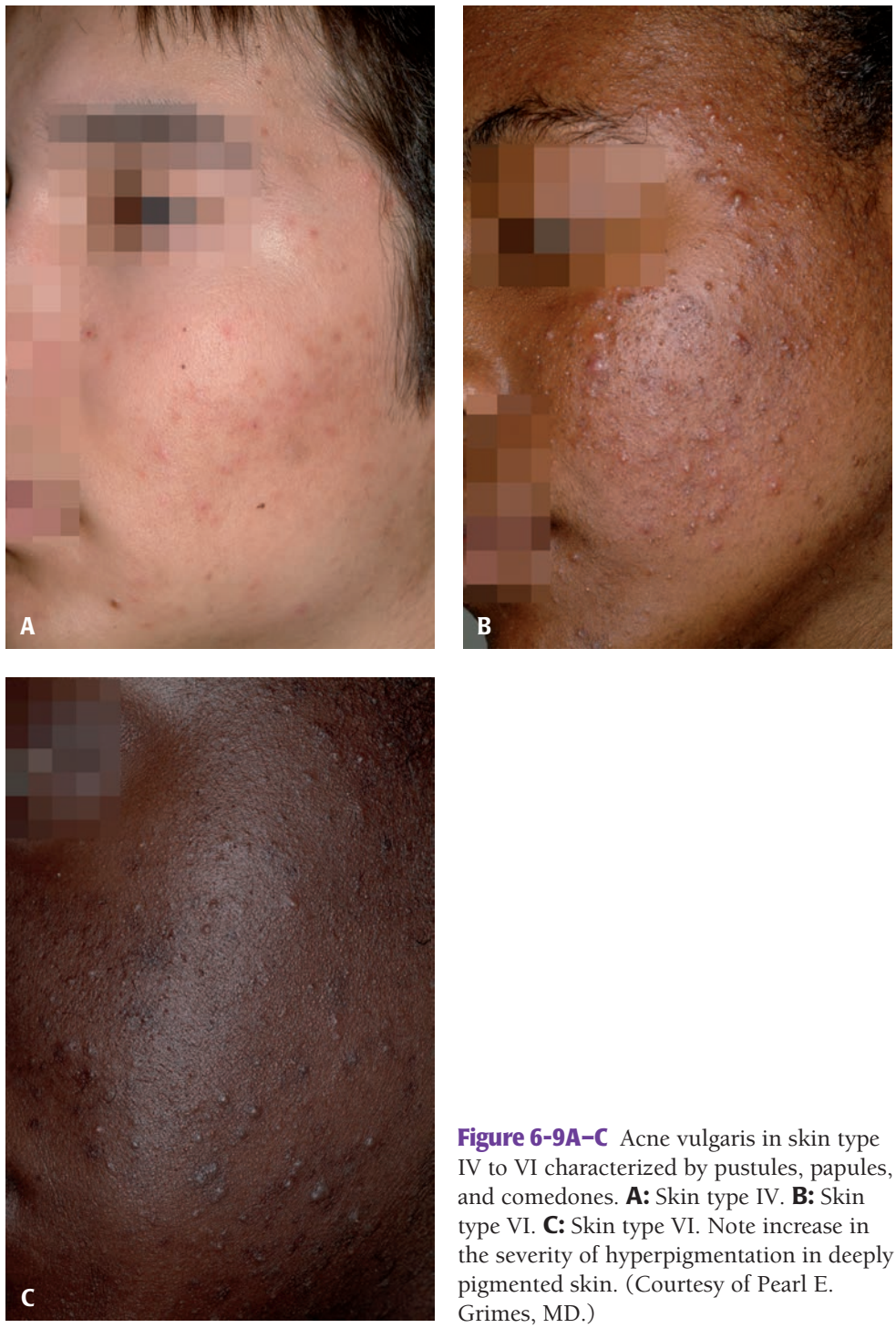

Figure 6-9A–C Acne vulgaris in skin type IV to VI characterized by pustules, papules, and comedones. **A:** Skin type IV. **B:** Skin type VI. **C:** Skin type VI. Note increase in the severity of hyperpigmentation in deeply pigmented skin. (Courtesy of Pearl E. Grimes, MD.)

ethnic groups. It is characterized by inflammatory papules and pustules in the beard region. The condition results from ingrown hairs because of the curved nature of the hair follicle in blacks. Women are also affected by this condition. Treatments include topical antibiotic formulations, benzoyl peroxides, and retinoids. Growing a beard alleviates the condition. Laser hair removal (see Chapter 32) is becoming increasingly popular for facial hair removal in men.

CULTURAL CONCERNS

In spite of the significant influence of the Western world on beauty standards of other countries, there remain tremendous differences between cultures. Culture often dictates beauty standards, as well as choice of cosmetic procedures and surgical outcomes (see Chapter 1). The basic appreciation of these factors is therefore helpful in

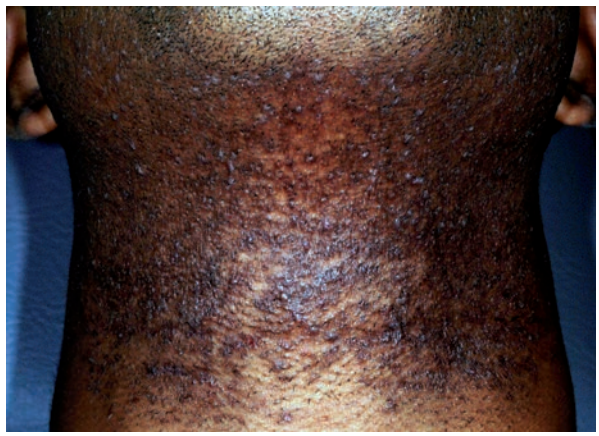

Figure 6-10 Pseudofolliculitis. Inflammatory papules and pustules in the beard area caused by ingrown hairs. (Courtesy of Pearl E. Grimes, MD.)

providing appropriate response to the aesthetic and cosmetic surgery desires and concerns of darker racial ethnic groups.

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7

Informed Consent and Treating the Cosmetic Patient

Mathew M. Avram and Daniel E. Kremens

By law, all patients have a right to informed consent before receiving any health-care treatments. This law applies to all procedures and treatments whether they be invasive or noninvasive, oral or topical, medical or cosmetic. Failure to obtain informed consent for a procedure or other treatment constitutes a battery and renders the physician liable for civil damages. This chapter will examine the law of informed consent as it applies to patients undergoing cosmetic procedures, particularly those with darker Fitzpatrick skin phototypes.

BACKGROUND

American jurisprudence has strongly supported the concept of patient autonomy. There is a strong judicial belief that a patient has a right to be free from nonconsensual touching or interference. As stated by Justice Cardozo, "Every human being of adult years and sound mind has a right to determine what shall be done with his own body."[1]

The doctrine of informed consent protects the patient from unwanted contacts. A patient need only demonstrate that he or she was not properly informed of the nature of touching or treatment to prevail in such an action.

Violation of the duty to obtain informed consent from the patient constitutes a battery. The burden of proof is far simpler than that of a negligence action, for which a plaintiff needs to prove a breach of a duty that caused harm. In an action based on battery, physical injury or harm need not be shown to prevail. All that needs to be shown is a nonconsensual touching or treatment. The focus of a battery action is always on whether the touching was consensual. Thus, there is no need for expert witnesses or learned medical treatises in these cases. Indeed, one does not even need to establish a doctor–patient relationship. All that is at issue is whether the patient was informed sufficiently before the physician's treatment.

REQUIREMENTS

There are several factors that must be included in a valid patient consent. The first factor is that the patient must have capacity to make a decision regarding his or her health care.[2] Dermatologists may encounter situations in which capacity is in question. For example, minors lack capacity to consent for many medical procedures. The cosmetic dermatologist therefore should see minors with their parents present, and the physician should determine which, if any, procedures are appropriate for young skin. Similarly, the cosmetic dermatologist may encounter patients with mental illnesses, such as body dysmorphic disorder (BDD), who look to cosmetic procedures as a way to fix their perceived imperfections.[3] Given their underlying pathology, such patients are often not satisfied with even the best results and may sue.[3] The cosmetic dermatologist should have a low threshold to seek appropriate psychiatric consultations before any procedure on a patient suspected of having BDD or other mental illness.

The second factor is that consent must contain adequate information.[2] Most jurisdictions use the "reasonable person" standard to determine what is adequate.[2] The consent must contain the information that a reasonable person requires to make a health care decision.[2] The consent must describe the diagnosis as well as the nature and purpose of the treatment. Furthermore, it must explain the risks and side effects of the procedure, as well as alternatives. For medications, side effects must be described even when there is only a small risk.

In assessing whether to describe each risk, it is important to consider any potentially severe side effects. Thus, even a small risk of serious morbidity or death should be disclosed. One must also consider the particular susceptibilities of the patient. In a patient with a higher Fitzpatrick skin phototype, the risk of pigmentary changes is higher than that of a skin phototype I or II. This should be emphasized both in the patient consultation as well as a proper written consent. For example, there is a higher risk of obvious hypopigmentation in a Fitzpatrick skin phototype VI

undergoing laser tattoo removal treatment than in a skin phototype I. The high risk of obvious and cosmetically unappealing hypopigmentation should be emphasized with such a patient. Such practice is not only good from a legal standpoint but also provides a patient with a realistic understanding of potentially troubling side effects. In the event the patient asks more specific questions, the duty expands. Thus, if a patient inquires as to the frequency of side effects such as keloids, the physician would be under a duty to provide more specific information regarding this question than if the patient had not directly asked.

The notion of adequate information also includes alternative treatments. Alternative methods of diagnosis, treatment, and probability of success must all be included in a proper informed consent. Therefore, if a patient is being treated for postinflammatory hyperpigmentation with salicylic acid peels, alternatives such as topical hydroquinone and other bleaching creams should be noted as part of an informed consent. Alternatives should be disclosed even if the procedure entails more side effects or even if the physician has less skill performing those procedures. Alternatives only include those procedures that are within the standard of care. Physicians who practice alternative care are under a duty to discuss traditional medical therapies and procedures as part of an informed consent.

A physician's conflict of interest also comes under the category of adequate information.[4] The physician must disclose all research and economic interests in a particular device or procedure before treatment. Therefore a physician must disclose financial ties to a laser company before treating a patient with that laser.

There are some issues that do not need to be disclosed in a consent form. The risk of poor or unskilled performance need not be disclosed. Moreover, professional training does not need to be included. Thus, if an ophthalmologist performs pulse dye laser for centrofacial rosacea, there is no duty to document lack of dermatology training.

Implicit in the consent for treatment is the option to refuse treatment.[2] In the cosmetic arena, refusal of treatment is typically not a serious concern. However, some jurisdictions require a physician to disclose the consequences of failing to treat as part of an informed consent. A patient refusing intralesional steroid treatment for an incipient keloid has a right to be informed of the consequences of a failure to treat.

The third factor in a valid consent is that the patient must consent freely.[2] Patients must not be coerced by the physician into accepting a cosmetic procedure. Coercion may be as obvious as threatening a patient if he or she does not consent to treatment or as subtle as exaggerating the benefits of accepting the proposed treatment.[2] The dermatologist must be careful not to embellish the expected results of a procedure.

CAUSATION

To establish causation in a battery action, one must demonstrate a link between a failure to disclose and the injury produced. In essence, the patient needs to show that he would have declined treatment in the event he was fully informed. There are two tests for making this determination. The first is the subjective particular patient test in which the determination is made in terms of the jury placing itself in the shoes of the plaintiff. This is the minority rule. The second rule, which is followed in most jurisdictions, is the reasonable person test. This is an objective standard and, accordingly, there is no need for the plaintiff's testimony. Here, the jury places itself in the shoes of the reasonable patient. A determination of whether the risk would be material to a reasonable patient under the circumstances is then made. The medical condition of the patient, patient age, risk of treatment, and risk of alternatives are all considered in making this determination.

DAMAGES

In the event that the duty to obtain an informed consent is breached and a procedure is performed that the patient otherwise would have refused, the physician is liable for all resulting damages.[5]

EXCEPTIONS

True emergency situations almost never arise in cosmetic patients. In the absence of a true emergency, courts are loath to protect a physician claiming this exemption. Courts are equally loath to honor blanket authorizations for medical care.[6] Overbroad waivers are viewed with disfavor and distrust, again because of the basic asymmetric relationship between a patient and a physician. Informed consent requires more specificity. Still, a patient can waive his right to know—i.e., "Doc, just do what you think is best."[7]

A patient who misleads a physician cannot subsequently make a claim based on failure to obtain an informed consent.[8] For example, a tattoo patient who incorrectly denies a history of gold intake cannot sue a physician for failing to discuss the high probability of chrysiasis after Q-switched laser therapy. The patient has a duty to provide the physician with relevant, accurate information as part of an informed consent case. Furthermore, a patient cannot claim miscomprehension in the absence of a showing of incompetence. The courts are skeptical of ex post facto claims of patient incomprehension and mental incompetence.

DOCUMENTATION

The best way to prove patient consent is by proper documentation. Written consent is the best proof of patient consent. A clearly worded patient consent form will protect the physician from a suit based on battery. It will not protect the physician from an action based on negligence or other legal causes of action.

The protections afforded to written consents, however, do have restrictions. The courts have long held that the physician and patient are in an asymmetric relationship. Thus, the courts have imposed duties on the physician to communicate to the patient in a comprehensible fashion. A written consent is not effective if the patient does not understand material information about the procedure. In other words, a written consent heavy on medical jargon regarding the expected risks and benefits of the procedure will not protect a physician in a case based on failure to obtain informed consent, i.e., battery.

Therefore, written consents should forego medical jargon in favor of layperson terms. Consents should use "bruising" rather than "purpura" when explaining the side effects of pulse dye laser. Similarly, for botulinum injections, terms such as "ptosis" should be replaced by "drooping." Complicated, legalistic consent forms create more problems in informed consent actions than they alleviate (Table 7-1). Juries are also more sympathetic to simple, layperson language than medical terminology.

Table 7-1

Preferred terms for written consent forms

Medical term	Layperson term
Hyperpigmentation	Darkening of skin
Hypopigmentation	Lightening of skin
Erythema	Redness
Edema	Swelling
Bullae	Blistering
Purpura	Bruising
Ptosis	Drooping
Diplopia	Double vision
Atrophy	Thinner skin

SUMMARY

The best way to avoid a legal case under the theory of battery is to maintain a good patient-physician relationship along with proper informed consent. Informed consent should not be thought of as a discrete event but rather as an ongoing dialogue with the patient involving communication and education.[2] Rushed conversations before extensive cosmetic procedures anger patients, particularly if there are unforeseen side effects. The cosmetic dermatologist should anticipate and communicate clearly foreseeable complications. Carefully explaining the risks and benefits of a procedure, alternatives, and expected side effects, along with a clear written consent, will obviate most cases of battery.

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8

Photography in Cosmetic Surgery

Pearl E. Grimes

THE IMPORTANCE OF PHOTOGRAPHY IN COSMETIC PROCEDURES

The unique reliance in dermatology on the recognition and interpretation of visual clues for diagnosing, treating, and monitoring skin conditions has made photography an important tool in dermatological practice for more than 100 years. As early as the 1860s, photographs and daguerreotypes were featured in atlases of skin diseases;[1,2] advances in technology have allowed the use of photography to become a standard part of dermatological practice, with many useful applications in cosmetic surgery.

Advantages and uses of photography

Photography is rapid and noninvasive, and high-quality images can be obtained relatively easily with careful attention to basic techniques. Photography can be performed in the consultation room and provides a permanent record that can be stored digitally and transmitted electronically. Standardized "before" and "after" or sequential images can be taken, providing invaluable backup in case of queries or disagreements about the outcomes of treatment. Table 8-1 summarizes the uses of photography in cosmetic surgery.

Key issues

The most important objective when setting up a cosmetic surgery photography system is to be able to produce high-quality, reproducible images that permit adequate assessment and comparison between time points. Factors such as the setup costs of photographic equipment, printing, and computer hardware/software support, as well as arrangements for the secure storage, retrieval, and transmission of images, need to be carefully considered. Finally, the need to assure patient anonymity and confidentiality, to obtain informed consent for photography, and to ensure that images cannot be altered inappropriately or tampered with, also need to be considered.

OPTIONS FOR PHOTOGRAPHY SYSTEMS

The basics

1. ***A designated area for taking photographs***. Ideally, this should be a permanent area, so that the consistency of images is easier to control and equipment can be left undisturbed between sessions. Sufficient space is required for patients to sit or stand with any supporting structures in place, with the camera at an appropriate distance and space for associated equipment and lighting as required.
2. ***A 35-mm single-lens reflex (SLR) or digital camera with an ultraviolet (UV) filter and tripod***. Increasingly, conventional film photography is being superseded by digital imaging.
3. ***A uniform, plain background***. A plain, nonreflective background is required: one wall mounted, plus a separate plain cloth or board against which to take horizontal close-up pictures.
4. ***Adequate, consistent lighting***. Cameras vary in how they permit color and white balance to be set (some are manual, others automatic). For close-up photography of the skin, flash photography provides consistency, but the short working distance may result in an overexposed, "washed-out" image. For whole-body photography, additional freestanding or wall-mounted lighting may be useful.
5. ***Patient seating***. The patient should sit or stand at a designated point, with the distance from the camera marked or recorded so that the same position can be used for serial images.
6. ***A chin rest or other equipment***. These standardize the focal length, steady the parts of the body to be photographed, and maintain consistent position for reproducibility of sequential photographs.
7. ***Image storage***. Adequate, secure storage is needed for both digital photographs or slides. Computer-based storage must be regularly backed up and needs to be sufficiently secure to resist hacking or tampering.

Table 8-1

The uses of photography in cosmetic surgery

- ***Diagnosis*** and for corroboration when a second opinion is sought
- ***Documenting and monitoring disease progression***: Photographs provide a permanent "baseline" record from which to assess change
- ***Documenting and monitoring treatment***: Serial images using standardized conditions permit assessment of the skin before and after treatment
- ***Informing decisions about retreatment*** or changes to the therapeutic approach
- ***Teaching/lecturing***: Photographs can be incorporated quickly and easily into slide presentations for educational purposes
- ***Patient information***: Images can be used to illustrate likely or possible outcomes of treatment
- ***Publication***: Photographs can be used in journal articles and books
- ***Insurance purposes***: For baseline documentation at diagnosis and to illustrate the outcomes of treatment
- ***Medicolegal purposes***: Photography provides a valuable aid to risk management in cosmetic surgery
- ***Telemedicine/teledermatology***: Electronic transmission of images to aid in diagnosis or monitoring of treatment is particularly useful for patients living in remote areas and for those in the military or in prison (teledermatology does, however, raise important medicolegal considerations)

8. ***Simple photomicrography***. Basic photomicrography can be performed using simple photography through the eyepiece of the microscope.

Conventional (film-based) or digital photography?

The advance of digital photography technology and the fall in the cost of equipment has led to the increasingly widespread adoption of digital imaging in cosmetic surgery. Table 8-2 compares the two methods.

Film-based photography

Conventional 35-mm photography offers superior resolution over digital imaging, but it can be more difficult to master and to produce reproducible images at different time points because of the variability introduced by different film batches, exposure, lighting, and development processes. Conventional photography can also require bulkier equipment than digital imaging and lacks the instant-preview facility of digital photography. Processing and printing of conventional film needs to be carried out professionally and can be expensive.

Digital photography

Digital photography offers instant imaging and previewing, without the delay or expense of processing. It also offers easy, convenient image storage, retrieval, databasing, and electronic transmission. Even basic digital images, though of lower resolution than analogue photographs, provide sufficient detail for diagnosis and monitoring in cosmetic procedures.

Basic, inexpensive digital equipment can provide high-quality images, but for high-end photography, more specialized (and costlier) equipment may be appropriate. A significant advantage of digital imaging in cosmetic procedures is the ability to manipulate images electronically to show patients how the results of treatment might appear.

Potential drawbacks of digital photography include high initial start-up costs (although the costs of digital systems have fallen as technology has improved), the possible need for staff training in new technology, and the cost of printing digital photographs, software, and computer backup. It can be more difficult to obtain consistent high-quality digital images, and the potential for inappropriate or unauthorized image manipulation may be greater with digital photography.

OPTIMIZING COSMETIC SURGERY PHOTOGRAPHY

Composing high-quality, standardized photographs that permit comparison at different time points following cosmetic procedures requires careful planning. Photographs must provide an accurate representation with sufficient detail and resolution, and the photographic setup should be designed so that images can be produced in a consistent, reproducible way.

Standardization of images

Consistency is key when documenting the results of cosmetic procedures over time or when images are required for medicolegal purposes. As well as standardizing the physical environment and equipment used for cosmetic surgery photography, the use of standard protocols for cosmetic surgery photography are essential. There should be consistency in positioning of the subject. Ideally, cosmetic surgery photography requires a point-source flash to avoid the elimination of shadows caused by the more widely used ring flash. The background should be plain matte black or midblue. Exposure should ideally be set manually and must be consistent for "before" and "after" images to avoid differences in visible detail. The number

Table 8-2

Comparison of conventional and digital photography

Conventional photography	Digital photography
Advantages	
Superior image resolution	Low-resolution images contain sufficient detail for diagnosis and assessment
Does not require expensive computer storage/databasing software	Quick, easy, and convenient
Images cannot be easily tampered with or transmitted	Instant preview facility
Basic equipment light, compact, and portable	Basic equipment light, compact, and portable
May not require additional up-front equipment costs or additional staff training	Does not require "hard copy" storage, thereby saving on printing costs and space
	Quick and convenient incorporation of images into slides for presentations
	Ease of electronic transmission
	Ease of image display and manipulation to demonstrate the results of treatment/procedures
Disadvantages	
Setup costs can be high	Setup costs can be high; advances in digital imaging may necessitate frequent replacement
Can be harder to master photographic technique to obtain consistent, high-quality images	Complex equipment/storage may be difficult to master or require specialist information technology training
Developing and printing costs can be high	Printing and electronic storage costs can be high
	Greater potential for inappropriate image manipulation

of images taken should be standardized. The distance between subject and camera should be uniform, and different lenses should be used to produce images of the desired size for different applications (e.g., full face and neck at a scale of 1:10 for documentation of rhytidectomy; close-up imaging of single features at a scale of 1:2 to show details of skin texture or incision lines). Specific views should be standardized for repeat photographs (e.g., frontal and lateral views in facial imaging, upper or lower body images). Photographs should be taken at specific intervals to document the outcomes of treatment or healing. Finally, specialized techniques or equipment should be considered for optimal results. These include ultraviolet light or polarized light, frequency of imaging, and inclusion of reference markers.

Image resolution

The "gold standard" for photographic image quality is 35-mm slide film, which produces images with a resolution of 4,096 × 2,736 pixels per frame.[3] This permits large-scale projection of images without "graininess" or loss of detail.

Digital cameras use a charge-coupled device, or CCD, which converts light into electrical voltage, and this is then converted by the camera into binary data to produce the photographic image. Some cameras have CCDs with pixel density equivalent to that of conventional slide film, but these are expensive. In addition, the high resolution of the images produced requires large amounts of computer memory for storage, and they take longer to transmit

electronically. However, even basic digital images with a resolution of just 768 × 512 pixels are adequate for sufficient recognition of details in dermatological photographs.[4]

Color/white balancing

For most cosmetic surgery photography, the use of a flash is preferable to produce a uniform color balance and aid the accuracy of image consistency and reproducibility. Cameras usually offer the option of setting the white/color balance either manually or automatically.

When taking photographs with 35-mm film and flash, color balance is assumed to be constant. However, when digital photography is performed, even using flash, most cameras retain sensitivity to ambient light. The white balance must therefore be calibrated to the light source by aiming the camera at a neutral white object and engaging the white balance control. The camera then calibrates itself to the ambient light conditions.

Image compression

The greater the resolution and depth of color of a digital photograph, the larger the file size. To make storage and transmission easier, quicker, and less costly, the digital camera (or scanner, or computer) generally "shrinks" or compresses the file as it is saved to memory. Subsequent viewing, projection, or printing results in the image being decompressed. File compression can be either lossless or lossy. Images compressed using the lossless method do not lose any data when subsequently decompressed but require more memory for storage. In contrast, lossy compression results in some loss of information, though usually in parts of the photograph where the visual data is least variable.

IMAGING FOR DIFFERENT APPLICATIONS

Table 8-3 summarizes the different imaging applications in dermatology.

Ultraviolet light examination and photography

UV radiation at wavelengths between 300 and 400 nm (Wood's light) penetrates the epidermis and is absorbed by melanin. Areas containing high concentrations of melanin therefore show up as dark patches, whereas hypopigmented

Table 8-3

Summary of different imaging applications in dermatology

Technique	Used in assessment of:
UV light examination and photography	• ***Pigmentation changes*** associated with melasma and vitiligo • ***Photodamage*** caused by sun exposure • ***Changes in skin color*** caused by scarring or collagen deposition
Polarized light photography	• ***Vascular lesion***—e.g., port wine stains, rosacea, periungual telangiectasia • ***Pigmented lesion***—e.g., nevi and lentigines • ***Photodamage*** to the skin • ***Inflammatory conditions***—e.g., psoriasis and acne • ***Skin surface morphology***—e.g., wrinkles, skin elevation/depression, loss of skin markings
Epiluminescence micrography (dermoscopy)	• ***Diagnosis and assessment of pigmented lesions***—e.g., malignant melanoma, benign pigmented macules, melanocytic nevi, lentigo maligna • ***Assessment of nonmelanocytic lesions***—e.g., pigmented basal cell carcinoma, seborrheic keratoses, hemangiomas
Confocal laser microscopic imaging	• ***High-resolution imaging, diagnosis, and assessment of skin pigmentation*** • ***Differential diagnosis of pigmented skin lesions, particularly malignant melanoma*** • ***Assessment of skin architecture*** • ***Imaging for basic skin research***

areas appear paler. UV light imaging is useful in the visualization, diagnosis, and assessment of:

- ***Pigmentation changes*** associated with melasma. The epidermal form of the condition is enhanced under UV light, whereas the dermal form is not. Mixed melasma features an increase in both epidermal and dermal pigmentation.
- ***Hypopigmentation*** of the skin associated with vitiligo.
- ***Photodamage*** caused by sun exposure.
- ***Changes in skin color*** caused by scarring or collagen deposition, which is not associated with changes in melanin content and which manifests as skin lightening in ordinary white light.

Polarized light photography

When light hits the skin, around 4% to 7% of the reflected light undergoes reflectance from the skin surface, which accounts for the surface "glare" or shine, and provides information about skin texture.[5,6] The remaining reflected light consists of that which has penetrated below the skin surface and been scattered by structures within it, including collagen fibrils, blood vessels, and pigmentation. This back-scattered light provides visual clues about skin infrastructure.

The multiple scattering of light returning from underneath the skin surface causes the incident light polarization to be disrupted, whereas regular reflectance preserves the plane of polarization. This difference can be used to distinguish details at the surface of and within the skin by the use of polarizing filters in parallel or at right angles to one another when taking photographs. If the filters are in parallel, details of the skin surface are highlighted at the same time that details of skin color, pigmentation, and vascularity are reduced. If the filters are perpendicular to one another, however, only the back-scattered light is able to pass through the lens, and the opposite effect is achieved.

Polarized light photography is useful for assessing a variety of conditions. It is beneficial for vascular lesions in the skin (including port wine stains, rosacea, and periungual telangiectasia). In addition, it is most beneficial for assessing pigmented lesions, including nevi, lentigines, photodamage, and melasma (Fig. 8-1A–C and Fig. 8-2 A–C). It has also proven valuable when assessing skin surface morphology, including the appearance of wrinkles, skin elevation, or depression and nail or hair-shaft dystrophies.

Epiluminescence micrography (dermoscopy)

Epiluminescence microscopy (ELM)—or in vivo cutaneous surface microscopy, dermoscopy, dermatoscopy, incident light microscopy, or magnified oil immersion—combines incident light magnification with oil immersion to examine pigmented structures within the skin.[7]

Small, low magnification (e.g., up to 10X), handheld dermoscopes are available for ELM, as well as more advanced and expensive equipment, such as stereomicroscopes and digital imaging equipment. The primary clinical use of ELM is in the diagnosis and assessment of pigmented lesions—such as malignant melanoma, benign pigmented macules, and melanocytic nevi—and in early recognition of lentigo maligna.[8–10] It is also useful for assessing nonmelanocytic lesions, such as pigmented basal cell carcinoma, seborrheic keratoses, and hemangiomas.[11]

Confocal laser microscopic imaging

In vivo confocal scanning laser microscopy (CSLM) is a specialized imaging technique that permits optical "sections" of the skin to be visualized at extremely high resolution. A diode laser, at a wavelength of 830 nm, is focused through a lens and the light used to scan selected areas of the skin. The reflected light is analyzed to produce images that are displayed on a screen. Movements of the laser permit different areas across the surface and through the thickness of the skin to be visualized. The level of detail approaches that of histology, but without the need for biopsy or other invasive techniques.

CSLM is a powerful tool for the noninvasive examination and assessment of skin pigmentation, and is useful for the study of skin architecture, with a number of applications in cosmetic dermatology. Its main clinical use is in the early differential diagnosis of pigmented skin lesions, including malignant melanoma, pigmented actinic or seborrheic keratoses, solar lentigines, and pigmented basal cell carcinomas.[12–16]

Commercially available integrated packages for dermatology imaging

The growth of photography in cosmetic procedures has been accompanied by the development of a number of purpose-built, integrated packages designed for imaging, photography and image storage, and display and editing (e.g., Canfield Visia, Vectra, and Omnia).[17] Such systems provide flexibility and a variety of options for detailed imaging in cosmetic dermatology.

MEDICOLEGAL CONSIDERATIONS IN COSMETIC SURGERY PHOTOGRAPHY

Principles of risk management

Cosmetic procedures present unique medicolegal considerations. Perhaps in no other medical specialty are the results of treatment, particularly when assessed over a period of time, so open to subjective opinion and interpretation. This necessitates careful attention to risk management, which should be regarded not so much as practicing defensive medicine as simply ensuring that the patient has received the best standards of clinical care on the basis that good practice is always defensible. Maintaining good standards of clinical practice should include the following:

- ***Ensuring adequate consultation*** with the patient, including a full history and thorough discussion of the potential

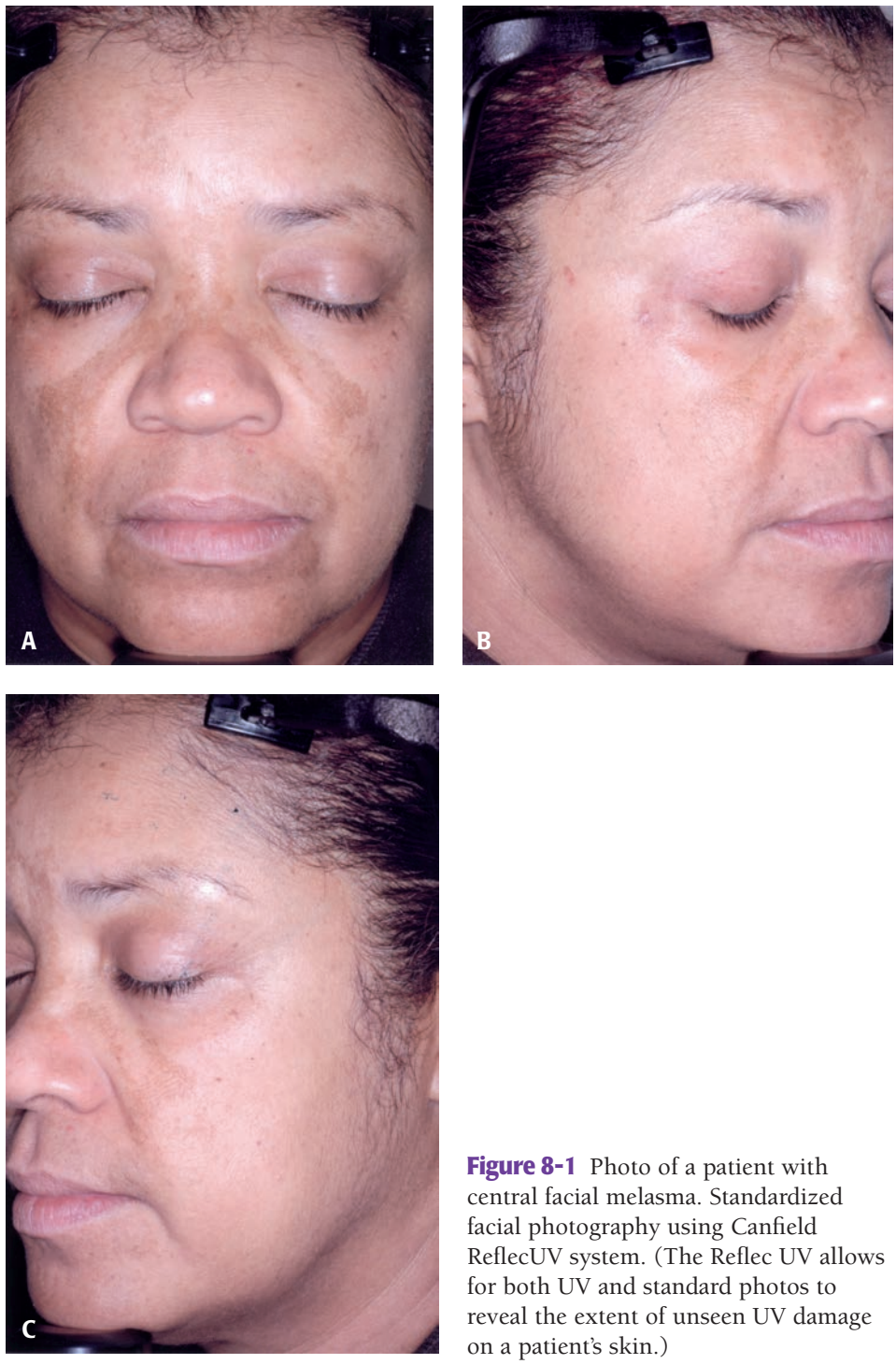

Figure 8-1 Photo of a patient with central facial melasma. Standardized facial photography using Canfield ReflecUV system. (The Reflec UV allows for both UV and standard photos to reveal the extent of unseen UV damage on a patient's skin.)

benefits and drawbacks of any intervention(s) being considered. Patients should be offered the opportunity to ask questions and discuss concerns, as well as to refuse, change their mind about, or delay treatment. Providing written information for patients to take away can help to reinforce the issues discussed, give time for reflection, help the patient to frame questions, and provide answers to queries.

- ***Maintaining high standards in creating and maintaining patient records***. Adequate documentation is needed (paper or electronic) of signs and symptoms; the diagnosis; treatment offered, including discussion of possible drawbacks or limitations of the suggested treatment and any concerns that the patient may have raised; and the progress and outcomes of treatment or healing over time.

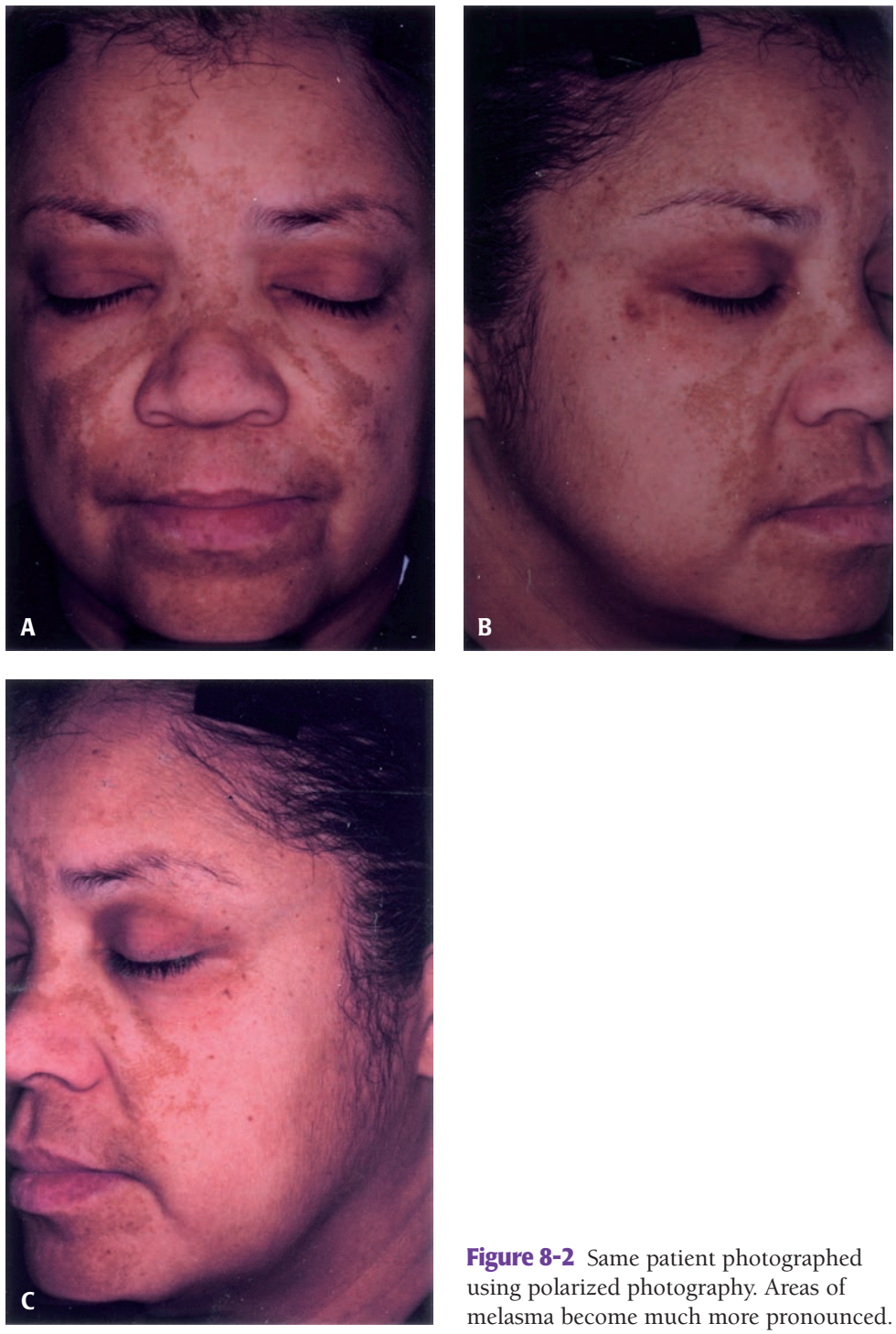

Figure 8-2 Same patient photographed using polarized photography. Areas of melasma become much more pronounced.

- ***Obtaining informed consent,*** preferably in writing, for any procedure performed. It may be useful to produce a standard form for obtaining informed consent that can be held with the patient's notes. Records should note whether the patient has been made aware of the downsides or limitations of treatment.
- ***Maintaining patient anonymity and confidentiality.*** In practice, this means ensuring that records and images are sufficiently secure that they cannot be viewed or disclosed, including electronically, to any third party (including other health care staff, e.g., receptionists) without the patient's permission; composing clinical photographs such that the patient's identity is concealed (it is no longer considered sufficient simply to "black out" the eyes in photographs, for example); obtaining informed consent for the use of clinical details or photographs for

teaching or publication (even where photographs are anonymous, it is advisable to obtain consent).

Photography as an aid to risk management in cosmetic surgery

Photography represents a powerful tool to aid risk management in cosmetic surgery in a number of ways. Because of the inherently subjective nature of visual assessment and the long periods that may elapse when only subtle changes occur, carefully composed photographs taken under standard conditions are particularly useful as a reproducible and permanent record. Photographs can be used to compare results before and after procedures, to document changes at different times during treatment or healing, and to help resolve disagreements or disputes about the outcomes of therapy. Close attention must therefore be paid to ensure consistency in lighting, exposure, background, and distance from the camera. Use of standardized color charts or other instruments is key to documenting color changes in the skin. It is important to produce images with sufficient resolution to show distinguishing or diagnostic features. The images should be dated so that changes can be tracked accurately over time.

Other medicolegal uses

Photographs can also be used to document the progress and outcomes of treatment for insurance purposes and to assist in legal disputes (e.g., for victims of burns or other accidents to provide proof of the extent of their injuries and the measures required to restore health and appearance).

Image manipulation

The convenience of digital photography has led to its widespread adoption for documentation of cosmetic procedures. However, the ease with which photographs can be altered using widely available software introduces issues of image manipulation. It can indeed be appropriate in some circumstances to change a photograph for educational purposes to show a patient how the results of cosmetic surgery may appear. In contrast, it would clearly be unacceptable and unethical to alter an image to suggest that the results of treatment were better than actually achieved or to enhance results in a photograph to convince another patient to undergo cosmetic surgery.

The American Society for Dermatology Surgery (ASDS) has developed a statement of ethics relating to this issue and views any manipulation of photographs intended to deceive the viewer as violating the ethical standards of the society.[18] Speakers at ASDS meetings are therefore required to make the audience aware of any changes they have made to photographs used in their presentations, either verbally or by marking each altered slide with an appropriate icon. Likewise, the editorial boards of journals and newspapers have become aware of image falsification and have devised strategies to deal with the issue.

Storage and transmission of images

Computer systems used to store or transmit photographs must be sufficiently secure to avoid unauthorized access, whether inadvertent (perhaps by other members of health care staff) or deliberate or malicious (i.e., hacking into data systems). The potential for loss of patient confidentiality and unauthorized image manipulation could lead to complaints and/or litigation. Such considerations may become more pressing as teledermatology becomes more widely used. The (U.S.) Health Information and Accountability Act requires health care providers to control and keep track of those who have access to identifiable digital medical information.

Conclusion

Advances in imaging technologies—in particular in digital camera technology and image processing, as well as image storage, retrieval, and electronic transmission in recent years—has made photography of cosmetic procedures simpler and quicker. It has made available an exciting new range of possibilities in clinical practice, teaching, and research. Given that dermatology is probably the leading medical specialty lending itself to the use of photography, practitioners are now better equipped than ever to make optimum use of photography in many areas of everyday practice and across a wide range of applications. An important use of photography in the field of cosmetic surgery is for documentation of the results of treatment, including changes in the condition of the skin over time following cosmetic intervention. Such images may be useful for medicolegal purposes if necessary.

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PART

2

Use of Cosmeceuticals and Pharmacologic Agents

9

Skin-Lightening Agents

Marta I. Rendon

Even skin coloration is highly desirable in many cultures and ethnic groups. As a result, hyperpigmentation disorders can cause significant stress and social ostracism.

Hyperpigmentation has many causes (Table 9-1). It can occur as a result of cumulative exposure to ultraviolet light, which can be a factor in melasma, solar lentigines, and ephelides. Hyperpigmentation can also result from certain medications, photosensitizing cosmetics, and inflammatory skin diseases. It can also occur as a postinflammatory response to chemical peels and cosmetic laser resurfacing procedures. In dark-skinned patients, laser therapy and surgical incisions often produce dark-pigmented scars and keloids. Although the incidence of hyperpigmentation occurs with increasing frequency beginning in the middle years, it can occur in young adults and can be associated with pregnancy and treatments for acne.

Multiple skin-lightening agents are available on the market. Many are associated with skin irritation, and an equal number are only partly effective or require long-term use before improvement occurs. In treating patients with darker skin, bleaching agents must be chosen carefully to avoid lightening pigmented lesions beyond the base color or causing irritation, which can lead to postinflammatory hyperpigmentation.

Many skin differences are apparent between individuals with lighter and darker skin tones, as well as among patients in various ethnic groups. These differences affect how the skin reacts to disorders such as melasma and postinflammatory hyperpigmentation, which may be accentuated in darker skin. Ethnic variability must be taken into consideration when treating patients with hyperpigmentation, as darker skin tends to be more sensitive to topical therapy.

Hydroquinone (HQ), a phenolic compound, is the most widely and successfully used agent for a variety of hyperpigmentation conditions, including melasma and postinflammatory hyperpigmentation. Recent interest in natural products has driven research in bleaching agents derived from plant sources and other natural ingredients (Table 9-2). In general, published evidence supporting the efficacy of many of these agents is poor. Fortunately, the effect of some bleaching agents on dark-skinned patients is known from clinical trials and experience. This chapter will include only those agents with evidence of a positive or negative effect on this population.

Table 9-1

Causes of acquired hyperpigmentation

Exogenous causes
Ultraviolet exposure (melasma, solar lentigines, ephelides)
Photosensitizing agents (bergamot oil, furocoumarin)
Medications (estrogens, tetracyclines, amiodarone, phenytoin, phenothiazines, sulfonamides)
Skin diseases and conditions
Melasma
Erythromelanosis follicularis
Linea fusca (Pellegra)
Poikiloderma of Civatte
Postinflammatory hyperpigmentation
Riehl's melanosis
Other diseases and conditions
Addison's disease
Hemochromatosis
Liver disease
Pituitary tumors
Pregnancy

Table 9-2

Depigmenting agents

Aloesin
Arbutin
Azelaic acid
Glycolic acid
Hydroquinone
Kojic acid
Licorice extract
Melatonin
Niacinamide
Paper mulberry
Retinol
Retinoic acid
Soy milk extracts
Salicylic acid
Tazarotene
Vitamin C

THE MELANIN PRODUCTION PATHWAY AND DARK SKIN

Knowledge of the melanin production pathway is necessary to understand the mechanism of action of skin-lightening agents. The melanin pathway begins with the action of the enzyme tyrosinase converting the amino acid tyrosine to dihydroxyphenylalanine (DOPA) and then to dopaquinone (see Chapter 2). Dopaquinone is subsequently converted to dopachrome, then to dihydroxyindole or dihydroxyindole-2-carboxylic acid (DHICA). In the presence of dopachrome tautomerase and DHICA oxidase, dopaquinone becomes the brown-black pigment eumelanin. In the presence of cysteine or glutathione, dopaquinone is subsequently converted into the yellow-red pigment pheomelanin.[1] Depigmentation can occur when an agent acts on key steps in this pigmentation pathway (Table 9-3).

Agents such as tretinoin act before melanin synthesis, blocking tyrosinase transcription. Many agents are effective during melanin synthesis by blocking tyrosinase or scavenging reactive oxygen species. Others work after melanin synthesis by increasing tyrosinase degradation or inhibiting melanosome transfer, or via accelerating epidermal turnover.[1]

Table 9-3

Reported effect of depigmentation agents on the melanin synthesis pathway

Premelanin synthesis
Tretinoin (tyrosinase transcription)
During melanin synthesis
Hydroquinone (tyrosinase inhibition)
4-Hydroxyanisole (tyrosinase inhibition)
4-S-CAP and derivatives (tyrosinase inhibition)
Arbutin (tyrosinase inhibition)
Aloesin (tyrosinase inhibition)
Azelaic acid (tyrosinase inhibition)
Kojic acid (tyrosinase inhibition)
Emblica (tyrosinase inhibition)
Tyrostat (tyrosinase inhibition)
Ascorbic acid [product reduction and reactive oxygen species (ROS) scavenger]
Ascorbic acid palmitate (product reduction and ROS scavenger)
Postmelanin synthesis
Linoleic acid (tyrosinase degradation)
α-linoleic acid (tyrosinase degradation)
Lecithins and neoglycoproteins (melanosome transfer inhibition)
Soy milk extracts (melanosome transfer inhibition)
Niacinamide (melanosome transfer inhibition)
Glycolic acid (skin turnover acceleration)
Lactic acid (skin turnover acceleration)
Linoleic acid (skin turnover acceleration)
Liquirtin (skin turnover acceleration)
Retinoic acid (skin turnover acceleration)
Helix aspersa Müller (skin turnover acceleration)

Dark or "ethnic" skin generally encompasses Fitzpatrick skin phototypes (SPTs) IV, V, and VI. Variations in skin color depend on various factors, including the amount of melanin produced and the number, size, and aggregation of the melanosomes within the keratinocyte. Although no

racial differences in the total number of melanocytes have been found, SPT VI has a higher total melanin content than SPT I and II (see Chapter 2). Although these differences have certain advantages, including reduced risk of photodamage with enhanced photoprotection and fewer incidents of skin cancer, there are also distinct disadvantages that must be monitored during therapy. These include increased frequency of hyperpigmentation, hypopigmentation, and irritant contact dermatitis. Little research has been conducted on different skin-lightening agents in non-Caucasians with darker skin. Significant data are lacking in reference to efficacy, tolerability, and treatment responses in this patient population.

DEPIGMENTING AGENTS

Hydroquinone

HQ is available over the counter (OTC) in strengths up to 2%, by prescription in strengths of 3% to 4%, and in concentrations up to 10% through compounding pharmacies. Four to 6 weeks of monotherapy with HQ is generally required before depigmentation becomes apparent (Fig. 9-1). HQ is the most potent inhibitor of melanogenesis in vitro and in vivo. It works by competitive inhibition of tyrosinase, which prevents conversion of dopa to melanin. Other mechanisms of action include the inhibition of DNA and RNA synthesis, degradation of melanosomes, and destruction of melanocytes.[2,3]

New HQ formulations—combining it with agents such as tretinoin, glycolic acid, vitamin C, retinol, or fluorinated steroids—are now available. The length of time required for these products to take effect varies. However, most patients show some improvement in hyperpigmentation in 1 to 3 months (Fig. 9-2 and Fig. 9-3). The combination of HQ 4%, tretinoin 0.05%, and fluocinolone 0.01% has been shown to have superior efficacy when compared with dyads of HQ and fluocinolone or HQ and tretinoin.[4] Several open-label and randomized clinical trials have assessed the efficacy and safety of HQ formulations compared with other modalities or placebo in darker racial ethnic groups. In general, the HQ formulations were well tolerated with minimal side effects.[5–9]

One randomized study examined topical combination therapy with HQ 4%, 0.05% tretinoin, and 0.01% fluocinolone acetonide in blacks, Asians, and Hispanics. No differences were seen in side-effect profile or efficacy among the treatment groups.[7]

In another randomized, controlled trial of HQ 4% versus placebo (n = 48; 4 men, 44 women) in Brazilian patients ages 19 to 55 with melasma, patients applied the product twice daily along with sunscreen. Outcomes were assessed at 12 weeks by subjective clinical evaluation and photography. Greater improvement was seen in the HQ

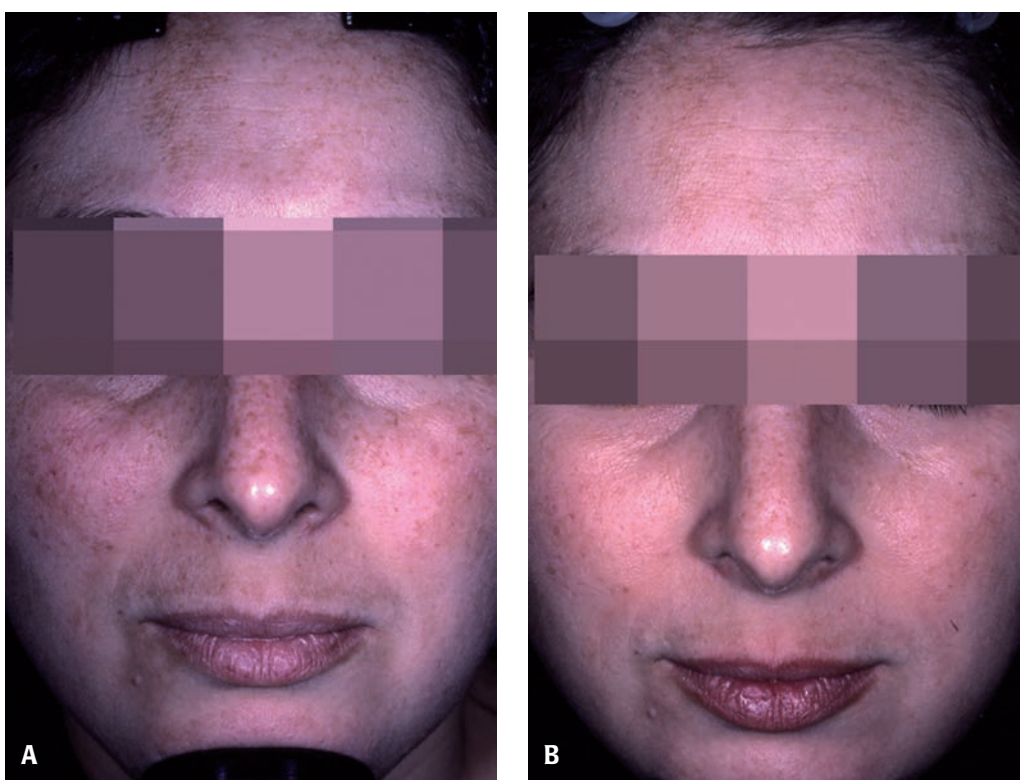

Figure 9-1 Melasma. **A:** Baseline. **B:** After 8 weeks of treatment with Hydroquinone 4% and retinol 0.15% applied twice daily. (Epiquin Micro). (Courtesy of Pearl E. Grimes, MD.)

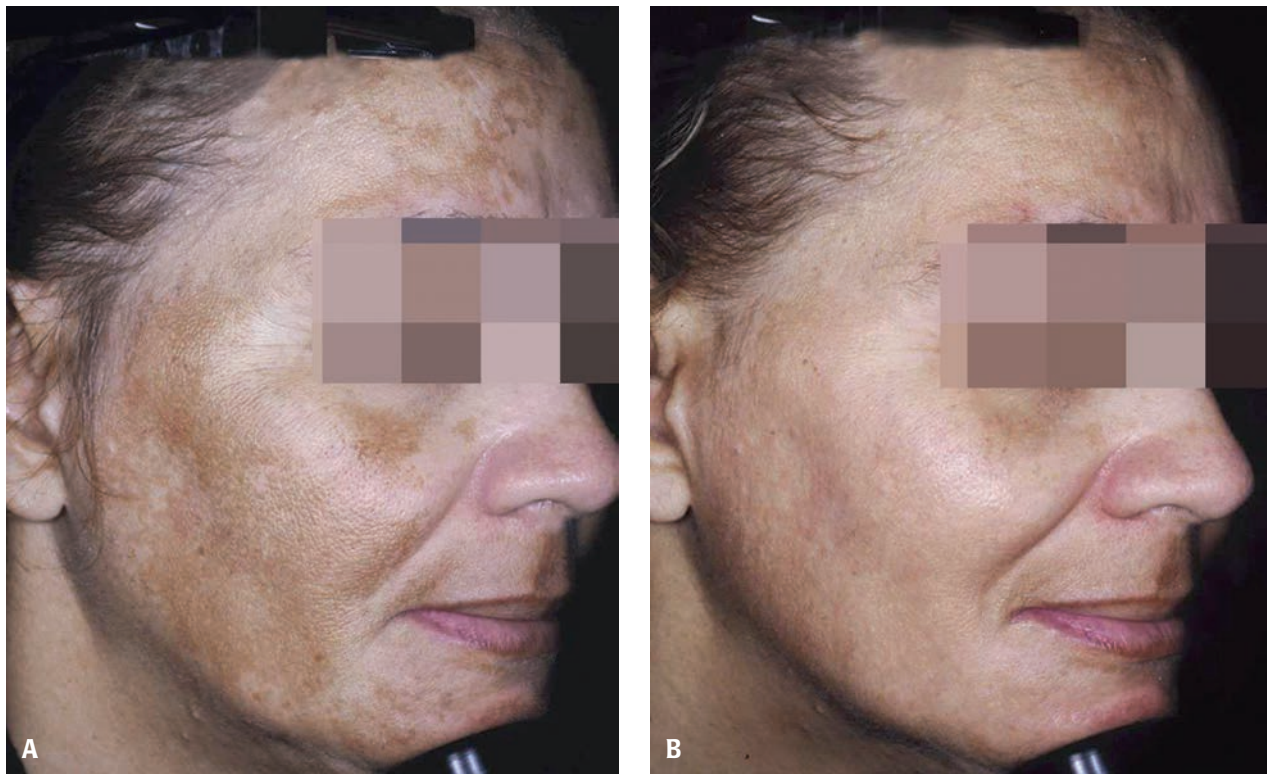

Figure 9-2 Melasma. **A:** Baseline. **B:** After 8 weeks of treatment with triple combination bleach, hydroquinone 4%, fluocinolone 0.01%, and tretinoin 0.05% applied once a day (Triluma). (Courtesy of Galderma.)

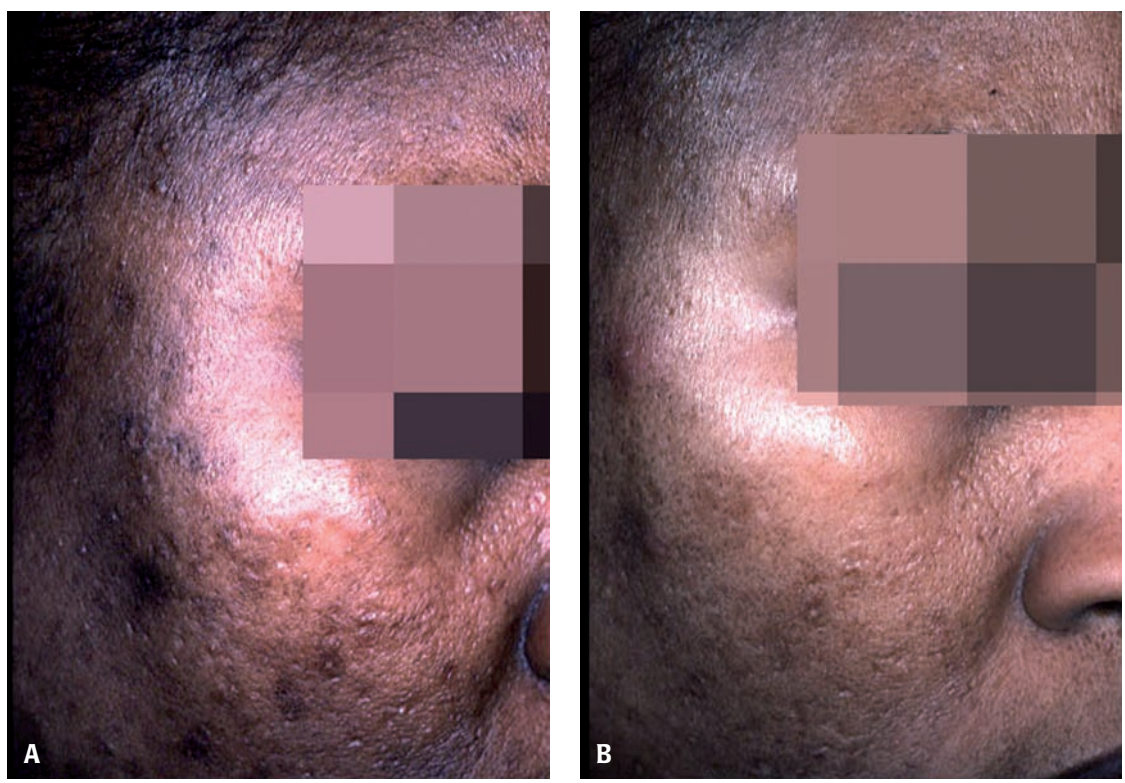

Figure 9-3 Postinflammatory hyperpigmentation. **A:** Baseline. **B:** After 4 weeks of treatment with hydroquinone 4% and retinol 0.15% applied twice daily (Epiquin Micro). (Courtesy of Pearl E. Grimes, MD.)

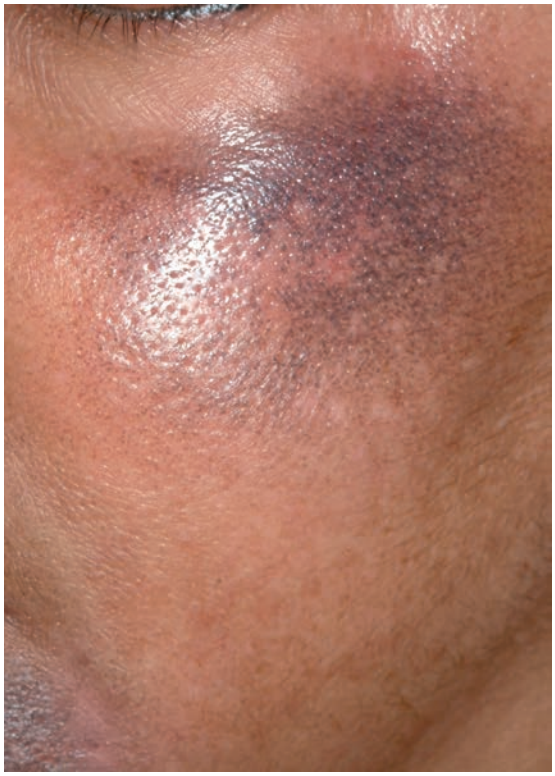

Figure 9-4 Biopsy-proven ochronosis. Erythema and hyperpigmentation after use of a hydroquinone. Concentration unknown. (Courtesy of Pearl E. Grimes, MD.)

group (95%) than in the placebo group (67%), and more patients on HQ (38%) had complete clearance versus those on placebo (8%). No adverse effects of HQ were reported.[8]

At this point, it is pertinent to mention that dark-skinned patients often feel they do not need sunscreen and therefore may apply sunscreens only occasionally or at most once daily. Physicians are reminded to address the issue with patients (see Chapter 12).

Although HQ is considered safe, the most frequent side effects include skin irritation and contact dermatitis, which can be treated with topical corticosteroids. In the United States, the Food and Drug Administration has recently raised concerns regarding potential side effects such as exogenous ochronosis and theoretical risks of carcinogenicity. Rarely, exogenous ochronosis can occur in the treated sun-exposed areas. Ochronosis is characterized by sooty hyperpigmentation, erythema, papules, papulonodules, and colloid milia in sun-exposed skin (Fig. 9-4). It is the most common chronic complication related to long-term HQ use.[9,10] It was initially described in South African Bantu women who applied strong concentrations of HQ for many years. Ochronosis is an ongoing problem in Africa. In contrast to Africa, most of the rare cases of ochronosis reported in the United States are related to use of 2% formulations of HQ. This difference in the frequency of ochronosis may be due to the routine use of sunscreens in the United States, the absence of resorcinol in HQ formulations, and the uncommon use of hydroethanolic formulations that are commonly used in Africa.[11]

Exogenous ochronosis is a serious disorder and difficult to reverse. For this reason, HQ is restricted in several African countries and highly regulated in some Asian countries. Alternating the use of HQ with another depigmenting agent in 4-month cycles can decrease the risk of exogenous ochronosis as well as skin irritation from HQ. Treatments for ochronosis include chemical peels, retinoids, and QS-755 Alexandrite lasers.[12,13]

Carcinogenicity assays have not sufficiently demonstrated the carcinogenic potential of hydroquinone, and epidemiologic studies of workers exposed extensively to hydroquinone have not shown any negative systemic health effects. There are no reported cases of skin cancers or internal malignancies related to topical use of hydroquinone skin lightening agents. Nevertheless, the FDA continues to scrutinize hydroquinone preparations closely.

In the United States, it is not uncommon for physicians to compound concentrations of HQ beyond 4% for clinical use in patients who have failed to respond to 4% formulations. Compounded products are often combined with nonfluorinated topical steroids and retinoids. Concentrations usually range from 5% to 10%.[12]

Fortunately, irritation is mild or uncommon with HQ at the most commonly used concentrations of 2% and 4%. Some cases of dermatitis, erythema, and stinging have been reported.[12,14] In one study of black women from South Africa, 35% had a positive 48-hour patch-test response to high concentrations (7%) of HQ. Fewer (26%) responded to the 5% formulation.[10] Mild hypopigmentation in the form of a halo around the treated area of hyperpigmentation is a common side effect and is mostly seen in darkly pigmented skin (Fitzpatrick skin types V and VI). Discontinuing the HQ will clear this condition in a few weeks (Fig. 9-5).

Kojic acid

Kojic acid, a substance found in the aspergillin oryzae fungus, is widely used in Asia as a skin-lightening agent in concentrations of 1% to 4%. It inhibits the catecholase activity of tyrosinase and suppresses the tautomerization of dopachrome and DICA (indole 5,6 quinone 2-carboxylic acid).

Kojic acid is often effective in patients who cannot tolerate HQ. In a study of Chinese women with epidermal melasma, a compound with 2% kojic acid, 10% glycolic acid, and 2% HQ was compared with the combination of 10% glycolic acid and 2% HQ. The gel containing kojic acid was more effective, clearing 60% of patients, compared with 47% of those receiving the combination minus kojic acid.[15]

Irritant contact dermatitis is a common side effect of kojic acid, which can be reduced by combining the agent with another, such as a topical corticosteroid. It is also combined with glycolic acid, arbutin, azelaic acid, and

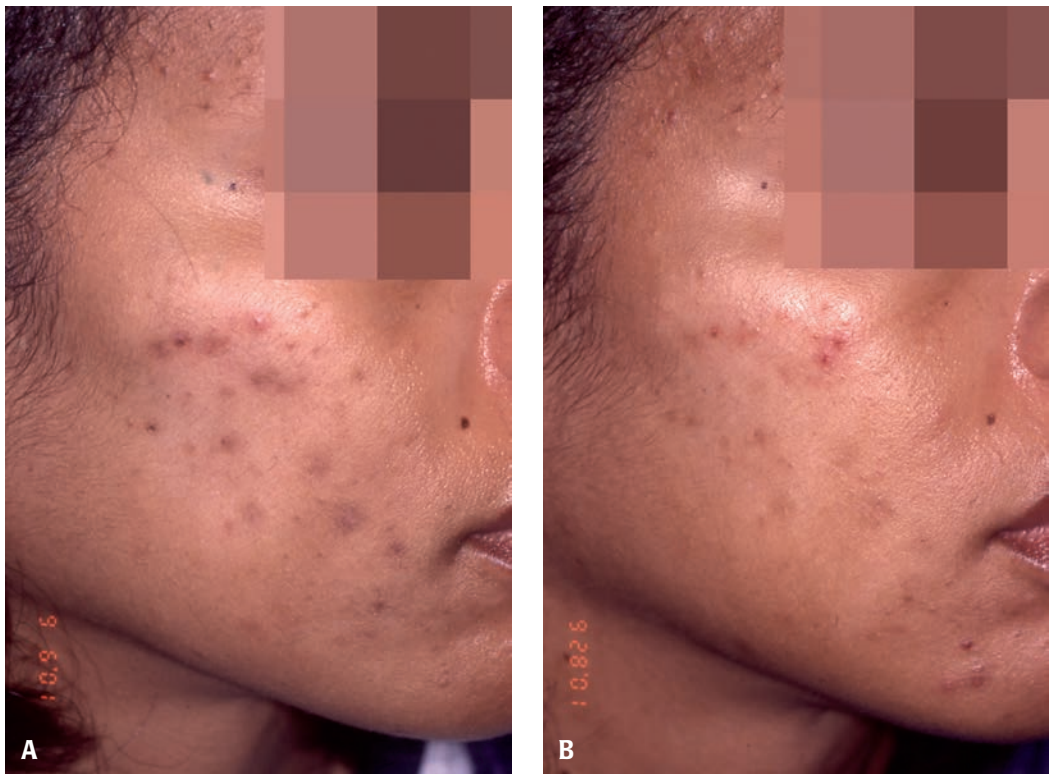

Figure 9-5 **A:** Perilesional hyperpigmentation induced by hydroquinone. **B:** Improvement after 2-week abstinence. (Courtesy of Pearl E. Grimes, MD.)

other herbal compounds. Products containing kojic acid are generally used twice daily for 1 to 2 months until the desired effect is achieved. In patients with pigmented or sensitive skin, kojic acid can be more irritating than glycolic acid.[15]

Arbutin

Arbutin and methylarbutin act in a dose-dependent fashion to inhibit tyrosinase activity and reduce the melanin content in melanocytes.[16] The concentration of arbutin necessary for skin lightening has not been determined. However, studies have shown arbutin to be less effective than kojic acid.[17] Products containing 1% arbutin alone and in combination with other agents are available. A 3% concentration is available, but it has not been studied in the United States.

Deoxyarbutin

Deoxyarbutin (dA) is a novel skin-lightening agent with an affinity for dark melanocytes. Unpublished studies conducted by the pharmaceutical developer showed dA to be significantly less cytotoxic to melanocytes, dermal fibroblasts, and epidermal keratinocytes than HQ.[18] In a clinical trial of 3% dA in white, freckled patients (n = 34) and darker-skinned patients of mixed ethnicity (n = 16), dA was shown to be effective in lightening basal skin tone and pigmented spots and reducing the number and size of hyperpigmented spots.[19]

Azelaic acid

Azelaic acid is a naturally occurring dicarboxylic acid that has minimal effect on normal pigment and the greatest effect on heavily pigmented melanocytes. It inhibits tyrosinase, and it may also inhibit DNA synthesis and mitochondrial activity in hyperactive and abnormal melanocytes. It is available by prescription in concentrations of 15% and 20%.

Azelaic acid may be the most thoroughly researched and studied compound next to HQ. Many of the clinical trials assessing the efficacy and safety of azelaic acid have been conducted in darker racial ethnic groups. It has been used successfully in the treatment of facial lentigo maligna, rosacea, solar keratosis, melasma, and hyperpigmentation associated with burns and herpes labialis.[20] Some studies report a superior effect on melasma as compared with HQ; others report no difference.[21,22]

Azelaic acid is effective on dark skin[21–23] and is generally well tolerated, even when used for long periods. In a randomized, double-blind study of 155 patients of Indo-Malay-Hispanic origin with melasma, patients applied 20% azelaic acid or 2% HQ plus a broad-spectrum sunscreen for 24 weeks. At the end of the study period, 73% of the patients on azelaic acid had good-to-excellent results in reduction of pigmentary intensity and lesion size, as compared with 19% of patients on HQ. Eleven patients on azelaic acid and 9 patients on HQ experienced transient mild-to-moderate irritation.[23]

The most common side effects are transient erythema and skin irritation, both of which tend to resolve naturally within 4 weeks.

Glycolic acid

Glycolic acid is an alpha-hydroxy acid derived from sugarcane. In low concentrations, glycolic acid produces rapid desquamation of pigmented keratinocytes by shortening the cell cycle. In higher concentrations, glycolic acid produces epidermolysis, which can effectively enhance the penetration of other depigmentation agents such as HQ.

When using glycolic acid on dark-skinned patients, treatment should be initiated at low concentrations to avoid inducing skin irritation or postinflammatory hyperpigmentation. Use of HQ before and after glycolic acid can lessen the risk of these pigmentary changes. Polyhydroxy acids, such as gluconolactone, may be less irritating and thus more useful in treating darkly pigmented patients.[24]

Glabridin (licorice extract)

Glabridin, the principal compound of licorice root extract, has been shown to be faster acting and have a greater skin-lightening effect than HQ.[25] It is available in concentrations of 10% to 40%, but its efficacy has been demonstrated in concentrations as low as 0.4% when combined with 0.05% betamethasone and 0.05% retinoic acid.[26]

N-acetyl-4-S-cystalminylphenol

N-acetyl-4-S-cystalminylphenol (NA-CAP) is a tyrosine-amine derivative analogue that targets melanocytes. It is less irritating than HQ.

NA-CAP has been shown to have selective melanocytotoxic and antimelanoma effects, particularly in black hair and skin.[27–29] It has also been tested in Japanese patients with skin types IV and V, with 60% improvement noted.[30]

Retinoids and retinoid combinations

Retinoids and retinol are naturally occurring compounds derived from vitamin A. They are particularly useful in treating dark-skinned patients with melasma, lentigines, and postinflammatory hyperpigmentation that often follows acne.[31] However, improvement may take up to 1 year.[32]

Retinol is less irritating than HQ, but it is also less effective. Compounding the product may increase its efficacy. A prescription product containing 0.15% retinol and 4% HQ has been shown to be effective in the treatment of hyperpigmentation.[33] The triple combination of retinoic acid (tretinoin), HQ, and corticosteroid has demonstrated 79% clearing of melasma.[34]

Tretinoin in concentrations of 0.04% to 0.1% is included in several prescription acne and anti-aging products. Retinol, which is found in OTC products, is less effective than tretinoin, but is also less irritating (see Chapter 10).

Mequinol (4-hydroxyanisol)

Mequinol is approved for the treatment of solar lentigines. The combination of 2% mequinol and 0.01% tretinoin has also been proven effective for this indication.

Mequinol has been shown to be a more effective depigmentation agent than 3% HQ in animal models, with a decreased propensity to cause irritation. The combination of mequinol and tretinoin showed enhanced depigmentation activity as compared with each component separately.[35] Mequinol appears to potentiate the action of pigment-specific lasers, possibly reducing the number of laser treatments required and preventing recurrences.[36] In dark-skinned patients, mequinol can prevent the development of postprocedural, postinflammatory hyperpigmentation.[37]

Paper mulberry

A popular depigmentation agent in Europe and South America, paper mulberry has been compared favorably with HQ and kojic acid. It produces little or no skin irritation[38] and therefore is popular for those with darker skin. Paper mulberry can be used in combination with other herbal compounds.

Soy

Unpasteurized soy milk contains two protease inhibitors that cause depigmentation through the reduction of melanin transfer. When used twice daily for 12 weeks, soy has proven to be both safe and effective in the treatment of mottled pigmentation and solar lentigines. Soy has an advantage in that it not only has skin-lightening effects, but also aids in photoprotection through potent antioxidant activity.[39]

Vitamin C

Vitamin C interacts with copper ions to reduce dopaquinone. Although topical vitamin C derived from fruits and vegetables has questionable value, the stable derivative known as magnesium L-ascorbic acid-2-phosphate (MAP) has shown good skin-lightening activity.[36] Vitamin C products may protect against ultraviolet-B radiation–induced phototoxicity. Topical vitamin C has been shown to improve melasma and postinflammatory hyperpigmentation.[40] Fortunately, these formulations do not cause significant irritation when applied topically and are well tolerated in darker racial ethnic groups.

Niacinamide

This form of vitamin B_3 works by inhibiting the transfer of melanosomes to the epidermal keratinocytes. Niacinamide 3.5% plus retinyl palmitate has been shown to be effective in the treatment of hyperpigmentation.[41] It can be used in all types of skin. Multiple products containing niacin and niacinamide are available OTC and through physicians, who dispense formulations with higher concentrations (up to 5%). Because of its lightening effects, niacinamide is used to improve photodamage. Niacin is an active form

of niacinamide employed in some delivery systems to improve efficacy. Niacin alone may produce a flushing or mild erythema reaction, which can be uncomfortable to some patients.

Melatonin

A hormone secreted in response to sunlight, melatonin has been shown to inhibit melanogenesis. It is sold as an antioxidant in a cream formation.[38] However, the concentration required for depigmentation has not been determined.

Aloesin

Aloesin is a derivative of aloe vera that has been shown to inhibit tyrosinase at noncytotoxic concentrations. It is considered an experimental product and is not available clinically.

IN THE PIPELINE

Research into less irritating, equally effective alternatives to HQ continues. Studies on many single agents are ongoing. The most promising may prove to be *Helix aspersa Müller*, liquiritin, oleic acid, linoleic acid, Emblica, and Tyrostat. Additional combination treatments are under development using kojic acid, licorice extract, and soy, which have already proven to be effective and safe.

CONCLUSIONS

When selecting a skin-lightning agent for darker skin types, selection of the optimal product for the particular diagnosis is key. Pigmentary disorders in darkly pigmented individuals can be recalcitrant to conventional treatments. In some cases, a combination of active ingredients or a physical therapy such as a chemical peel, microdermabrasion, or laser therapy is necessary. It may be wise to start with a milder product to avoid the serious side effects that can occur in this patient group.

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10

Topical Retinoids in Ethnic Skin

Stefani Takahashi and Julie Iwasaki

Vitamin A (retinol) and its derivatives are known as retinoids.[1] Their topical forms have been used for acne, photoaging, and hyperpigmentation for decades. Throughout the years, many new formulations and vehicles have become available, and continued research can help improve their use. This chapter will discuss all-*trans* retinoic acid, all-*trans* retinol, adapalene, and tazarotene, along with their pharmacology, indications, and side effects. Additional focus will be given to the use of such topical retinoids in ethnic skin.

TOPICAL RETINOIDS

ALL-*TRANS* RETINOIC ACID

All-*trans* retinoic acid (tretinoin), a metabolite of retinol, was developed more than 30 years ago and initially was found to loosen comedones. Thus, it was the first retinoid used for the topical treatment of acne. Ortho Pharmaceuticals introduced this drug as Retin-A in the 1970s. Women using Retin-A for acne coincidentally discovered that it also improved their skin texture, even after their acne was under control. Retin-A was then found to have a new application: to improve photoaging by improving fine lines and enhancing general skin appearance.

As research continued, additional formulations of tretinoin became available. One formulation was Renova, a tretinoin in a new emollient vehicle, which was approved by the FDA to help improve photodamaged skin. Because of the well-known drying properties of Retin-A, Renova was developed to counteract this side effect. Its moisturizing quality was better tolerated in postmenopausal women. Avita is a tretinoin formulation that complexes with polyoprepolymer-2 to slow its absorption into the skin, which decreases irritation. Retin-A Micro uses a microsponge technology to deliver tretinoin in a more controlled manner to similarly reduce irritation.

All-*trans* retinol

All-*trans* retinol is the parent form of vitamin A so it is not considered a drug when it is added to other compounds. In vitro studies have shown that it is oxidized in the skin to tretinoin; thus, it has similar side effects to this drug. Because it shares tretinoin's irritant qualities, newer formulations were developed to allow for a more controlled delivery. All-*trans* retinol was introduced into cosmetic products by Avon in 1984 to improve photoaging and hyperpigmentation.[2] It is available in formulations of numerous over-the-counter products.

Adapalene

Adapalene, a derivative of naphthoic acid, is commonly available as a 0.1% gel, cream, or lotion to be applied once daily. Adapalene microcrystals penetrate open follicles to the depth of the sebaceous glands within 5 minutes of treatment. Adapalene was found to have a more selective interaction with retinoid receptors than tretinoin; thus, it was developed to improve acne with less skin irritation. In the 1990s, Galderma released this drug as Differin.[2,3]

Tazarotene

Tazarotene, released by Allergan as Tazorac, is a topical retinoid developed to help both acne and psoriasis. The 0.1% tazarotene gel is FDA approved for use in both acne and mild-to-moderate psoriasis; the 0.05% tazarotene gel is only FDA approved for psoriasis. Its side effects include skin irritation and koebnerization. Tazarotene cream 0.1% has also been released by Allergan as Avage to help improve photoaging (facial fine lines, wrinkling, hypopigmentation, hyperpigmentation, and solar lentigines).

PHARMACOLOGY OF TOPICAL RETINOIDS

The first-generation topical retinoids, such as tretinoin, are made by modifying the polar end group and the polyene side chain of vitamin A. Adapalene and tazarotene are both third-generation polyaromatic retinoids that are made by cyclization of the polyene side chain[1] (Fig. 10-1).

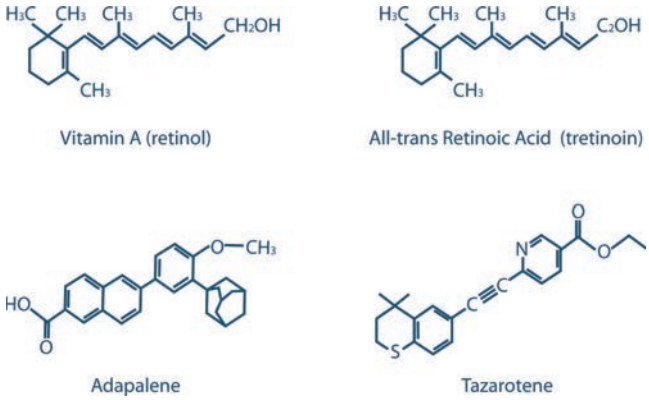

Figure 10-1 Chemical structures of Vitamin A, All-trans Retinoic acid, Adapalene, and Tazarotene.

All-*trans* retinoic acid and all-*trans* retinol

Topical all-*trans* retinol is taken up by epidermal keratinocytes as a fat-soluble drug and binds to cellular or cytosolic retinol-binding protein (CRBP). Inside the keratinocytes, excess all-*trans* retinol is stored as retinyl esters in the form of lipid droplets by acyl CoA:retinol acyl transferase (ARAT). Because topical all-*trans* retinoic acid cannot be reduced to retinol, it increases the amount of intracellular retinoic acid to cause potential side effects. If retinoic acid levels become low in the epidermis, retinol is mobilized from retinyl esters and is oxidized to all-*trans* retinoic acid and its isomers (9-*cis*).

All-*trans* retinoic acid, bound to cellular all-*trans* retinoic acid-binding protein (CRABP), then binds to nuclear retinoic acid receptors (RAR), while the isomers bind to both retinoid X receptors (RXR) and RAR. RAR and RXR belong to the steroid-thyroid hormone family, and each family contains an alpha, beta, and gamma isotype. They form homodimers and heterodimers that bind to retinoic acid response elements (RAREs) in DNA to directly influence cell differentiation, proliferation, and immune responses (Fig. 10-2).

C-Jun and C-Fos are genes that are involved in photoaging. Levels of C-Jun rise when exposed to ultraviolet (UV) radiation, whereas C-Fos remains the same. C-Jun and C-Fos can then combine to form a heterodimer, activator protein-1 (AP1), which induces collagenase, gelatinase, and stromelysin. Retinoids inhibit the overexpression of C-Jun, which causes an indirect effect from the down-regulation of AP1 by competing for required coactivator proteins. AP1 is normally responsible for proliferative and inflammatory responses; thus retinoids have antiproliferative and anti-inflammatory actions.[1,2,4]

Adapalene

Adapalene is a lipophilic synthetic retinoid with a selective affinity for RAR-beta and RAR-gamma. RAR-gamma is the primary receptor for topically applied adapalene because RAR-beta is not present in epidermal keratinocytes. Only trace amounts of adapalene are absorbed systemically because adapalene's lipophilicity causes selective uptake into the pilosebaceous unit and dissolution within the sebum. The hepatobiliary system removes the systemically absorbed adapalene.[1,2]

Tazarotene

Tazarotene is rapidly hydrolyzed by skin esterases into its active metabolite, tazarotenic acid. Tazarotenic acid binds mostly to RAR-beta and RAR-gamma in the epidermis and has no affinity for RXR. It modulates the expression of retinoid responsive genes to regulate cell proliferation, cell differentiation, and inflammation. Tazarotene down-regulates the expression of keratinocyte transglutaminase I (Tgase I), hyperproliferative keratins (K6 and K16), migration inhibitory factor-related protein (MRP-8), and epidermal

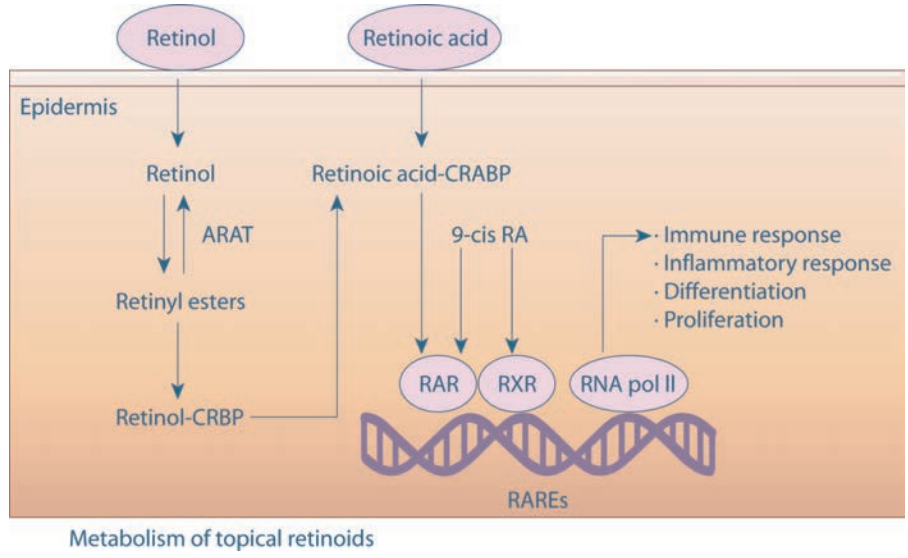

Figure 10-2 Metabolism of topical retinoids. ARAT, acyl CoA:retinol acyl transferase; CRBP, cytosolic retinol-binding protein; CRABP, cellular all-*trans* retinoic acid-binding protein; RA, retinoic acid; RAR, retinoic acid receptors; RAREs, retinoic acid response elements. (Courtesy of Pearl E. Grimes, MD.)

growth factor receptor, while inducing tazarotene inducible genes (TIGs) 1, 2, and 3.

Although it is rapidly metabolized, a small amount of tazarotene can be absorbed systemically. This is degraded by oxidation to inactive sulfoxine and sulfone derivatives that are excreted in the urine and feces. In normal skin, systemic absorption can be up to 5% of the applied drug, and the maximum blood concentration of tazarotene gel is at 9 hours after the application. The half-life of the drug is less than 20 minutes, and the terminal half-life is about 18 hours.[1,2]

INDICATIONS

The most important aspect of treating a patient with topical retinoids is patient education regarding proper application techniques and expectations. Side effects, such as local skin irritation, and the fact that noticeable results may take months to appear should be discussed. Desquamation corresponds to the hyperproliferative response of RARs to tretinoin, although erythema does not appear to be receptor mediated. Administration of topical retinoids needs to be titrated, depending on the patient's reaction to the medication. A general rule is to start treatment with the lowest strength formulation and then gradually increase it as the patient gains tolerance. Sunscreens and moisturizers should be incorporated as daily regimens.[1]

Acne vulgaris

Topical retinoids are an important, if not essential, component in the treatment of acne vulgaris (Fig. 10-3). Their mechanism of action involves its anti-inflammatory properties and its normalization of the follicular epithelium to loosen comedones and prevent sebum buildup, not sebum production. They are used for mild acne that is nonscarring, has open and closed comedones, and has moderate pustules. For moderate to severe acne, they are used in combination therapy. Topical retinoids need to be maintained to have comedolytic effects. Cystic acne is more severe and does not respond well with monotherapy topical treatment but may be useful in combination therapy or as maintenance therapy once control of the disease has been reached.[2,5]

In treating acne vulgaris with topical retinoids, patients must be aware that onset of improvement may take several weeks. Topical retinoids are usually applied as a thin layer of the retinoid nightly. The disease can worsen in the first month of treatment as the follicular epithelium loosens. After 2 months of sustained treatment, a continued improvement is usually noted. At this point, the main goal of treatment is to prevent development of new comedones. Combination therapy of topical retinoids with mild topical antimicrobial agents is often used.[2]

In a review of acne in African American patients with Fitzpatrick skin types IV through VI, adapalene

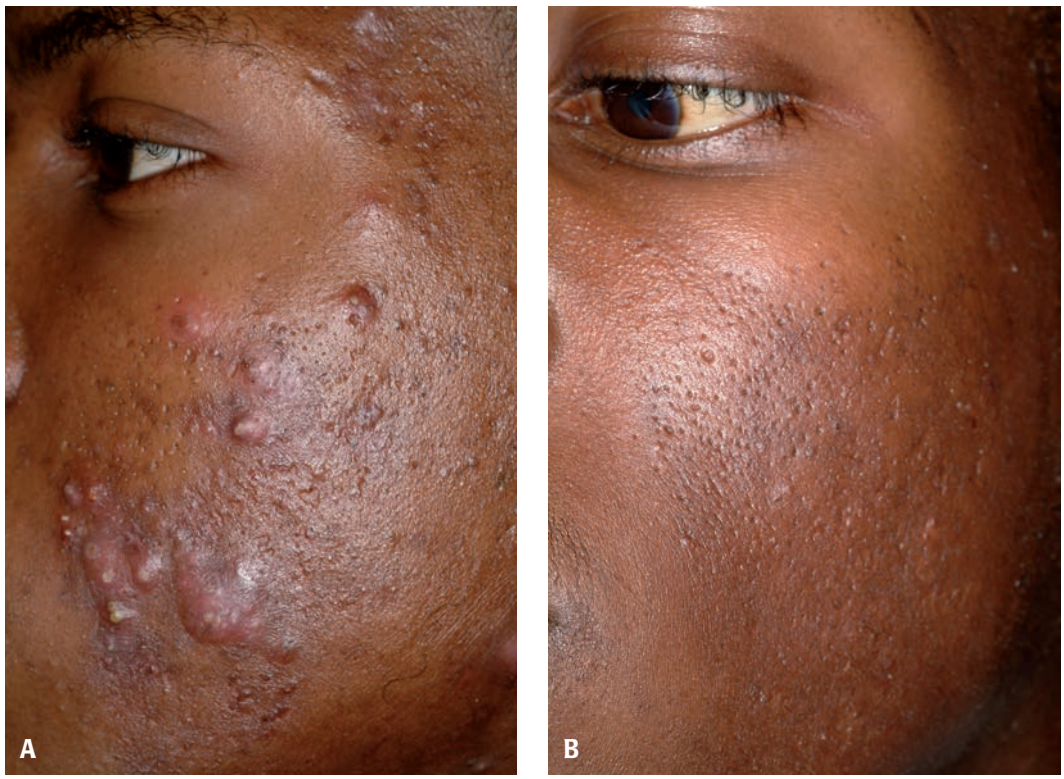

Figure 10-3 Acne treated with tazarotene 0.1% cream in an African American. **A:** Before. **B:** After. (Courtesy of Pearl E. Grimes, MD.)

demonstrated efficacy for the treatment of mild to moderate acne vulgaris. Compared with white patients with acne vulgaris, adapalene significantly reduced the number of inflammatory lesions and caused much less erythema and scaling in black patients. Most of the ethnic patients also had a reduction in number and density of postinflammatory hyperpigmented macules. However, the combined number of inflammatory and noninflammatory lesions was similar in the two patient populations, as well as the dryness that was due to the topical retinoid. Overall, adapalene gel 0.1% can be used to prevent and reduce acne associated hyperpigmentation and decrease the number of both inflammatory and noninflammatory lesions (Fig. 10-4).[5–7]

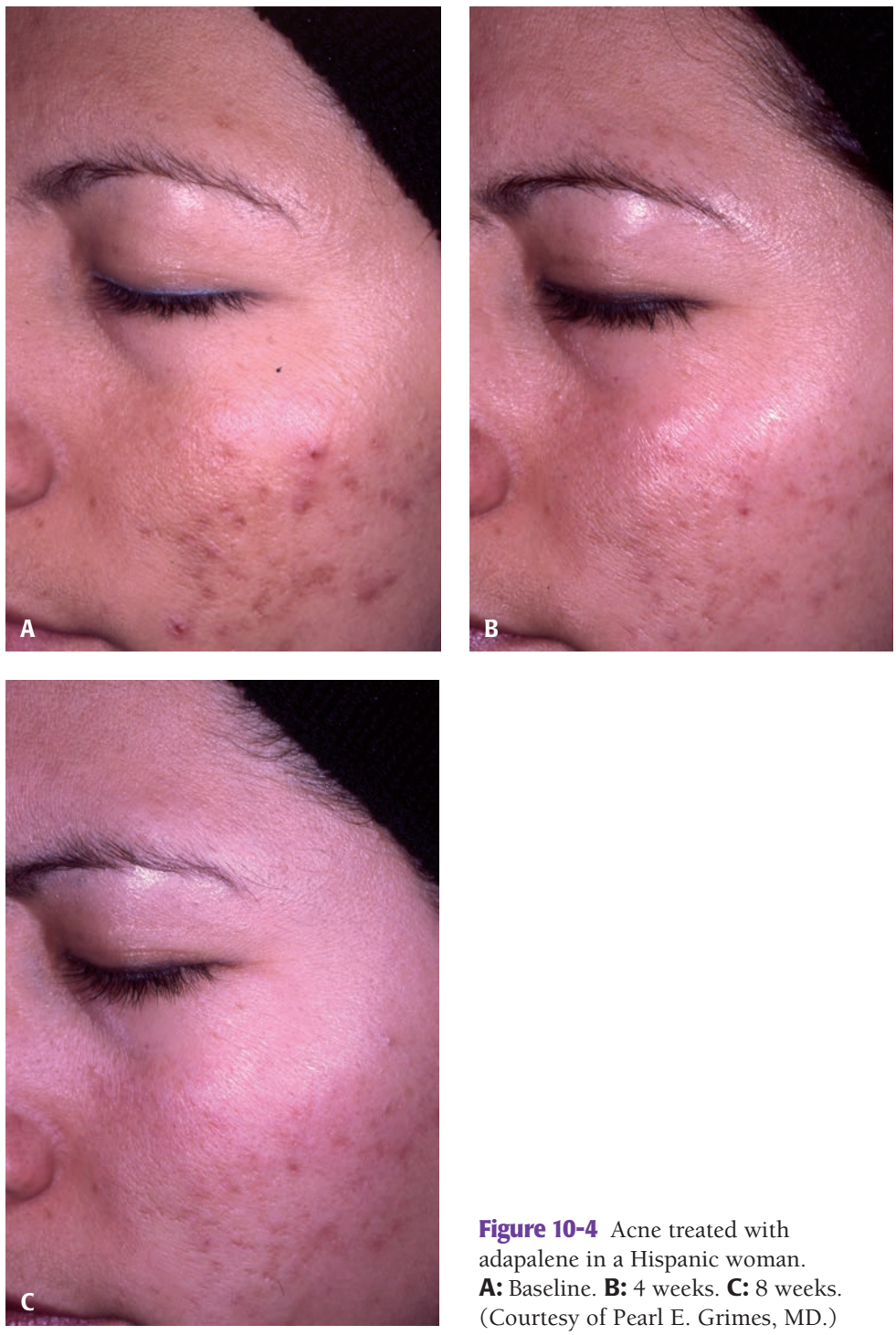

Figure 10-4 Acne treated with adapalene in a Hispanic woman. **A:** Baseline. **B:** 4 weeks. **C:** 8 weeks. (Courtesy of Pearl E. Grimes, MD.)

Acne vulgaris is also a common problem among Asians, who also have a predisposition for postinflammatory hyperpigmentation. Adapalene gel 0.1% was compared with tretinoin gel 0.025% in a randomized study of 150 Chinese patients over an 8-week period. Both adapalene and tretinoin were shown to reduce the number of inflammatory and noninflammatory lesions. Tretinoin caused more irritation than adapalene, although the irritation was mild. In the Chinese population, both adapalene gel 0.1% and tretinoin gel 0.025% are effective treatments for mild to moderate acne vulgaris, but adapalene causes less irritation.[8]

Photodamage

In general, photodamaged skin is characterized by rhytides, telangiectasias, solar comedones, blotchy pigmentation, and actinic keratoses (AKs).[2] The melanin content and melanosomal dispersion pattern in darker skin as compared with lighter skin may provide protection from accelerated aging because of UV radiation. Darkly pigmented skin can still experience photodamage, but this often occurs at a later age. Photoaging in black skin presents as inconsistent pigmentation, such as hypopigmentation or hyperpigmentation. In Asian women, photoaging presents differently as epidermal atrophy, disorderly differentiation, cell atypia, and poor polarity.[9]

All-*trans* retinoic acid has been shown to improve fine wrinkling, increase dermal collagen, and repair elastin fiber formation. Photoaging may be treated with nightly use of tretinoin. Topical alpha-hydroxy acid formulations may be used with topical tretinoin to enhance the penetration in photodamaged skin, but this may cause increased irritation.

Initially, epidermal mucin and temporary compaction of the stratum corneum can improve the texture and fine wrinkles of photodamaged skin. Long-term topical tretinoin treatment can lead to epidermal hyperplasia of atrophic skin, dispersion of melanin granules, removal of dysplastic keratinocytes, new dermal collagen formation, angiogenesis, decreased elastosis, and comedolysis. Clinically, the skin appears smoother, more evenly toned, and has fewer fine lines and wrinkles.[2,10]

Topical tretinoins were found to normalize the differentiation of dysplastic epithelium in AKs. They decrease the amount of AKs on the face by about 50% when used alone for at least 6 months. Topical tretinoin can be used with topical 5-fluorouracil (5-FU) to enhance the penetration of 5-FU in the treatment of actinic keratoses.[2] Retinoids have been used in Thai,[11] Chinese,[12] Japanese,[12] and African American[13] patients with photodamaged skin. The subjects experienced overall improvement in skin texture; the skin surface became less rough and scaly, and small, hyperkeratotic growths tended to disappear (Fig. 10-5).

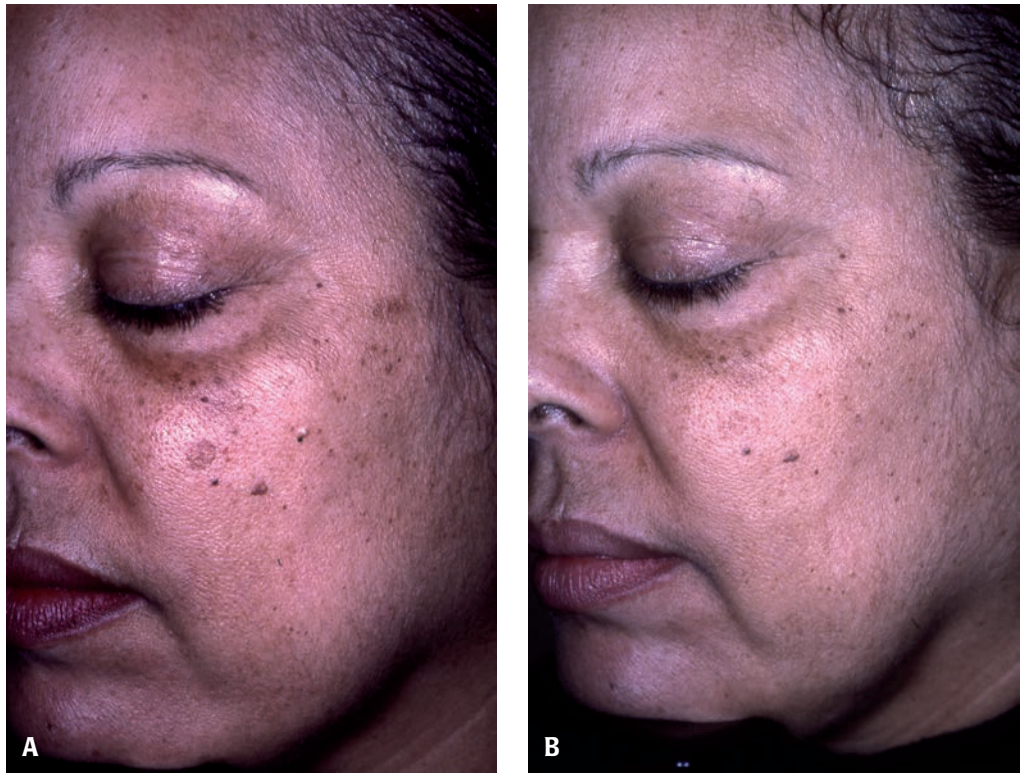

Figure 10-5 Photoaging in an African American characterized by hyperpigmentation and texturally rough skin. **A:** Baseline. **B:** Marked improvement after 12 weeks of treatment. (Courtesy of Pearl E. Grimes, MD and Johnson and Johnson, New Jersey)

Hyperpigmentation

Topical retinoids are also used in the treatment of hyperpigmentation, including that seen in postinflammatory hyperpigmentation (Fig. 10-6), melasma, and solar lentigines. They can be used alone in mild cases, but more severe problems can be treated with combination therapy. Tretinoin has been used with hydroquinone, topical steroids, and/or alpha-hydroxy acids.[2]

In one study, human and murine melanocyte monolayer cultures were studied to evaluate the suppressing effect of tretinoin on melanogenesis. These results showed that tretinoin does not have a direct inhibitory effect on melanogenesis or on cell-cell interactions between melanocytes, keratinocytes, or fibroblasts. Instead, tretinoin may be involved in keratinocyte proliferation, the acceleration of epidermal turnover, and the binding of CRABP-I.[13,14]

In a study of 2,000 black patients who saw a dermatologist, the third most common diagnosis was a pigmentation disorder other than vitiligo. Most of these patients presented with postinflammatory hyperpigmentation.[14] Postinflammatory hyperpigmentation commonly occurs following acne, folliculitis, eczema, or irritation from shaving.[17] It appears to be more severe in darker skin types because of the release of inflammation mediators that trigger melanogenesis and melanocyte proliferation.[5]

In a study by Grimes and Callender,[18] 74 patients from darker racial ethnic groups with acne vulgaris–induced postinflammatory hyperpigmentation were assessed in a double-blind, randomized, vehicle-controlled study. Once-daily application of tazarotene 0.1% cream was shown to be effective against postinflammatory hyperpigmentation, achieving significantly greater reductions compared with vehicle in overall disease severity and in the intensity and area of hyperpigmentation within 18 weeks. Side effects, including erythema, peeling, dryness, and burning, were very minimal.

Tretinoin, 0.1% retinoic acid cream, can also improve postinflammatory hyperpigmentation in black patients. Fifty-four patients were involved in a 40-week-long randomized, double-blind, vehicle-controlled study. After 40 weeks of treatment, the patients who used tretinoin had significantly lighter postinflammatory hyperpigmented lesions on the face than the control patients. The epidermal melanin content of the lesions decreased by 23%, and there was a 40% lightening of the lesions with tretinoin compared with a 3% decrease in epidermal melanin content and 18% lightening of the lesions with the vehicle alone. Tretinoin also lightened the normal skin in black patients. Retinoid dermatitis developed in 50% of tretinoin-treated subjects but diminished as the study progressed.[17]

A triple drug combination of fluocinolone acetonide 0.01%, hydroquinone 4.0%, and tretinoin 0.05% applied once daily at night has been shown to be efficacious in the treatment of postinflammatory hyperpigmentation. The topical corticosteroid suppresses melanocyte secretion of melanin, and the hydroquinone blocks melanin biosynthesis by inhibiting tyrosinase and degrading melanosomes. Tretinoin enhances epidermal turnover, which causes a dispersion of keratinocyte pigment granules. Together, these topical drugs work synergistically to improve postinflammatory hyperpigmentation.[19]

Melasma is an acquired facial hyperpigmentation.[20] It is more prevalent in black, Hispanic, and Asian people and is attributed to hormonal factors, UV radiation, and the liability of melanocytes.[9] Tretinoin was shown to lighten melasma in black patients with minimal side effects. In one study, 28 patients applied 0.1% tretinoin or vehicle cream daily to their faces and were followed over 10 months in a randomized, vehicle-controlled study. Using the Melasma Area and Severity Index Scale to assess improvement, there was a 32% improvement in the tretinoin-treated group compared with a 10% improvement in the vehicle-treated group. Signs of improvement were not significant before week 24. Histologically, tretinoin was observed to cause a decrease in epidermal pigmentation by transferring melanosomes to keratinocytes. Sixty-seven percent of the tretinoin-treated patients did acquire mild retinoid dermatitis. Overall, the use of tretinoin as monotherapy for the treatment of melasma is limited.[20,21] Hence, tretinoin is best used for melasma in combination with other lightening agents.

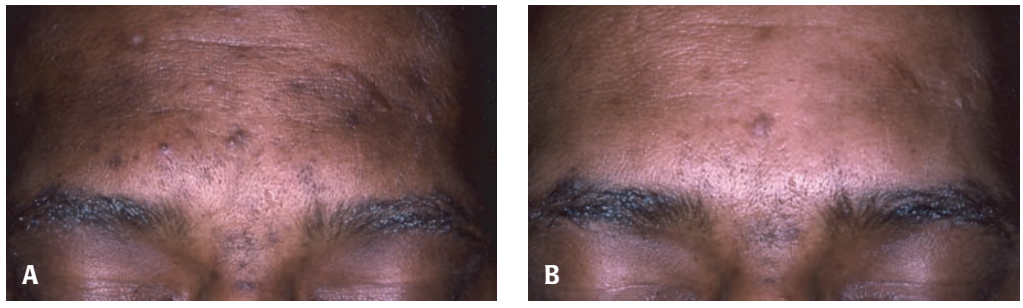

Figure 10-6 Postinflammatory hyperpigmentation and acne treated with tazarotene 0.1% cream. **A:** Baseline. **B:** After 8 weeks. (Courtesy of Pearl E. Grimes, MD.)

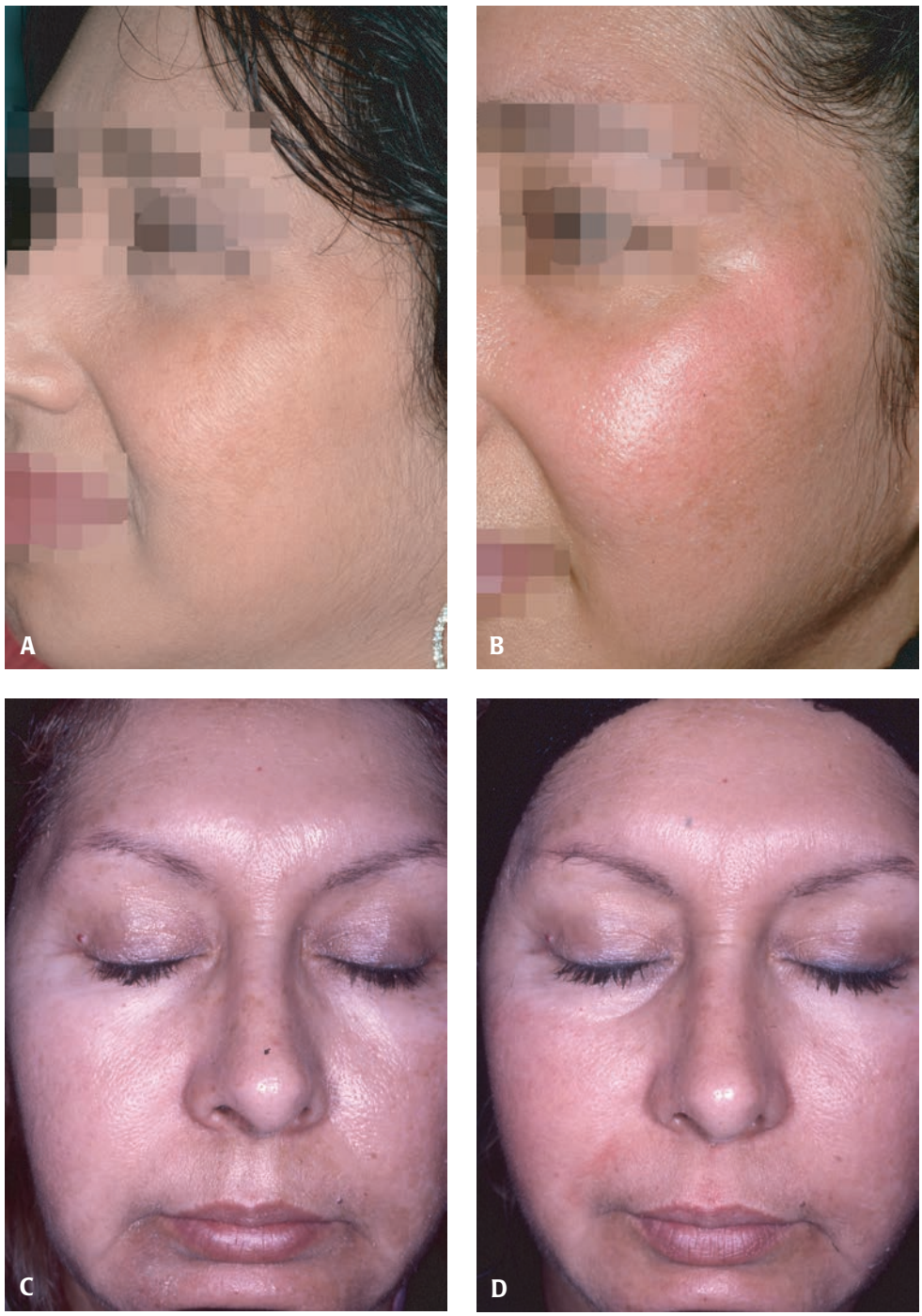

Figure 10-7 Retinoid dermatitis characterized by erythema and irritation of the cheeks **(A)** Baseline and **(B)** 2 weeks after use of retinoid. **C:** Baseline and **(D)** 6 weeks. Note erythema and edema. (Courtesy of Pearl E. Grimes, MD.)

In a community-based trial, a triple combination treatment of fluocinolone acetonide 0.01%, hydroquinone 4.0%, and tretinoin 0.05% in a hydrophilic cream formulation has been shown to improve melasma in all ethnic groups. There were 1,290 patients enrolled from 393 centers in the United States. The treatment significantly lightened melasma at 4 weeks and had a continued benefit at 8 weeks.[22]

Studies have shown that topical 20% azelaic acid is better than 2% hydroquinone and is just as effective as 4% hydroquinone for the treatment of melasma and postinflammatory hyperpigmentation. Tretinoin has been shown to

enhance the effect of topical 20% azelaic acid after 3 months of treatment. Azelaic acid may inhibit the energy production, and/or DNA synthesis of hyperactive melanocytes.[23] It may also inhibit tyrosinase activity.

Tretinoin 0.1% cream has also been shown to reduce the hyperpigmentation of lentigines caused by photoaging in the Chinese and Japanese populations. There were 23 Chinese and 22 Japanese patients involved in a double-blind, randomized, vehicle-controlled study conducted over 40 weeks. Ninety percent of the tretinoin-treated patients had significantly lighter lesions compared with 33% of the vehicle-treated patients. According to the histological analysis, the tretinoin-treated patients showed a 41% decrease in epidermal pigmentation compared with a 37% increase in the controls.[12]

SIDE EFFECTS

Side effects of topical retinoids include irritation, erythema, desquamation, pruritus, burning, photosensitivity, dry skin, fissuring, bleeding, and worsening psoriasis (Fig. 10-7). Photoallergy and phototoxicity have not been proven, but patients show photosensitivity by a reduced tolerance to UV radiation. Because of these side effects, noncompliance and discontinuation of the treatment can occur. To reduce the severity of such reactions, the patients should avoid other products that can cause additional irritation. For example, abrasive soaps and products containing alcohol, salicylic acid, benzoyl peroxide, sulfur, and resorcinol should be avoided.[1] Overall, topical retinoids are safe and effective, as shown by histological examination of skin that was treated up to 4 years. There was no keratinocyte or melanocyte atypia observed that was caused by topical retinoid use.[10]

Because irritation from topical retinoids use can cause postinflammatory hyperpigmentation (Fig. 10-8), newer formulations and synthetic analogues have been used. Cream- and emollient-based preparations are better tolerated, and microsponge vehicles are now used for 0.1% and 0.04% tretinoin gels.[24] Bershad et al. demonstrated that using 0.1% tazarotene gel for up to 5 minutes once or twice daily is a safe and effective method for treating acne while minimizing side effects.[25] Other ways to minimize irritation include applying a small amount of topical retinoid when the skin is completely dry, which slows penetration.

A randomized study by Leyden et al. evaluated tolerability of retinoid concentration, formulation vehicle, skin sensitivity, of individual retinoids in 253 patients. Less irritation and tolerability was seen with lower retinoid concentrations. The researchers found that the irritation induced by a gel or cream formulation depended on the specific retinoid used. Normal skin

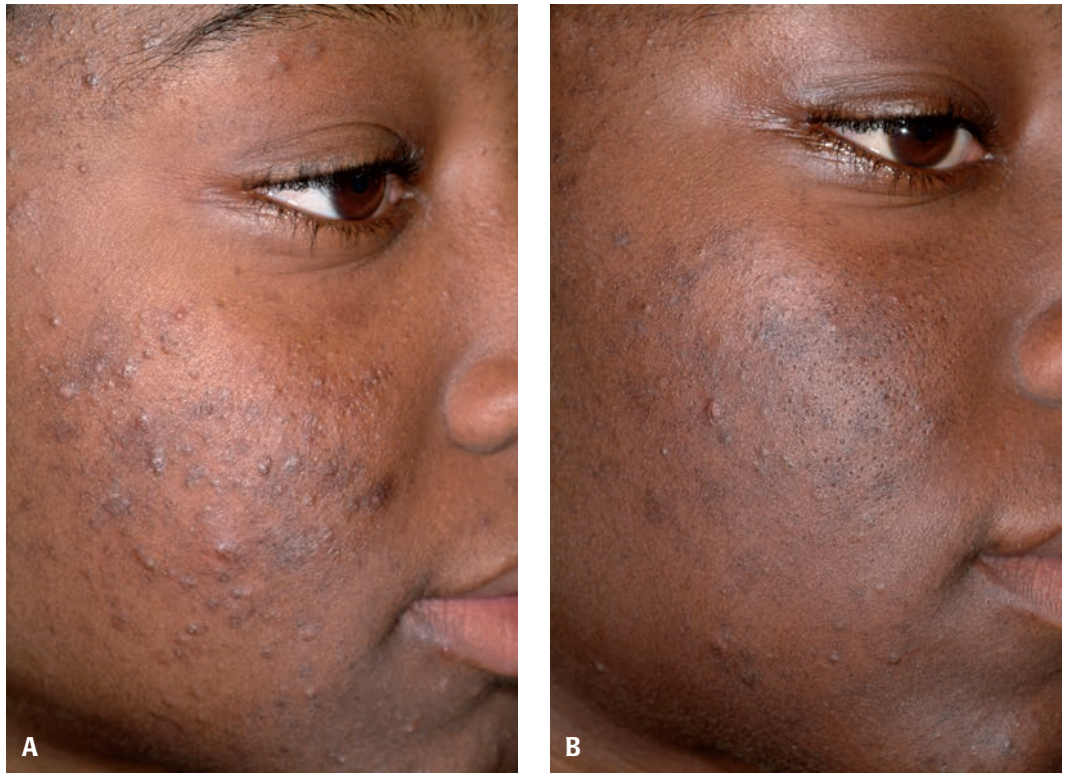

Figure 10-8 Acne treated with tazarotene 0.1% cream. Significant improvement, but patient developed localized and diffuse hyperpigmentation. **A:** Before. **B:** After. (Courtesy of Pearl E. Grimes, MD.)

Table 10-1

FDA pregnancy categories for topical retinoids

Name	Category	Birth defects
Tretinoin	C	Unknown
Adapalene	C	Unknown
Tazarotene	X	Possible

tolerated tazarotene cream better than tretinoin cream, and adapalene and tretinoin microsponge vehicles were tolerated better than tazarotene gel. Sensitive skin tolerated tazarotene and adapalene cream better than tretinoin cream, and adapalene gel was tolerated better than tazarotene gel.[26]

TERATOGENICITY

Vitamin A is required for normal growth and differentiation. The absorption of topical retinoids is usually controlled, but it can become a problem if a large surface area is treated. It is not known whether the drug can affect a developing embryo and fetus, so topical retinoids should be avoided during pregnancy. Also, it is not known whether topical retinoids are present in breast milk, so caution should be taken during this time (Table 10-1).

Tazarotene is contraindicated in women who may become or are pregnant. The patient should be informed of the potential risk to a fetus before the initiation of treatment, and adequate birth control should be used. A negative pregnancy test should be obtained within 2 weeks before treatment, and the treatment should begin during a normal menstrual period. If a patient becomes pregnant while using this drug or if a patient is already pregnant, treatment should immediately be discontinued.[2,27]

CONCLUSION

Topical all-*trans* retinoic acid, all-trans retinol, adapalene, and tazarotene are all used alone or in combination to effectively treat acne vulgaris, photodamaged skin, and hyperpigmentation in ethnic skin. The increased melanin content of darker skin types makes it more prone to pigmentation disorders in response to inflammation, injury, and treatment. With appropriate education on potential side effects and proper medication use, topical retinoids may be used safely and efficiently in darker racial ethnic groups.

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11

Antioxidants

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Antioxidants have had a key position in the medical and scientific arena since the early 1900s. More recently, they are taking center stage in the dermatologic and aesthetic community, where they are reported to play a critical role in skin health and youthfulness. Another increasingly important role is that they are being used to augment the effects of cosmetic procedures.[1,2] The fuel that has ignited this unquenchable flame for knowledge of antioxidants includes the pursuit of optimal health and well-being, the desire for optimal skin care, the search for longevity and eternal beauty, and the anti-aging movement. Additionally, the increased life span of the population, the desire to align with nature by spending more time outdoors, and the trend toward the use of "natural products" have also contributed to this growing phenomenon.[3] Research has demonstrated a wide range of potential benefits from antioxidants, including improved cognition, improved immune function, prevention of malignancy, overall disease prevention, and anti-aging. Despite the steadily growing popularity of antioxidants and the increase in research in this area, there remains a large gap in detailed information about them, including results demonstrating their direct benefit in the general population.[4] There is an even greater deficit of specific benefits in skin of color (worldwide the majority of the population), as most studies of this nature are performed on skin types I through III.[5]

ANTIOXIDANTS

Antioxidants have been touted as the premier anti-aging substances for scavenging of free oxygen radicals and other harmful agents that have deleterious effects in the body and to the skin. They are defined as oral, topical, or intrinsic substances that protect and possibly correct oxidative injury to the body and the skin caused by free radicals.[6] It has been reported that antioxidants have the ability to actually reverse these and other damaging environmental assaults from sunlight, air pollution, alcohol, cigarette smoke, and stress. Some of these substances not only restrict blood flow to our skin and organs, but also generate potent, destructive free radicals. These free radicals ultimately cause massive internal destruction beyond the cellular layer in every organ system of our body, rapidly increasing the aging and disease process overall, both inside and out. Nonetheless, although there has been a preponderance of speculation and growing clinical investigation supporting the benefits of antioxidants, firm evidence is lacking as to the direct link or cause-and-effect relationship and consistent, reproducible scientific data to guide their usage.[7]

UNDERSTANDING FREE RADICALS AND OXYGEN REACTIVE SPECIES

The molecules that make up the cells of our bodies and skin are held intact and made stable by the bonding of paired electrons. When oxygen molecules are involved in reactions in the body and the skin, these electron pairs are disrupted and lose their partner (the bonds are split), and unstable free radicals are formed. Free radicals (e.g., superoxide, nitric oxide, hydroxyl radicals) and other reactive species (e.g., hydrogen peroxide, peroxynitrite, hypochlorous acid) are produced in the body, primarily as a result of aerobic metabolism. Antioxidants (e.g., glutathione, arginine, citrulline, taurine, creatine, selenium, zinc, vitamin E, vitamin C, vitamin A, and tea polyphenols) and antioxidant enzymes (e.g., superoxide dismutase, catalase, glutathione reductase, and glutathione peroxidases) exert synergistic actions in scavenging free radicals.[8]

As part of an internal process that occurs naturally in the body to repair this state and regain stability, a reaction begins that can affect every cell in the body. These very unstable free radicals quickly react with other compounds in efforts to regain their stability. They do this by attacking the nearest stable molecule to "steal" a partner; this regains stability, but results in the formation of another free radical. The process continues, ultimately ending up with a "chain" of rapid free radical formation and cascading damage to the body and skin. In summary, free radicals

are formed from oxidative damage incurred normally through body metabolic processes; environmental factors, such as ultraviolet (UV) radiation, pollution, herbicides, and pesticides; or other chemical exposure and cigarette smoke.[9] The free radicals that arise during normal metabolic processes in the body are purposefully generated in response to messages from the body's immune system to help neutralize viruses, bacteria, and other entities that can be harmful to the body. Hence, this free radical formation serves a useful purpose to the body. The body's natural antioxidative processes limit the activity of these free radicals. Excessive free radical formation that occurs as the result of negative environmental influences can cause extensive damage. Free radical damage can accumulate over time and has been implicated in a number of disease processes and aging. It is this excessive and cumulative damage that the body cannot handle alone.[9,10] Antioxidation is the process of correcting the imbalance, hence halting the continuous chain reaction or repairing and possibly reversing any damage caused over time. Antioxidants prevent the unstable oxygen molecules from interacting with other molecules, ultimately halting the chain reaction of free radicals. This is achieved as the antioxidants donate one of their electrons to reproduce the stable pair of electrons. These molecules do not, in turn, become unstable; they are stable with or without this electron. They are often referred to as *scavengers* because of their ability to help to prevent cell and tissue damage that could lead to disease and aging.[9] They "neutralize" the free oxygen radicals, stopping them from breaking down cells and allowing the cells to function normally.

RESEARCH ON THE ANTIOXIDATION PROCESS

Although there is no direct link or proof that antioxidants can effectively stop or reverse the aging and deterioration process, continued scientifically sound research has shown strong evidence of positive change and support of proposed benefits with the use of antioxidants when compared with placebo or nonuse groups. Early antioxidant supplementation studies indicate life-span extensions by antioxidant feeding in various experimental organisms. Data collected under tightly controlled conditions also show that the feeding of 2-mercaptoethanol (0.25%) effectively prolonged both the median and maximum life spans of mice.[11] Among the most widely publicized research trials on antioxidants was a 5-year study published in 1993 involving approximately 30,000 residents of north-central China. Participants were given either a placebo or a dietary supplement containing one of seven vitamin-mineral combinations. In this study, persons who received a daily dose of beta-carotene, vitamin E, and selenium had a reduced cancer rate of 13%. Although many questions remain as to the significance of these findings for other populations, the study represents the first large-scale, randomized, prospective, placebo-controlled study showing the benefits of dietary supplementation with antioxidant vitamins and minerals. Much of the previous evidence was based on epidemiological studies of populations that suggested an association between antioxidants and disease prevention but were not designed to reveal cause-and-effect relationships. There has been growing evidence over the past three decades showing that malnutrition (e.g., dietary deficiencies of protein, selenium, and zinc) or excess of certain nutrients (e.g., iron and vitamin C) give rise to the oxidation of biomolecules and cell injury.[8] A large body of the literature supports the notion that dietary antioxidants can protect against the harmful effects of radiation and play an important role in preventing many human diseases (e.g., cancer, atherosclerosis, stroke, rheumatoid arthritis, neurodegeneration, diabetes, and aging). There are, however, other theories in place.

THEORIES OF AGING

There are many theories that address the so-called pillars of aging. Most of these theories support the benefits of antioxidants in the treatment and prevention of aging, including aging skin, based on free radical damage. Many others provide alternate explanations and reasoning behind disease and aging processes, some which totally go against the free radical theory and dispute the use of antioxidants and supplements.

The free radical theory

The free radical theory was developed in 1956 by Denham Harman at the University of Nebraska.[12–14] This theory describes the development of an unpaired electron—which is ultimately destructive to the cells—and its efforts to stabilize. Any reaction in the body that uses oxygen (even eating, drinking, and breathing) can result in free radical formation; however, under normal circumstances, the body has built-in mechanisms (intrinsic antioxidation mechanism) to neutralize this free radical formation. When other excessive use of oxygen and undesirable oxidation processes occur (i.e., via pollutant, cigarette smoke, chemicals, radiation), the body is unable to handle the rate of free radical formation, hence these destructive processes occur. Antioxidants such as beta-carotene, vitamins C and E, grape-seed extract, Hydergine, melatonin, and vinpocetine have shown significant free radical scavenging benefits.[12–14]

The mitochondrial decline theory

Mitochondria are found in every cell and function to create adenosine triphosphate (ATP). ATP is necessary for every function of life. Enhancement and protection of the mitochondria are essential not only to preserve life moment to moment, but also for the body's regenerative

and repair processes. However, as we age, mitochondria become less efficient and fewer in number, hence producing overall less ATP. Idebenone (coenzyme Q10), pregnenolone, acetyl-L-carnitine, and Hydergine are felt to be helpful in the overall process of maintaining stable levels of ATP.[12]

The cross-linking theory

Also known as the *glycosylation theory of aging*, cross-linking occurs in the presence of oxygen and involves the binding of glucose to protein, which impairs the protein and limits its ability to function. Examples of disease processes in which this mechanism is at work include diabetes, cardiac enlargement, renal disorders, and the binding of DNA resulting in cellular damage and the development of cancer. Dietary modification (a reduction in simple sugars and other simple carbohydrates) and supplements have shown great promise in the battle to prevent, slow, and even break existing cross-links.[12,15]

The DNA and genetic theory

This theory, developed by genealogist Don Kleinsek, focuses on the encoded programming within our DNA.[12] We are born with a unique code and a predetermined tendency to certain types of physical and mental functioning that regulate the rate at which we age. The timing of this rate can be influenced via the accumulation of damage from DNA oxidation as a result of diet, toxins, pollution, and radiation. Other theories related to DNA damage involve the process of glycosylation (see the previous section, "The Cross-Linking Theory") and the cell division process. The cell division process results in the shortening of telomeres (the sequence of nucleic acids extending from the ends of chromosomes), which leads to cellular damage and the inability of DNA to repair itself correctly, ultimately leading to cellular dysfunction, aging, and death (the *telomerase theory*). Because oxidation does play a role in the process of DNA damage, theoretically, antioxidants may serve some use in this theory. However, Kleinsek and his team of researchers have indicated that certain hormones may be the key in this genetic repair process.[12]

The neuroendocrine theory

The neuroendocrine theory is an alternative theory focused on hormones and aging. First proposed by Ward Dean and Vladimir Dilman, this theory states that the loss of the ability of the hypothalamus over time to dictate precisely its regulatory functions of the body's organs and glands, and the loss of sensitivity of the receptors that uptake the individual hormones, lead to cell death. It is proposed that cortisol levels, which increase with age, damage the hypothalamus. Substances that slow down the accumulation of cortisol (DHEA, gerovital-H3, phenytoin) are felt to slow down this cortisol accumulation. Hormone replacement therapy is also felt to positively alter this process.[12,16]

The membrane theory of aging

This theory, first described in Hungary by Imre Zs-Navy of Debrechen University, focuses on the removal of toxins by antioxidants. With age, the cell membrane loses its lipid content. This loss impairs the ability of the cell to efficiently conduct normal cell functions such as chemical transfer, heat processes, and electrical processes. A cellular toxin, lipofuschin, is thought to accumulate in the brain, heart, lungs, and skin. Substances that have been touted to aid in the removal of the accumulated lipofuscin are the amino acids acetyl-L-carnitine, carnosine, and centrophenoxine.[12]

The Hayflick limit theory

Developed by Leonard Hayflick, this theory focuses on substances that slow down cell division. The Hayflick limit theory suggests simply that the number of times a human cell can divide is limited. Working with Paul Moorehead in 1961, the two theorized that after that limited number of cell divisions is reached, the cells stop dividing and die.[12] According to this theory, efforts to slow down cell division should be helpful in extending life. Suggested substances that may be helpful include carnosine and RNA supplements.[12]

ANTIOXIDANTS AND THE SKIN

Skin aging results in characteristic tissue alterations, such as the degradation of collagen and the formation of visible fine lines and wrinkles.[17] One of the major and important contributions to skin aging, skin disorders, and skin disease results from reactive oxygen species (ROS) or free-oxygen radicals such as superoxide, hydrogen peroxide, and hydroxyl radicals.

As an organ constantly exposed to its milieu and biological targets, the skin is often a target for oxidative stress caused by endogenous sources, such as neutrophils or pathological processes linked to inflammatory skin diseases, chronic infections, and exogenous sources (UV light being a primary culprit). Over the course of evolution, the skin has developed a complex defense system to protect the organism from oxidative damage. An overload of this system seems to be responsible, at least partially, for serious skin diseases, including the formation of tumors and premature skin aging. Hence, it seems to be a reasonable strategy to support the natural defense system of the skin, using substances that appear to alter this damage.

The skin is an extremely metabolic tissue that has the largest surface area in the body and serves as the protective layer for internal organs. Because skin is exposed to a variety of damaging species that originate in the outer environment, in the skin itself, and in various endogenous sources, it is a key contender and target of oxidative stress. For these reasons, the skin possesses a large number of

specific defense mechanisms for both physical and biochemical protection. The organization of the skin is very sophisticated, composed of several layers, each of which play a specific role and carry out a different function. Each layer has its own defense system, and the various systems differ from each other based on the layer's vulnerability to oxidative stress.[18] For example, studies have demonstrated that vitamin E (alpha-tocopherol) is, relative to the respective levels in the epidermis, the major antioxidant in the human stratum corneum (SC); its depletion is a very early and sensitive biomarker of environmentally induced oxidation; and a physiological mechanism exists to transport alpha-tocopherol to the skin surface via sebaceous gland secretion. Furthermore, there is conclusive evidence that the introduction of carbonyl groups into human SC keratins is inducible by oxidants and that the levels of protein oxidation increase toward the outer SC layers.[19] There are a number of antioxidants that report benefit, many of which are widely studied, and currently used in many marketed cosmeceutical products (Table 11-1). There are other less known antioxidants with myriad systemic as well as "purported" skin antioxidant effects (Table 11-2).

Vitamin A and beta-carotene

Vitamin A was the first fat-soluble vitamin to be discovered. Two independent research teams—Osborne and Mendel at Yale University and McCollum and Davis at the University of Wisconsin—simultaneously discovered it in 1913.[11] The body acquires some of its vitamin A through animal fats. The rest it synthesizes in the intestines from the beta-carotene and other carotenoids abundant in many fruits and vegetables.

Although vitamin A is best known for promoting and maintaining healthy eyesight, it is also the most abundant vitamin of the skin. Eighty percent of this vitamin is present in the skin in the form of an ester known as retinyl palmitate. This ester is hydrolyzed to form vitamin A. Vitamin A is then oxidized to retinoic acid, its active metabolite. Through its binding to nuclear receptors, retinoic acid may promote cellular differentiation, inhibit proliferation, and induce apoptosis. Multiple studies have shown that vitamin A, as well as its precursors and metabolites, plays a key role in skin and mucous membrane epithelial cell maintenance and function. In addition, these properties are exemplified by the use of vitamin A derivatives in the treatment of photoaging.

In the 1930s, it was postulated that vitamin A deficiency developed in all areas of sun exposure, being extremely sensitive to sunlight and particularly to ultraviolet light A (UVA). During that time, it was also noted that skin exposed to sunlight aged faster than skin that was protected from sunlight. By 1955, it was reported that the application of vitamin A as retinyl palmitate to aged skin rejuvenates the skin to some degree.

The term *retinoid* applies to the naturally occurring forms of vitamin A, as well as its many synthetic analogues. One of the most well known retinoids, retinoic acid (tretinoin), has proven to be effective in both the prevention and repair of skin photodamage. Studies have shown that tretinoin not only prevents UV-induced collagen degradation, but it also increases collagen formation, reverses epidermal atrophy, and promotes uniformity in melanin dispersion. These changes combat photoaging by improving fine wrinkles, skin laxity, and hyperpigmentation.

Carotenoids, such as beta-carotene, are natural antioxidant precursors of vitamin A. In addition to its role in vitamin A synthesis, beta-carotene has inherent photoprotective properties. Its ability to reduce UV-induced erythema may make beta-carotene a key player in the prevention and treatment of photoaging. Other known functions of beta-carotene are anticarcinogenic and antiarithrogenic effects, as well as immunomodulation.

Vitamin C

Although knowledge of vitamin C (L-ascorbic acid) was first gained in the 18th century, it received widespread attention in 1971 when Nobel prize winner Linus Pauling published his book *Vitamin C and the Common Cold*. Vitamin C is a water-soluble vitamin that is also a potent antioxidant. It is needed for the growth and repair of tissues in all parts of the body, the synthesis of collagen, and the formation of scar tissue, tendons, ligaments, and blood vessels. It is also essential for the healing of wounds and for the repair and maintenance of cartilage, bones, and teeth.

Vitamin C works both inside and outside the cells to combat free radical damage. Vitamin C also works along with glutathione peroxidase (a major free radical–fighting enzyme) to revitalize vitamin E. No organ system stores ascorbic acid as a primary function, and so the body soon becomes depleted. If vitamin C is not replenished via the digestive system (or some other means), its deficiency will eventually lead to scurvy and death. Vitamin C has relatively few side effects. Serious side effects attributed to vitamin C are kidney stones and the destruction of vitamin B_{12}. As a topical agent at levels ranging from 0.3% to 10%, vitamin C has numerous benefits to the skin. These include protecting skin cells from UV-induced damage and a delay in tumor formation after skin exposure in cases of extensive UV damage;[31] a reduction in transepidermal water loss, which strengthens the skin's barrier response; the promotion of collagen production with the potential to thicken dermal skin; and enhanced effectiveness of cosmetic procedures, such as chemical peels and microdermabrasion treatments.[32,33]

Although the information is somewhat limited, studies suggest that vitamin C may also be helpful in slowing the progression of Parkinson disease and the prevention of Alzheimer disease.[34] It works with other antioxidants, such as selenium, beta-carotene, and vitamin E, to protect the eyes against developing macular degeneration.[35,36]

Table 11-1

Commonly used antioxidants and their functions

Antioxidant	Characteristics and functions	
Vitamin A Retinoic acid (Tretinoin) Beta-carotene	Lipid soluble Regulator role in DNA synthesis Necessary for development & maintenance of epithelial cells, mucus membranes, and skin Promotes skin rejuvenation	Anti-aging properties Enhances resistance to infection Promotes and maintains healthy eyesight
Vitamin C	Water soluble Reduces transepidermal water loss Essential for wound healing Protects skin cells from UV induced damage	Strengthens skin barrier response Promotes collagen production Thickens dermal skin Delays tumor formation after skin exposure to UV
Vitamin E	Free radical scavenger Protects against oxidative damage to DNA and white blood cells Reduction of UV-induced skin cancer	Regulates cell proliferation Improves insulin sensitivity Improves glucose transport Suppressive action of low-density lipoprotein (LDL)
Coenzyme Q10 (Ubiquinone)	Lipid soluble Structurally similar to vitamin E Cellular energy Immunologic stimulant Increases circulation	Beneficial to cardiovascular system Anti-aging effects Life-span extending properties Protects keratinocytes from oxidative damage Turnover of epithelial cells enhanced
Alpha hydroxy acids (AHAs) Lactic acid Tartaric acid Malic acid	Decrease in corneocyte cohesion Facilitate shedding of corneocytes Increase epidermolysis	Stimulate production of collagen and elastin Chelating agents: Decrease calcium ion concentrations Exfoliation: Induce apoptosis
Silymarin	Flavonoid isolated from milk thistle Strong antioxidant activity	Free radical scavenger Antitumor effects
Green tea polyphenols	Catechins: Anti-inflammatory and anticancer Protects against effects of heart disease, osteoporosis Aids in weight loss	Bioflavonoids: Anticancer, antibacterial, and antiviral properties Helps maintain cellular membrane and DNA structural integrity
Superoxide dismutase	Reduces rate of cell destruction Revitalizes cell	Neutralizes superoxide Converts superoxide radicals to H_2O_2
Alpha lipoic acid (ALA) (also known as Thiotic acid)	Improves skin texture Reduces fine lines, wrinkles, and scars Used in the treatment of diabetic neuropathy	Scavenges a wide range of reactive oxygen species Participates in the recycling of other antioxidants (vitamins E and C, coenzyme Q10, and glutathione)
Beta hydroxy acids and beta-lipohydroxyacid	Improves acne and skin texture General skin anti-aging effects	Comedolytic properties Induces epidermal thickening

Table 11-1

Antioxidants and their functions (*continued*)

Antioxidant	Characteristics and functions	
Selenium	Photoprotective properties Decreased intake is associated with increased incidence of some cancers	Role in the formation and function of the selenium dependent glutathione peroxidases, which detoxify hydroperoxides
Soy isoflavone	General skin anti-aging effects Photoprotective properties Osteoporosis prevention	Weak estrogenic activity Used in the treatment of heart disease, cancer, and menopausal symptoms
Zinc	General skin anti-aging Beneficial in wound healing Used to in the treatment of seasonal conjunctivitis	Maintains the integrity of biological membranes resulting in protection against oxidative injury Vital for proper functioning of the immune system, digestion, reproduction, vision, taste, and smell

Vitamin E

Evidence has been obtained showing dietary vitamin E to protect against oxidative damage to DNA in human lymphocytes and white blood cells. Studies on mice have reported reductions in UV-induced skin cancer. Other clear evidence of vitamin E's protective effect has been seen in its suppressive action of low-density lipoprotein (LDL) oxidation both in vitro and in vivo. New evidence on the physiological roles of antioxidants, in addition to their well-known role as free radical scavengers, is emerging from recent research. Early findings suggesting a beneficial effect of vitamin E in improving glucose transport and insulin sensitivity and a possible putative role as a regulator of cell proliferation should open new research dimensions.[37] Vitamin E may be more effective if combined with other antioxidants, such as coenzyme Q_{10} and vitamin C.

Coenzyme Q_{10}

Discovered in 1957 by Frederick Crane, a plant physiologist at the University of Wisconsin Enzyme Institute, coenzyme Q_{10} (CoQ_{10}), or ubiquinone, is the only lipid-soluble antioxidant (in its reduced form, ubiquinol) that is synthesized in the body and present in cellular membranes and in lipoproteins. In 1958, D. E. Wolf and Karl Folkers first described the chemical structure of CoQ_{10}. From 1957 through 1988, there were some 2,300 medical studies on CoQ_{10}. Since then, there have been countless others.[38]

The exceptional antioxidant properties of CoQ_{10} effectively counteract free radical damage and provide significant protection against UVA-induced depletion of cell membrane components, preventing damage to collagen and elastin.[39–41]

CoQ_{10}, an antioxidant that is structurally similar to vitamin E, plays a crucial role in the generation of cellular energy. It is a significant immunologic stimulant, increases circulation, is beneficial for the cardiovascular system, and has anti-aging effects. It appears to qualify as a highly beneficial anti-aging nutrient based on its multiple mechanisms of action, its broad range of effects on a number of life-threatening or debilitating clinical conditions, its lifespan–extending properties in more than one species, and its absence of adverse effects. Beneficial effects have been demonstrated in some conditions with as little as 30 to 60 mg per day.[39]

Multiple animal studies have shown an increased life span related to CoQ_{10}.[39–41] As research continues to accumulate, it appears that the higher the dosage, the greater the benefit (as evidenced by supplementation with 390-mg in breast cancer and 1,200-mg in Parkinson disease patients), and that the primary limiting factor on CoQ_{10} dosage is the cost.[39–41]

There are a number of conditions in which CoQ_{10} tissue concentrations are altered with functional consequences. Oxidative stress generated by, for example, physical exercise increases tissue ubiquinone levels by increasing biosynthesis, as does administration of drugs like clofibrate. In contrast, aging is generally associated with decreases in tissue CoQ_{10} levels. For example, levels of CoQ_{10} in the skin are low in childhood, reach a maximum at around 20 to 30 years of age, and then decrease steadily with increasing age. It has been postulated that topically applied CoQ_{10} can penetrate the skin and attenuate

Table 11-2

Miscellaneous antioxidants and their functions

Antioxidants	Purported uses	Function
Acetyl L-carnitine	General skin anti-aging effects, symptomatic diabetic neuropathy	Transport of long-chain fatty acids across the mitochondrial membrane and transport of small and medium chain fatty acids out of the mitochondria
EUK-134	Improvement in skin erythema caused by Ultraviolet (UV) exposure, reduction in adverse developmental outcome due to ethanol exposure in utero, renal dysfunction	A synthetic superoxide dismutase and catalase mimetic with similar actions on the skin
Ferulic acid	General skin anti-aging effects, photoprotection, diabetes, Alzheimer's, macular degeneration, menopause, enhances athletic performance	Arises from the metabolism of phenylalanine and tyrosine
Glutathione	General skin anti-aging, skin lightening, heart disease, osteoarthritis, memory loss, kidney dysfunction, and pulmonary disease	Reduces disulfide bonds formed within cytoplasmic proteins to cysteines by acting as an electron donor Immune system booster and detoxifier Antimelanogenic effects
Grape seed extract	Improvement in skin erythema and wound contraction; used as a laxative and antacid Small human trials have shown possible efficacy in decreasing LDL and increasing total antioxidant activity	Scavenging of hydroxyl and peroxyl radicals; inhibition of the oxidation of LDL
Methionine	General skin anti-aging effects; ingredient in most hair, skin, and nail supplemental vitamins; lowers blood cholesterol; maintains normal body weight	Neutralizes hydroxyl radicals, essential for the production of nucleic acid, collagen, and proteins
Melatonin	Suppresses UV-induced skin damage, modulates the immune system, protects against degenerative diseases, promotes sleep and prevents jet lag	Inhibits metal ion-catalyzed oxidation processes Antiapoptotic activity
Nicotinamide adenine dinucleotide (NADH) (also known as coenzyme 1)	Reduces wrinkles, skin erythema, and hyperpigmentation; improves skin texture; memory enhancer, decreases blood cholesterol, lowers blood pressure	Production of cellular energy
Oligomeric proanthocyanidins (OPCs) (also known as flavonoids)	Photoprotection, reduction in fine lines and wrinkles, protects the liver from damage, repairs connective tissue, slows aging	Moderates allergic and inflammatory responses

both the depth of deep wrinkles characteristic of photoaging, as well as increasing the turnover of epidermal cells. CoQ_{10} is also highly effective in protecting keratinocytes from oxidative DNA damage induced by UV light.

Alpha hydroxy acids

Alpha hydroxy acids (AHAs) are a group of organic carboxylic acids that are naturally occurring and nontoxic and have been used to promote a more youthful complexion by people in many civilizations. In ancient Egypt, Cleopatra used AHAs in the form of milk baths to soften her much-admired skin. AHAs are found in fruit, sour milk, sugarcane, and other products processed through biofermentation.

In low concentrations, AHAs cause a decrease in corneocyte cohesion and facilitate the shedding of corneocytes. In higher concentrations, they result in epidermolysis, upper dermal changes, and may even stimulate the production of collagen and elastin, producing vibrant, less-wrinkled, and more uniformly colored skin.[42] Nonetheless, the specific mechanism of action of AHAs has not been fully determined. It is hypothesized that AHAs act as chelating agents, decreasing local calcium ion concentrations from cation-dependent cell adhesion molecules. Another proposed mechanism for AHA-induced exfoliation is an increase in apoptosis.

The simplest molecule of AHAs and the most widely used in skin care is glycolic acid, made from sugarcane, which is used extensively for photoaging and wrinkles. Studies done by Moy et al. demonstrated that glycolic acid may stimulate collagen production in skin fibroblasts.[43] Another commonly used AHA is lactic acid that is derived from milk. It is widely used as a milder or slightly less irritating alternative to glycolic acid and like glycolic acid is primarily used for anti-aging to soften lines, reduce photodamage from the sun, improve skin texture and tone, and improve overall appearance. Other AHAs include tartaric acid (derived from grapes), malic acid (derived from apples and pears), and citric acid (derived from citrus fruits). All have similar benefits.

Major side effects of alpha hydroxy acids are irritation and sun sensitivity. People with darker skin tones are at a higher risk of long-term pigment changes with aggressive use of AHAs. Their use can increase sun sensitivity by 50%.[42,44,45] Hence, it appears that although AHAs may reverse some of the damage caused by photoaging, they can make the skin more susceptible to photoaging at the same time. Larger cohort studies need to be done to fully evaluate efficacy as well as the specific mechanism of action.

Silymarin

Silymarin, *Silybum marianum* (L.),[46] a flavonoid isolated from milk thistle (present in artichokes), is used clinically in Europe and Asia as an antihepatotoxic agent,[47,48] largely because of its strong antioxidant activity. Because most antioxidants afford protection against tumor promotion, a detailed study was done that assessed the protective effect of silymarin on tumor promotion in a mouse-skin model. It was concluded that silymarin possesses exceptionally high protective effects against tumor promotion (protection against tumor incidence, tumor multiplicity, and tumor volume), and that the mechanism of such effects may involve inhibition of promoter-induced edema, hyperplasia, proliferation index, and the oxidant state.

As a therapeutic agent, silymarin is very well tolerated and largely free of adverse effects.[49,50] It has been marketed recently in the United States for its potential antioxidant benefits. Recent studies show that it may inhibit UVB-promoted cancers in animals. Mechanistic studies have shown that silymarin is a strong antioxidant that is capable of scavenging both free radicals and reactive oxygen species in rodents and in cell cultures, and that it results in a significant increase in cellular antioxidant defense machinery by ameliorating the deleterious effects of free radical reactions.[51–55]

Green tea (tea polyphenols)

Recent scientific studies have indicated that green tea could protect against cancer, heart disease, and osteoporosis; aid in weight loss; and help ward off skin cancer and signs of aging. Green tea is consumed mostly in Asian countries—including India, Japan, Korea, and China—although it is not quite as popular as its cousin, black tea, which is consumed by more than 75% of tea drinkers. Like black tea and oolong tea, green tea comes from the *Camellia sinensis* plant, but its leaves are not fermented before steaming and drying; they remain fresh.

These teas contain large quantities of polyphenols (a class of bioflavonoids) and have been shown to have antioxidant, anticancer, antibacterial, and antiviral properties. Most of the polyphenols in green tea are catechins. Catechins are antioxidants that have also been shown to function as anti-inflammatory and anticancer agents. One of the major catechins in green tea has been shown to be the most effective agent against skin inflammation and cancerous changes in the skin.

There is evidence that the compounds in green tea protected mouse skin from cancer caused by sunlight. Initial experimental studies on human skin by Katyar et al. found that the polyphenols in green tea also had anti-inflammatory and anticancer properties.[56]

Studies by Conney, et al. have been done to determine how green tea protects against cancer.[57] In their initial studies, caffeine was removed from the tea, and the decaffeinated tea was fed to mice at a moderate dose. Results revealed that when the caffeine was removed from green tea, the tea lost most of its effectiveness at inhibiting skin cancer. Reproducible evidence is still scarce to show the benefit in humans.[57]

Superoxide dismutase

Superoxide dismutase is an enzyme that is also a potent antioxidant. It revitalizes cells and reduces the rate of cell

destruction by neutralizing superoxide. It converts the reactive oxygen species by converting superoxide radicals into hydrogen peroxide, which is then changed into molecular oxygen and water. Superoxide dismutase levels tend to decline with age, whereas free radical production increases. Its potential as an anti-aging treatment has been suggested. Compounds that mimic superoxide dismutase have been shown to extend the life span of experimental worms by near 50%.[58]

ANTIOXIDANTS AND SURGERY

Cosmetic surgery has increased in popularity, not only as a way to maintain youthfulness, but also to approve general appearance. A 2004 report of the American Society of Plastic Surgeons noted that Botox injections increased by 184% from 2002; chemical peel by 26%; laser skin resurfacing by 13%; and soft-tissue fillers, such as collagen, by 14% and fat by 22%.[59] Total cosmetic minimally invasive procedures increased by 81%. In the past, cosmetic surgery was frowned upon in the black community, but in 2004, African Americans accounted for nearly 5% of the 8.7 million cosmetic-surgery procedures. The basis of the past stigma was multifactorial and included religious factors, lack of trust, economic factors, and ethnic pride in maintaining unique ethnic features. These factors are not unique to African Americans but have been observed across numerous cultures and ethnic groups to varying degrees. Similar results demonstrating the growth of cosmetic procedures were observed in a survey by the American Society for Dermatologic Surgery in 2005. There was an overall 32% increase in minimally invasive cosmetic procedures from 2003 to 2005, with a 58% increase observed from 2001. There was no information on ethnic breakdown of the growth of these procedures.[60]

THE BENEFITS OF ANTIOXIDANTS IN COSMETIC SURGERY OF THE SKIN IN THE ETHNIC POPULATION

Despite the flooding of the media and academic literature of information on antioxidants, there are significant deficits in our understanding of the nuances of antioxidant therapy. Similarly, there is a definite lack of information on racial and ethnic differences in skin structure, physiology, and function stemming from a significant lack of ethnic diversity in currently available clinical investigations. Consequently, few definitive conclusions can be made on skin diseases in ethnic skin, especially in the areas of antioxidants and cosmetic surgery and a relationship between the two. The literature does support a racial differential in epidermal melanin (pigment) content and melanosome dispersion in people of color compared with fair-skinned persons. These differences appear to, at least in part, account for the lower incidence of skin cancer in darker-skinned individuals compared with those with white skin and a lower incidence and different presentation of photoaging in people with skin of color. Regardless of age, all skin types and age ranges need sun protection and can benefit from antioxidants with ingredients that mimic the structure of skin and have cell-communicating ingredients. There is virtually no existing information on the benefits of antioxidants in specific ethnic groups; any conclusions drawn result from extrapolation of the results from studies on fairer skin tones.

Much work remains in efforts to gain a detailed and precise understanding of the specific mechanisms of action, methodology that includes evaluation tools in all skin types, optimum formulation and delivery modes, dosage, and firm evidence of the direct link or cause-and-effect relationship between usage and results. We are, however, well on the way to an improved and more accurate understanding of the varied benefits of antioxidant therapy in disease and cancer prevention, anti-aging, and overall health maintenance. As we continue to achieve this knowledge, we will be able to apply it to more diverse and broader applications, such as specific disease processes, disease prevention, unique benefits that will meet the needs of the various ethnic groups, and many cosmetic procedures.

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12

Photoprotection

Vermén M. Verallo-Rowell

The deleterious effects of ultraviolet and visible light on human skin include sunburn, suntan, phototoxic and photoallergic reactions, aggravation of hyperpigmentary disorders, photoaging, immunosuppression, solar keratoses, and the induction of skin cancers. For more than 70 years, commercial sunscreens have been used to mollify these detrimental cutaneous effects of light. The first, containing benzyl salicylate and benzyl cinnamate, was developed and marketed in the United States in 1928.[1]

Since the development of the early formulations to prevent sunburn, sunscreens have evolved as the gold standard for skin protection from ultraviolet light. In general, sunscreens are used to prevent sunburn, limit photodamage, and decrease the risk of skin cancers, including basal cell carcinomas, squamous cell carcinomas, and malignant melanoma. The International Agency for Research on Cancer reported that although the data on sunscreen prevention of actinic keratoses and squamous cell carcinomas is adequate, that on basal cell carcinomas and melanomas is inadequate.[2] Despite this finding, most clinicians and researchers agree that an overall sun protection program should include limited sun exposure, protective clothing, sun visors, hats, and daily use of sunscreen.

INDICATIONS FOR SUNSCREEN USE IN DARKER RACIAL ETHNIC GROUPS

Individuals encompassing Fitzpatrick's skin types III/IV through VI generally have olive, brown, or black skin (see Chapter 2). Such individuals have a substantially lower incidence of skin cancers and photoaging. Photoimmunosuppression has been reported to be milder, and photosensitivity is less common.[3] Why, then, do people with darker skin need sunscreens?

Disorders of hyperpigmentation have emerged as a key indication for sunscreen use in darker skin types. These include melasma, postinflammatory hyperpigmentation (PIH), ephelides, lentigines, Hori's nevus, postlaser, and phototherapy hyperpigmentation. Albeit less life threatening than cancers and melanomas, these skin problems seriously affect quality of life (see Chapter 6). Skin cancers are another indication. Although still relatively rare among those with darker skin, the incidence is growing. The Cancer Registry in Singapore in 1988 noted increasing incidence of skin cancers, excluding melanoma.[4] By 2002, skin cancer, including melanoma, reached the top-ten cancers list.[5] This higher ranking for skin cancer may be attributed to more affluence, a favoring of increased outdoor leisure activities, longer life spans, and exposure to more solar ultraviolet rays brought on by the factors that promote stratospheric ozone depletion.[6]

Sociological/cultural issues further influence the use of sunscreens in darker skin. A unique irony regarding skin color is that those with lighter skin cherish being darker (i.e., acquiring a tan), whereas many of those with olive or darker skin prefer to have lighter-colored skin. Toward this goal, sun avoidance is a popular practice. Unless demanded by work or for play, when outdoors, those with darker skin who prefer light skin color look for deep shades, use parasols, wear wide-brimmed hats, and cover up with clothing.[7] They also frequently use skin lighteners.[8] Both practices are common among those who are generally of mixed heritage: African Americans;[9] Africans;[10] Asians;[11] Hispanics;[12] Middle Easterners;[13] and Caribbean Islanders.[14] This is true even among some of the more ethnically homogenous Asians from Japan,[15] China,[16] or Korea, who, despite being fairer than other Asians, consider themselves "brown."[17]

Use of sunscreens is not a common practice because darker skin phototypes III/IV to VI do not burn readily and have a baseline color that darkens easily and is perceived to be protective.

Because sun-induced/aggravated hyperpigmentations are common in those with darker skin, their customary sun behavioral practices are obviously not enough to avoid these conditions. What follows is a review of the light wavelengths that sunscreens protect against to understand which to use for the specific indications needed by those with darker skin.

ELECTROMAGNETIC RADIATION WAVELENGTH EFFECTS AND PROTECTION

Sunlight is divided into three components, including ultraviolet (UV) light, visible light (VL), and infrared light (IRL), with UV representing the most important component (Fig. 12-1). UV is divided into three groups based on the wavelength of light: (i) UVC (100–280 nm), which minimally affects the earth's surface because it is blocked by the ozone layer, (ii) UVB (290–320 nm), which causes erythema, sunburn, DNA damage, solar elastosis, hyperpigmentation, and skin cancer, and (iii) UVA (320–400 nm), which requires a higher dose to induce erythema but easily elicits two pigment-darkening responses, both produced by the photo-oxidation of melanin.[18] Immediate pigment darkening (IPD) starts in seconds after UVA exposure and disappears within 2 hours. At higher doses of 8 to 25 J/cm^2 from 2 to 24 hours after exposure, IPD is followed by more pigmentation, the PPD or persistent pigment darkening. In those with lighter skin, this lasts about 24 hours.[19] In those with darker skin, it lasts much longer, often continuing into the delayed tanning effect of both UVB and UVA.[20] UVB does not produce IPD nor PPD, but produces, with UVA, a delayed tanning response that peaks at 72 hours. This is brought on by an increase in the number of active melanocytes and tyrosinase, which together produce new melanosomes, melanin, and transfer to keratinocytes.[21]

IPD and PPD are not photoprotective,[21] an important point to remind those with darker skin who may think that their immediate darkening protects them from the sun. The UVB-induced delayed tanning after erythema has a sun protection factor (SPF) of 3, which is a few points higher in darker skin.[21]

Erythema reactions

Both UVB and UVA produce acute erythema, but UVA is much less efficient than UVB. Approximately 1,000 times more UVA than UVB is needed to elicit the same erythema response.[22]

Solar UVB-induced acute erythema starts after about 4 hours of exposure, peaks at 8 to 24 hours, and fades after a day or so. However, among the very fair or very old, this may last for weeks.[23] The acute erythema induced by UVA for both light and darker skin color is milder than the UVB erythema and biphasic. The first phase appears immediately after exposure and fades in several hours. The second phase starts at about 6 hours and peaks at 24 hours.[24]

After a single erythema response, both UVB and UVA increase epidermal and dermal mitotic activity. That of UVB persists for days to weeks, with much more thickening of the epidermis and dermis.[24] Only after repeated exposures does UVA produce thickening of the epidermis, but this is much less than that from UVB.[24]

Chronic erythema produces P^{53} gene mutation, which is found in 90% of squamous cell carcinomas, 60% of actinic keratosis, and 50% of basal cell carcinomas.[25] Even nonerythemal sun exposure induces reactive oxygen species-mediated DNA change and pyrimidine dimer formation leading to skin cancer in animal models.[26]

Repeated UVA radiation has in recent years been shown to produce even more immunosuppression than UVB.[27] Animal models develop skin alterations of the Langerhans cells—their number, functions and morphology—resulting in photoimmunosupression. This is medi-

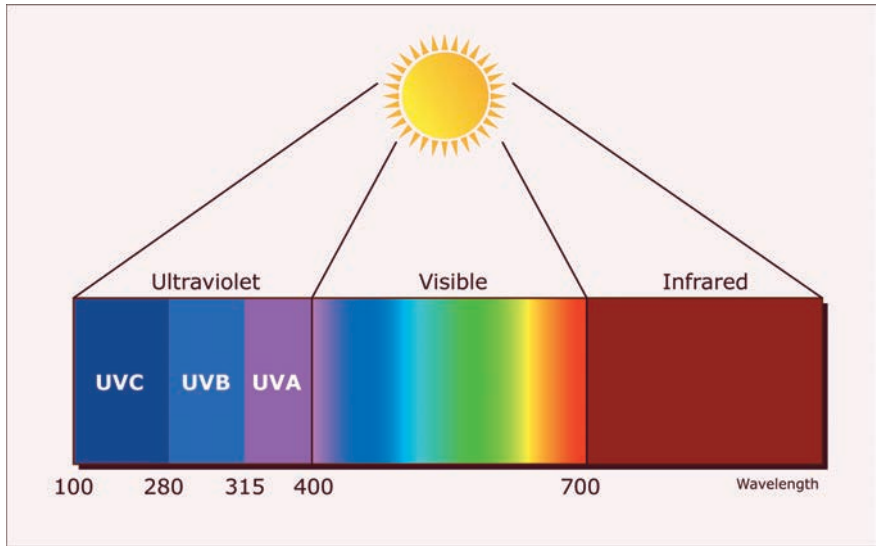

Figure 12-1 Schema of the electromagnetic spectrum of light and the wavelengths of its three components discussed in the text in regard to their specific effects on darker skin.

ated in part through the generation of cis-urocanic acid, tumor necrosis factor, and interleukin-10.[28]

UVA, much more than UVB, elicits the photosensitivity reactions to cosmetics, drugs, and environmental chemicals, often resulting in the appearance of PIH in darker skin types.[29]

Visible light

Verallo-Rowell, in a cross-sectional photopatch testing of 20 patients with melasma, compared with 20 without, used VL to irradiate photoallergens.[30] In the melasma group, 29 photopatch tests to 11 fragrances, 11 North American Contact Dermatitis Group (NACDG), and 7 plant allergens were (+), relevant, and significant ($p = 0.005$, CI: 1.54–4.49). A follow-up open study of 20 melasma patients examined the exposed parts of the body. All showed irregular *subtle* pigmentation in a classic pattern of photosensitivity. The subtlety of the dyschromia was attributed to the "sun-shy" behavior of the all Asian patients. Patch tests with the same photoallergens as the previous study, irradiated with UVA at slightly less than the predetermined Minimal Erythema Dose (MED) elicited (+) to (+++), relevant reactions.[31]

Melasma cases that worsened instead of improving as expected following intense pulsed light (IPL) therapy prompted a study by Negishi et al. on very subtle epidermal melasma (VSEM).[32] Best seen under UV photography, VSEM was described as otherwise "invisible to the naked eye," although photographs "under normal light" appear similar to the subtle melasma and photosensitivity among the sun-shy Asians reported by Verallo-Rowell.[31]

The importance of these initial observations is relevant to the VL and IRL-emitting lasers and light devices used to treat melasma. We have just started a multicenter, prospective controlled study on the relationship of melasma and photosensitivity. The results of this study may continue to improve our understanding on the specific sunscreens and light devices to use in the prevention and treatment of melasma patients. In this respect, among Negishi et al.'s 223 IPL-treated melasma patients, 63 (28.3%) had VSEM. Of the 45/63 nonusers of sunscreens, 50.6% had VSEM. Of the rest—18/63 who were sunscreen users—only 13.4% had VSEM.[32]

To summarize, despite outdoor sun avoidance practices, people with darker skin are prone to hyperpigmentations. UVA and VL (much more than UVB) aggravate and elicit photosensitivity, PIH, and melasma. Anti-UVA and anti-VL sunscreens are thus indicated in normal skin to help prevent hyperpigmentations; in the treatment of melasma and other pigmentation problems to inhibit formation, retard proliferation of melanocytes, and protect lightened skin; and overall to facilitate therapeutic effects during and postmelasma treatment. Postlaser and light therapy sunscreens help prevent pigmentations and help avoid the stimulation by light of viable melanocytes. All these also help to avoid potentially more serious sun-related cancers and immunosuppression.[33,34]

SUNSCREENS AGAINST LIGHTS EMITTED BY OUTDOOR/INDOOR LIGHT SOURCES

Outdoors

On the earth's surface, the amounts of solar UVB and UVA, at a ratio of 20:1, are strongest between 10 A.M. and 4 P.M.[22] and vary depending on latitude, altitude, season, time of day, clouds, and ozone layer. Compared with UVB, UVA is of longer wavelength, is less affected by these factors, and can penetrate deeper into the skin.[22] Solar VL and IRL are much more abundant, but have longer, thus weaker, wavelengths, which therefore are considered harmless to the skin.[22]

Indoors

In cars and through windows, clear glass absorbs and acts as a protective shield against the shorter wavelengths (below 320 nm) of UVB.[35] Untinted glass allows UVA through. Ordinary tint can block a large portion of UVA up to about 370 to 380 nm, whereas dark-tinted glass containing metals provides significant protection against UVA and VL. This is limited by the U.S. Federal Motor Vehicle Safety Standard,[36] which requires that side window glass allow the transmission of at least 70% VL radiation. It has been estimated that approximately 50% of outdoor UVR also occurs indoors, from scatter and reflection on bright surfaces or rippling water.[21]

In short, for the hyperpigmentation problems of darker skin types who generally avoid the sun but do not use sunscreens: Indoors, where UVA and VL are ubiquitous, daily anti-UVA and anti-VL sunscreens are needed, especially after cosmetic surgery with laser and lights. Outdoors, in addition to the anti UVA and VL, anti-UVB sunscreens are needed. Sun avoidance,[37] sunglasses,[38] and hats and clothing[39] extend skin photoprotection.

SUNSCREEN INGREDIENTS

Active sunscreen ingredients are best called organic (chemical), or inorganic (physical, chemical-free). Table 12-1 lists the names, light wavelength absorption maximum or range, and their known safety and stability profiles. The U.S.-approved ingredients include 14 organic filters (9 anti-UVB; 5 anti-UVB and A) and 2 inorganic filters.[40] Table 12-1 also lists the European-approved sunscreen ingredients.[41–45] Two, called the Mexoryls, are made by L'Oreal (Clichy, France): Mexoryl SX[41–44] (terephthalydene dicamphor sulphonic acid) and Mexoryl XL (drometrizole trisiloxane). Both are UVA absorbers at

Table 12-1

Absorption, safety, and photostability of some sunscreen ingredients approved by the United States and European Regulatory Boards[40]

Names	Maximum absorption peak/range in nanometers	Safety, photostability
UVB Filters: PABA Derivatives		
Padimate O: (Octyldimethyl PABA)	311: good filter	Photolabile but, less than the other PABAs
Cinnamates		
Octinoxate: (Parsol MCX,OMC: octylmethoxycinnamate, Escalol 557, Eusolex 2292)	311: < potent filter than Padimate O To ↑ SPF, add other UVB filters	Unstable. Encapsulated form: ↓ photodegradation by 53%–35%
Cinoxate: (ethoxy-ethyl-p-methoxycinnamate, Uvinul N-539 Neo HeliopanE1000)	289: less often used filter	
Salicylates (Weaker UVB Filters)		
Octisalate: Octyl salicylate Homosalate: Homomenthyl salicylate Trolamine salicylate	307 308 260–305	↑ effect of other UVB filters, ↓ photodegradation of avobenzone, oxybenzone, others. In water-soluble sunscreens and hair products
Others: Octocrylene Ensulizole (PBZole sulfonic acid)	303: Photostable 310: Water soluble, skin light	Improves product stability; enhances SPF of sunscreen
Benzophenones Bp (Broad-spectrum UVA Filter)		
Oxybenzone (benzo'none-3, Bp3, Eusolex4360,UvinulM40) Sulisobenzone (Bp4,benzophenone-4) Dioxybenzone (benzophenone-8)	Two absorption peaks 288, 325 UVB to UVA strong filter 366 352	Bp group (92) photolabile Inactivates antioxidant systems; stabilized by octocrylene, salicylates, camphor, methylbenzyliden, micronized, ZnO, TiO_2
UVA Filters		
Butyl methoxydibenzoyl methane (avobenzone, Parsol 1789)	380: strong filter BUT: Photolabile: ↓ 50%–60% after 1-hour exposure	Strongly ↑ degrades OMC (99); See Bp on how to ↑ photostability
Anthralinates		
Meradimate (menthyl anthralinate, Ensulizole)	340: weak filter, mainly UVA2	
Inorganic: Favored Name for Nonchemical or Physical[46–50]		
Titanium dioxide: Pigmentary Nonmicronized 200–500 nm Micronized 10–50 nm	>UVB, UVA2, <UVA1 filter. ↑ photoreactive than ZnO Photoexcited, micronized cause cell death	Refractive index = 2.6, thus whiter than 1.9 of zinc oxide, though particle size smaller, more difficult to formulate
Zinc oxide (Z-cote) Microfine	UVA 2 and UVA 1 up to 380 nm; better protection than TiO_2	Photostable

Table 12-1

Absorption, safety, and photostability of some sunscreen ingredients approved by the United States and European Regulatory Boards[40] (*continued*)

Mexoryls by L'Oreal[41–44]		
Mexoryl SX (terephthalylidene trisiloxane, silatriazole)	345 UVB broad spectrum filter Humans: Prevent UVA-induced pigmentation, epidermal hyperplasia ↓ skin hydration, elasticity photostable	Animals: ↓ UVR-induced cancers, photoaging ↓ formation cis-urocanic acid, epidermal Langerhans cells: role in immunosuppression
Mexoryl XL (drometriazole trisiloxane, silatriazole)	303 and 344; UVB/UVA broad spectrum	Liposoluble Photostable
Tinosorbs by CIBA[45]		
Tinosorb M (methylene-bisbenzotriazolyl tetramethylbutylphenol	303 and 358 broad spectrum Microfine organic particles in aqueous phase of emulsion	Both are photostable Stabilize OMC and avobenzone No hormonal activity
Tinosorb S (bis-ethylhexyloxyphenol methoxyphenyl triazine (anisotriazine)	348 nm Broad-spectrum oil soluble	

344- and 345-nm maximum wavelengths. In addition, Mexoryl XL absorbs at UVB with 303 as its maximum wavelength.

In animals, Mexoryl SX studies prevented UVA-induced histochemical alterations associated with photoaging.[41–44] An anti-UVB sunscreen, with (compared with without) the Mexoryl SX significantly suppressed UV ray–induced carcinogenesis,[42] reduced cis-urocanic acid formation, and prevented the decrease in the number of epidermal Langerhans cells, the changes known to play a role in immunosuppression.[43] In humans, Mexoryl SX applied before UVA exposure reduced UV-induced pigmentation, epidermal hyperplasia, skin hydration, and elasticity.[44]

Two new European filters developed by Ciba Specialty Chemicals (Basel, Switzerland) are the Tinosorbs: *M* (methylene-bis-benzotriazolyl tetra-methylbutylphenol and *S* (bis-ethylhexyloxyphenol methoxyphenyl triazine (anisotriazine). Both have been shown to be broad-spectrum filters: Tinosorb M at UVB:303 and UVA:358 nm; Tinosorb S at UVA:348 nm maximum wavelength absorption. Tinosorb M has microfine organic particles, dispersed in the aqueous phase of the sunscreen emulsion, whereas Tinosorb S is oil soluble. Both are photostable and without hormonal activities.[45]

Titanium dioxide (TiO_2) and zinc oxide (ZnO) provide Anti-UVB, UVA, and Anti-VL protection. They are now available in more cosmetically acceptable formulations.[46] The addition of iron oxide pigment to opaque photoprotective agents enhances VL photoprotection and cosmetic acceptability.[47] A broad-spectrum sunscreen with a wide anti-UVB, UVA, and VL range from combining TiO_2 with bisoctrizole is also on the horizon.[48]

The basic formula of colored cosmetic products usually has TiO_2, ZnO, and pigment-inorganic sun filters that make the products, such as a lipstick, inherently photoprotective. A powder makeup may have a baseline SPF of 3 or 4, whereas a foundation makeup, with its higher amounts of TiO_2 and ZnO, may have full-spectrum UVA and VL protection.[49] The actual amount of cosmetics a person applies on the face, however, is less than the 2 mg/cm^2 amount used in the testing for protection factors. One study showed that by layering—or applying one on top of the other—thin amounts of a sunscreen cream base, powder, and foundation, a protection factor against UVA (PFA) of 14 and protection factor against visible light (PFV) of 1.4 were achieved.[50]

ANTIOXIDANTS

The natural antioxidants are enzymatic (GSH peroxidase, catalase, and superoxide dismutase) or nonenzymatic (GSH, alpha tocopherol, and beta carotene). Plants are a rich source of antioxidants, because unlike man, plants are not able to walk away from the sun.[51–62] Antioxidants neutralize the free radicals formed by the normal oxidative processes in the body. With more oxidative stress, including that from sun exposure, the natural antioxidants may not be able to cope with the increased number of free radicals. Oxidative cell damage can lead to photoaging, immunosuppression, and photocarcinogenesis.[40]

Antioxidants have very weak sunscreen effects, but they are increasingly found in sunscreens, primarily to help deal with UV-induced oxidative stress. In sunscreens, antioxidants need to be present in adequate amounts to be effective. But they are inherently unstable, do not diffuse well enough to cover a wide skin area, and are easily removed by washing, perspiration, or rubbing. The ideal delivery of antioxidants is therefore, ingested as food supplement. Table 12-2 lists some antioxidants, their sources, and their possible effects taken internally or in sunscreens. Among those antioxidants that have been shown to be protective against UVA and/or immunosuppression are vitamins C and E,[51,52] polypodium leucotomos,[53,54] zinc,[55,56] green tea,[57] and N-acetylcysteine.[58,59]

SUNSCREEN PROTECTION FACTORS

Protection factors to look for in anti-UVA and -VL broad-spectrum sunscreens, in order, are the following:

PFA

PFA is assessed by many in vivo and vitro methods, but there is still no universally accepted procedure from either the U.S. FDA or European regulatory bodies.[60] In vivo determinations use the two end points that are visible in the skin after exposure to UVA. These are the IPD[61] and the PPD.[62] Between the two, PPD is more commonly used, as it remains stable between 2 and 24 hours, and is easily read in white skin. In brown skin, the IPD is readily visible, and the dose to elicit both IPD and PPD is virtually the same.[20]

The critical wavelength and UVA:UVB ratio (boots star rating)

The critical wavelength (CW)[60] and UVA:UVB ratio (Boots Star Rating)[63] are derived from similar in vitro methods. A spectrophotometric method is used to determine a sunscreen's transmission/absorption of light at a range of 290 to 400 nm. The sunscreen's CW is calculated as the point at which 90% of the light is absorbed, whereas the Boots Star Rating calculates the data as a ratio of the UVA to the UVB. The German DGK Sun Protection Task Force, from the results of a six intra- and interlaboratories comparative study, concluded that the reproducibility of the *CW* and the UVA/UVB ratio was superior to any in vivo end point.[64] Hence, they favor the in vitro method, using specific changes to older methods.

The photosensitivity protection factor or protection factor for visible light

Photosensitivity protection factor (PPF) was developed to predict the VL protection factor of sunscreens containing ZnO and pigmentary grade TiO_2.[46] For patients sensitive in the visible light range,[47] two SPF-25 sunscreens in vitro achieved a PPF of 4.1 to 9.6. In vivo PPF determination using blue VL[46] at 430 +/− 30 nm was higher at a range of 3 to >10, (median 8). For consistency with the FDA-recommended name, PFA for UVA protection, *PFV* for visible light is proposed. The PFV for consumer acceptable cosmetics containing ultrafine dispersions of TiO_2 and ZnO ranged from 1 to 4.[50]

Immune protection factor

The immune protection factor (IPF) is assessed using reactions from solar-simulating radiation (SSR), a light source that contains both UVA and UVB. This is based on the ability of sunscreens to inhibit suppression of the induction arm of local contact hypersensitivity response, such as to nickel sulfate, or the elicitation phase of delayed hypersensitivity response to recall antigens. UVA is known to play a significant role in immunosuppression. IPF is rarely used in sunscreen labels, although studies now show that IPF has a better correlation with the UVA than the UVB's SPF.[65]

The *SPF* is the oldest and most popularly recognized factor for outdoor sun protection. It is defined as the ratio of the least amount of ultraviolet exposure required to induce minimal erythema in sunscreen protected skin versus that required for unprotected skin. Against sunburn mainly from UVB and its chronic effects, there is 94% protection with an SPF of 15 and 97% with an SPF of 30.[66]

Summary

Those with darker ethnic skin have commendable sun avoidance behavior, but additionally need protection from UVA and VL, which are present indoors. Based on the American Academy of Dermatology's UVA Consensus Conference,[60] the author recommends: Daily use of sunscreens with organic, inorganic, possibly antioxidant ingredients, and broad-spectrum anti-UVA, -VL, and -UVB claims, with these values:

- CW >370 nm
- UVA:UVB ratio of 0.6 to <0.8 (*** or superior) or ≥0.8 (**** maximum);
- PPF or PFV of at least 4, layered if less
- SPF of 30+ for outdoor use.

HOW MUCH TO APPLY?

Apply about 2 mg/cm^2 of sunscreen, the same amount used in testing for the SPF that is claimed on the sunscreen package. Overall, the median application thickness among mostly Fitzpatrick phototypes I through III[67] and for those who are photosensitive, has been shown to be an average of about 0.5 to 1.0 mg/cm^2. Most inorganic products appear white, so users of inorganic sunscreens apply less: Two-thirds that of the organic ones. Fortunately, more cosmetically acceptable organic sunscreens are now

Table 12-2

Some antioxidants and their action by topical/oral route[40]

Name/source	Topical	Oral
Carotenoids From plants Not a UV filter		Beta carotene:120–180 mg/d ↓ EPP photosensitivity, 4–5 year study ↓ SCC
Vitamin C In fruits, vegetables Not a UV filter	L-ascorbic acid, unstable, but absorbed >20-fold. Other forms more stable, but not converted to L-ascorbic acid	
Antioxidant combinations Work best	Animals: Topical individually effective, but C and E increased protection	L-ascorbic acid 3g/d + alpha tocopherol 2g/d ↑ MED to SSR Animals: Vitamins C and E, ↓ acute effects of SSR, ↓ nickel sensitivity
Polypodium leucotomos Plant extract	↑ UV for IPD, MED ↑ Minimal melanogenic dose ↑ Minimal phototoxic dose	Phototoxic, pigmentary protection, anti-inflammatory
Zinc trace mineral Divalent zinc ion	Protect against free radicals ↓ UVA- and UVB-induced sunburn cell formation	↓ UVA-1 induced apoptosis, protects against UVA-induced DNA damage
Green tea polyphenols Best studied topical/oral: Animals/humans	Protect against UVB-ROS inflammation, photoaging, contact hypersensitivity, ↓ photocarcinogenesis	↓ sunburn cells; ↓ UVR erythema, carcinogenesis, immunosuppression, anti-inflammatory
Isoflavones Soybean—Genistein Equol—Red Clover	After UV exposure protect against inflammation/immunosuppression in a dose-dependent manner	
Plant oligosaccharides Xyloglucans tamarind seeds Aloe barbadensis	Reduction of IL-10. Prevention of UVB-induced systemic immunosuppression	Aloe gel effects decays rapidly, but suppression of DTH is stable over time
N-acetylcysteine:NAC ↑ levels of endogenous antioxidant glutathione	In mice, applied before UVB exposure, can protect against immunosuppression	In cultured human fibroblasts Protects against UVA cytotoxicity
Hydroxycinnamic acids Caffeic Acid: plants Ferrulic Acid: Olives Potent antioxidant	Protects UVB induced erythema in vitro. In vivo (100) prevents photodamage of lotions/sunscreens	In food inhibits lipid peroxidation and oxidative spoilage

DTH, dietary butylated hydroxytoluene; EPP, erythropoietic protoporphyria patients; IPD, immediate pigment darkening; MED, minimal erythema dosing; ROS, reactive oxygen species; SCC, squamous cell carcinoma; SSR, solar-stimulating radiation; UV, ultraviolet; UVA, ultraviolet A; UVB, ultraviolet B; UVR, ultraviolet ray.

available, with more to come, and layering can be used to boost these protection factors.[50]

HOW OFTEN?

For outdoors and beach use, the general recommendations are that sunscreens be applied 15 to 30 minutes before sun exposure, then reapplied after 15 to 30 minutes to compensate for improper initial application, then every 2 to 3 hours, especially after swimming or sweating.[68] For multiday sun exposures, higher SPFs are needed, because the skin is more sensitive on the second day from the UVB-induced erythema peak at 24 hours.[68]

One study found daily use as more protective against UV-induced skin changes than intermittent use of the same product in white skin.[69] For darker skin, daily-use protects not just from outdoor sun, but also indoors from reflected solar UVA and VL, from artificial light sources, as well as from cosmetic surgical light and laser devices.

Lawsuits against sunscreen manufacturers have questioned the accuracy of sunscreen protection factor claims. At the American Academy of Dermatology's Melanoma/Skin Cancer Detection and Prevention Month 2006 news conference, Draelos clarified this perceived inconsistent performance. Sunscreens are rated under ideal conditions that actual usage often does not mimic. Therefore, follow these guidelines on how to use sunscreens properly: Use at least 1 ounce (about one shot glass full) to ensure a thick enough layer for the whole body, apply 30 minutes before going out, reapply every 2 hours, and don't wipe the sunscreen off.[70]

ADVERSE REACTIONS TO SUNSCREENS

Contact dermatitis

Irritant, allergic, photoallergic, and phototoxic contact dermatitis have been reported,[71] although considering the widespread use of sunscreens, they are relatively uncommon.[72] Among the organic sunscreen filters, BP-3—commonly used as a UVA filter—is the most common photoallergen. Avobenzone, oxybenzone, sulisobenzone, PABA, padimate O, methylbenzylidene camphor, octinoxate, and ensulizole have also been reported to induce reactions.

A Singapore study[73] gave similar results, plus allergic reactions to fragrance mix and/or Balsam of Peru. Worth watching out for are reactions to the organic anti-UVA filters: 4-tert-butyl-4′-methoxy-dibenzoylmethane (Parsol A), 2-(2-hydroxy-5-methylphenyl)-benzotriazole (Tinuvin P), and benzophenone derivatives, which in a Japanese study gave positive results.[74]

Once a reaction occurs, patch and photopatch testing of active ingredients, inactive ingredients, and even the test product itself are valuable, so sunscreens without the specific allergen can be chosen. A general rule to follow is that because fragrance is among the top allergens that cause contact dermatitis and is also a photoallergen, particularly for sensitive patients, the use of totally unscented sunscreens is ideal.

Hypovitaminosis D

A recent review of current nutrition data strongly indicates that vitamin D sufficiency is needed not just for calcemic but also noncalcemic health at all stages of life.[75] This review cites optimum serum levels of 25-hydroxy vitamin D: 25(OH)D to be approximately or higher than 30 to 50 ng/mL (75–125 nmol/L). These serum levels can be maintained by 500 to 1000 IU of vitamin D per day (0.06 ng/mL/IU/day). The best source for vitamin D is sun exposure and secondarily from food and supplements. For darker skin, the MED in the summer noonday sun in the southern United States is about 60 to 80 minutes.[75] From this it has been computed, and we can further extrapolate, that sun exposure to suberythemal doses (25%–50% MED) of about 20% to 40% of the body surface would produce about 1,000 IU of vitamin D.

However, compared with apparently normal Caucasian women of the same age on similar diets, in Boston, African American women 20 to 40 years old were found to have half as much 25(OH)D. In the summer/fall, this was a low 16.5±6.6, down to 12.1±7.9 ng/mL in winter/spring. It was therefore suggested that sunlight stimulates the skin to make vitamin D, but pigmented skin makes less.[75] The same observation was made of Norwegians living at 60°N, compared with Africans who, despite living at 10°N, had a high rate of vitamin D deficiency.[76] Veiled women have also been found to be vitamin D deficient.[77]

Thus, children and adults with darker skin, in the absence of adequate sun exposure because of strict sun-avoidance practice and daily sunscreen use greater than about 20% to 40% of the body, even if living in the tropics, may need 1,000 IU vitamin D daily supplementation to achieve the 30 to 50 ng/mL blood levels.

Estrogenicity

Bp-3, homosalate, methylbenzylidene camphor, OMC, and octyl dimethyl PABA are among the UVB and UVA filters reported to have estrogenic effects. These studies, all done in animals, are still controversial for many reasons, including the unrealistically high exposure test amounts used in comparison with potential human exposure.[78] So far, there appears to be no biologic relevance or application of the results of these studies to the aesthetics of human skin.

HOW DO DARKER SKIN TYPES DEVELOP THE HABIT OF DAILY SUNSCREEN USE?

Giving people with darker skin types the answers to questions about sunscreens specific to their problems will help them develop the habit of daily use. Doctors need to learn from past failures in trying to change behavior patterns that are ingrained cultural habits. Since the 1980s, dermatologists have established skin cancer prevention and detection programs to educate the public about the sun[79] by the *use* of sunscreens and by sun-avoidance practices. The reasons: to avoid skin cancers, photoimmunosuppresion, and photoaging.

In August 2005, Naylor and Robinson's editorial in the Archives of Dermatology recognized that these campaigns have failed on many fronts.[80] They conclude that a "significant percentage of the population will continue to ignore . . . worse, a substantial number will continue to intentionally seek UV exposure for the purpose of cosmetic tanning."[80]

The immediate gratification provided by the sex appeal of a visually well-tanned body decidedly is more important than the future effects that photoprotection can offer. This mind-set, applied to those with darker skin, suggests that emphasis should be made on the evident attractiveness now of the even-colored nonhyperpigmented skin, and further, that the daily use of sunscreens can keep it looking that way. Sex appeal, sophistication, and good looks are crucial, hence sunscreens/products should be cosmetically desirable, using terms such as ultrasheer, cool, and elegant, and be marketed with a "must-have" look for the daily handbag. Once the daily use of sunscreens is in place, optimal improvements following cosmetic surgery and the prevention of future hyperpigmentations becomes the bonus.

One last lesson learned from Hillhouse and Turrisi[81] concerns the delivery of the sunscreen message. They call it "inconsistent, . . . leading consumers to make purchasing decisions based primarily on price, convenience, and marketing." The message to those with darker ethnic skin should therefore be simple: *"To keep your skin looking great, use your broad-spectrum sunscreen daily."*

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PART

3

Therapies for Dyschromias

13

Laser Therapies for Disorders of Hyperpigmentation

Malcolm S. Ke and Teresa Soriano

Laser and light source therapy for disorders of hyperpigmentation in darker skin types are limited by their potential to cause postinflammatory dyspigmentation. Any aggressive therapy resulting in inflammation may induce this unwanted response, hence fulfilling the adage, "the treatment may be worse than the disease." Perioperative use of topical bleaching agents and sun-protective measures are valuable in optimizing outcomes. Inciting factors, if present, need to be identified and discontinued to prevent further dyspigmentation during and after surgical treatment.

The use of lasers and light sources for hyperpigmentation is generally based on wavelengths targeting melanin or pigment as the chromophore. Although no quantitative differences in melanocytes are seen in various ethnic groups, melanocytes of darker-skinned individuals produce greater quantities of melanin and demonstrate exaggerated responses to cutaneous injury. This translates clinically to an increased susceptibility to irritation and to a greater risk of further pigment alteration in darker-skinned individuals. It is wise to perform a test spot on a representative lesion before treating the entire area.

Nonablative light sources, such as the intense pulsed light system, have been used safely and effectively to treat patients with darker skin. Various Q-switched lasers that deliver pulses in the nanosecond range are commonly used to treat pigmentary disorders. They include the 532-nm Nd:YAG, 694-nm ruby, 755-nm alexandrite, and 1,064 nm Nd:YAG. Given increased melanin absorption at shorter wavelengths, the use of longer wavelength lasers is generally preferred in treating darker-skinned patients. Ablative lasers such as the 2,940-nm Erbium:YAG and 10,600-nm CO_2 lasers carry a significant risk of postinflammatory dyspigmentation; therefore, they are reserved for selective resistant cases and should be used with caution. A new modality called fractional photothermolysis may prove to be the happy medium between ablative and nonablative techniques.

CLINICAL APPLICATIONS

Melasma

Melasma is an acquired form of hyperpigmentation that is more prevalent in darker-skinned women. It typically manifests as brown to gray patches on the face that worsen with sun exposure. Melasma may occur during pregnancy or oral contraceptive use but commonly arises de novo. Histologically, melanin can be found in the epidermis, dermis, or both.

The treatment of melasma is challenging and is best approached with a combination of treatment and preventative measures. Although the condition may resolve after termination of pregnancy, ceasing oral contraceptive use, or sun avoidance, it commonly persists indefinitely. The use of topical bleaching agents alone in conjunction with sun-protective measures may provide an adequate cosmetic outcome. Both phenolic and nonphenolic depigmenting agents have been shown to improve melasma in darker skin types.[1] In evaluating combination treatments, Pathak et al. reported optimal results with the application of 2% hydroquinone, 0.05% to 0.1% retinoic acid, and a broad-spectrum sunscreen for the treatment of melasma in Latinas.[2] Various chemical peels have also been used alone or in conjunction with topical bleaching agents in an effort to expedite results, prevent relapse, or treat recalcitrant cases.[3-8]

The use of lasers for the treatment of melasma has yielded suboptimal results. Earlier studies with the 510-nm pigmented lesion dye laser revealed minimal improvement and even darkening of treatment areas.[9,10] Results with the Q-switched ruby laser were inconsistent.[11,12] Ablative lasers such as the Erbium:YAG and CO_2 lasers carry a high risk of dyspigmentation, especially in darker skin types. In a study using the Erbium:YAG laser to treat 10 patients with melasma recalcitrant to bleaching creams and chemical peels, all patients developed postinflammatory hyperpigmentation 3 to 6 weeks postoperatively.[13] Combination laser

treatment with a Q-switched alexandrite and CO_2 laser in a split face study in six Thai women revealed greater improvement in MASI scores on the combination treated side as opposed to the side treated by the alexandrite laser alone.[14] However, two patients developed severe hyperpigmentation, and two patients had transient hypopigmentation.

A relatively new nonablative technology, fractional photothermolysis (FP), has shown promise for the treatment of melasma (Fig. 13-1). FP produces a pixilated pattern of multiple columns of thermal damage, referred to as microthermal treatment zones (MTZs), on the skin.[15,16] FP can control the pattern density and depth of thermal damage. In this way, different three-dimensional MTZ shapes can be created. This thermal damage extends into the reticular dermis while producing photocoagulation of the epidermis. Importantly, FP does not affect the tissue surrounding MTZs. Thus, the remaining viable cells support a rapid healing time, with re-epithelialization achieved in 1 day. With the extrusion and replacement of damaged tissue, a "fractionalized resurfacing" occurs. The procedure is repeated four to five times at 2- to 4-week intervals. Postprocedure side effects are typically mild and include erythema and edema. Because there is no dermal or epidermal ablation, there is none of the significant recovery time associated with ablative laser therapy.[15]

Preliminary studies have shown improvement of melasma after a series of fractional resurfacing treatments.[17,18] In a study of 10 patients with skin types III through V treated for recalcitrant melasma, 60% had >75% clearing after four to six fractional resurfacing treatments at 1- to 2-week intervals.[17] The precise mechanism leading to clinical improvement of melasma is unclear. Increased absorption of the concurrent bleaching agents through the microthermal treatment zones and/or increased elimination of epidermal and dermal pigment are proposed theories. Further investigations are necessary to assess the efficacy and safety of this technology in Fitzpatrick skin types V and VI.

Postinflammatory hyperpigmentation

Postinflammatory hyperpigmentation (PIH) is one of the most common causes of altered skin pigment and presents as dark patches occurring at sites of previous cutaneous inflammation. Although it can manifest in various skin types, it is more frequently seen with greater intensity and persistence in darker skin types, affecting men and women equally.[19,20] Essentially any disease with cutaneous inflammation can potentially result in PIH in individuals capable of producing melanin. Common culprits include acne, atopic dermatitis, lichen planus, mechanical trauma, ionizing and nonionizing radiation, heat, contact dermatitis, and photo-induced dermatoses.[20–21] In addition, cutaneous laser therapy is a common cause of PIH.[22]

The management of PIH involves prevention of further pigment deposition and diminishing hyperpigmentation. First and foremost, treatment or removal of the etiologic insult is essential to avert development of new lesions. Protecting the areas from sun exposure is also critical to prevent darkening of existing lesions. In some circumstances, the above measures, along with a tincture of time, result in the resolution of PIH. However, in cases of incomplete or slow resolution, other treatment modalities can be incorporated.

In general, laser therapy for PIH in darker skin types has been disappointing as it carries the risk for further pigment darkening. However, in some instances and for certain conditions, laser treatment has been reported to be useful. Tafazzoli et al. conducted a study evaluating the 694-nm Q-switched ruby laser to treat postsclerotherapy hyperpigmentation in eight patients, noting a 75% to 100% resolution in 58% of the treated areas and 25% improvement in 33% of the treated areas.[23]

Monotherapy with topical retinoids has been shown to facilitate resolution of PIH. A randomized, double-blind, vehicle-controlled study evaluating tretinoin 0.1% cream versus vehicle alone for 40 weeks to treat facial PIH in black patients demonstrated significant lightening.[24]

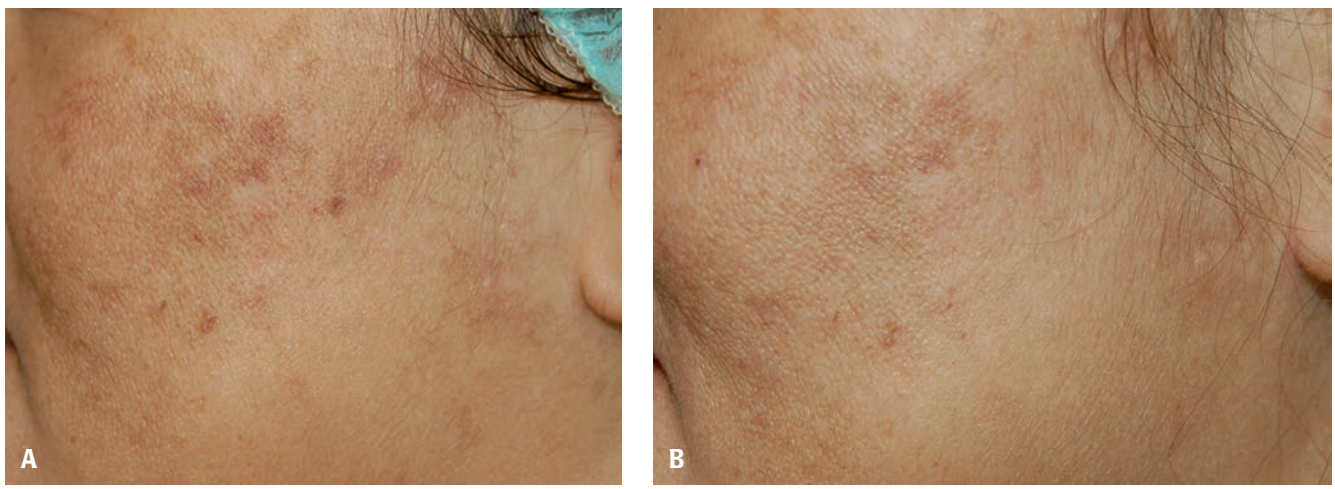

Figure 13-1 Melasma on cheek of woman with skin type IV treated with fractional photothermolysis. **A:** Before treatment with Fraxel. **B:** After with Fraxel.

Overall improvement was initially noted after 4 weeks of therapy. Of the tretinoin-treated patients, 12 of 24 (50%) experienced erythema and desquamation; however, none had any further hyperpigmentation or dyspigmentation. In another double-blind, randomized, vehicle-controlled study, Grimes and Callender reported the efficacy of once-daily tazarotene 0.1% cream in the treatment of PIH from acne in patients with Fitzpatrick skin types IV through VI.[25] Significant advantage over vehicle was noted at 10 weeks of therapy. Patients noted minimal erythema, burning, and peeling. Additionally, an open-label study of darker-skinned patients with acne showed the utility of adapalene 0.1% gel to reduce PIH.[26]

The concomitant use of various bleaching agents has been shown to improve PIH. Kligman and Willis proposed the combination of tretinoin, hydroquinone, and dexamethasone for the effective treatment of PIH.[27] In a small study, the application of 2% hydroquinone and 10% glycolic acid gel twice daily and 0.05% tretinoin cream at night was shown to improve PIH in patients with darker skin types.[28] Similarly, Yoshimura et al. described the efficacy of tretinoin combined with hydroquinone and lactic acid in reducing PIH.[29]

For PIH refractory to topical bleaching agents alone, chemical peels can be a safe and effective option in darker skin types.[30] Pretreatment with bleaching agents, such as hydroquinone, should be used to minimize the risk of peel-induced hyperpigmentation. Chemical peels should be started at a lower concentration and titrated up as tolerated and necessary. Superficial chemical peels such as salicylic and glycolic acids, which target the stratum corneum to the papillary dermis, can safely be used to facilitate the resolution of PIH. In a study of five patients with skin types V and VI, pretreatment for 2 weeks with hydroquinone 4% cream followed by a series of five 20% to 30% salicylic acid chemical peels (B-lift) at 2-week intervals resulted in 51% to 75% improvement of PIH in one patient and 75% improvement of PIH in four patients.[6] No adverse effects were noted. Burns et al. demonstrated greater and more rapid improvement with the addition of glycolic acid peels to a topical regimen of hydroquinone, glycolic acid gel, and tretinoin.[28] In this study, patients with skin types IV through VI received six serial glycolic acid peels along with the topical regimen, noting an additional benefit with minimal adverse effects compared with the patients who were treated with the topical regimen alone.

Medication-induced hyperpigmentation

Some medications—such as amiodarone, minocycline, tricyclic antidepressants, phenothiazine, antimalarials, clofazamine, gold, silver, bismuth, and arsenic—may induce dyspigmentation over sun-exposed areas, varying from blue-gray to red-brown. Chemotherapy-induced hyperpigmentation may appear as a localized eruption, such as the flagellate pigmentation of bleomycin or the flexural hyperpigmentation of topical carmustine, or as generalized hyperpigmentation as with busulfan, cyclophosphamide, or methotrexate.

Removal of the offending agent can lead to the resolution of the pigmentation over time; however, some medication-induced pigmentation may persist for years despite cessation of therapy.

Q-switched lasers can be useful in the treatment of certain medication-related hyperpigmentation. The Q-switched ruby and alexandrite lasers have been reported to be effective in the resolution of the imipramine-induced blue-gray pigmentation without discontinuing the medication.[31] Another report described the successful treatment of amiodarone-induced hyperpigmentation with the Q-switched ruby laser.[32]

Minocycline-induced hyperpigmentation[33–35] can be treated safely and effectively with Q-switched lasers. Alster and Gupta reported complete pigment resolution in six patients with minocycline-induced hyperpigmentation after an average of four bimonthly sessions using the Q-switched alexandrite laser.[36] Clearance of minocycline-induced hyperpigmentation has also been reported with the Q-switched ruby and Nd:YAG lasers. In darker-skinned individuals, the use of the longer wavelength 1,064-nm Q-switched Nd:YAG laser would be preferable over the shorter wavelength lasers to minimize the risk of posttreatment dyspigmentation.

Lentigines

Often referred to as "liver spots" or "age spots," lentigines are hyperpigmented macules that manifest on sun-exposed areas. Multiple lesions are often seen, and some lesions can enlarge to patches. Histologically, increased melanin is seen in the basal layer of the epidermis, whereas underlying solar elastosis can typically be seen in the papillary dermis. Because lentigines occur on visible parts of the body and can be viewed as a sign of photoaging, patients often seek cosmetic treatment for these lesions.

Therapy consists of topical bleaching agents and different cosmetic procedures, including cryotherapy, chemical peels, lasers, and light sources. Cryotherapy is a commonly used modality to treat lentigines. Liquid nitrogen is the most popular cryogen in the United States, but nitrous oxide and carbon dioxide have also been used. One freeze-thaw cycle is usually adequate to treat lentigines and minimize complications. Possible adverse effects include temporary pain, edema, and bullae formation at the treated site. Longer-lasting and potential permanent complications include hyperpigmentation, hypopigmentation, and scarring. Chemical peels, including glycolic acid, TCA, Jessner's solution, and salicylic acid have been used to improve lentigines. Additionally, to achieve and maintain resolution of lentigines, the use of broad-spectrum sunscreens and sun protective habits are critical. Various topical therapies, such as hydroquinone, tretinoin, adapalene, and combination mequinol and tretinoin have been used successfully and safely to lighten lentigines.[37–39] However, they can take time to attain optimal results.

Advancements in laser technology targeting the broad absorption spectrum of melanin have rendered newer systems more effective and safe for the treatment of lentigines. Pretreatment and concomitant use of a bleaching agent and sunscreens can minimize PIH and optimize results.[40–42] A test spot 3 to 4 weeks before full treatment of the area is advisable. In addition, careful clinical assessment of the nature of the pigmented lesion before treatment is paramount. Clinically atypical lesions require further evaluation to rule out possible malignancy. Treatment failure and recurrence should prompt a re-examination of the original diagnosis, as illustrated in the case of repigmentation after Q-switched ruby laser treatment of a lentigo later biopsied as lentigo maligna melanoma.[43]

There have been a plethora of lasers used to improve lentigines, including the pulsed dye (510 nm), copper vapor (511 nm), krypton (520–530 nm), frequency-doubled Nd:YAG (532 nm), diode (532–630 nm), Q-switched ruby (684 nm), Q-switched alexandrite (755 nm), Q-switched Nd:YAG (1,064 and 532 nm), and CO_2 (10,600 nm) lasers. Although lasers are typically effective in lightening lentigines with minimal risk in light skin types, the risk of dyspigmentation is greater for darker skin types. This is particularly true with continuous-wave lasers. Q-switched lasers, such as the Q-switched Nd:YAG and ruby lasers, have been used to treat lentigines (Fig. 13-2).[44,45] These devices emit very short pulses of energy that induce both photothermal and photomechanical reactions after preferential absorption by melanin.

Other lasers and light sources, in addition to the Q-switched lasers, have been employed to treat lentigines in ethnic skin. Kono at al. reported the 595-nm long-pulsed dye laser to improve lentigines in a study of 18 Asian patients of skin types III to IV.[46] Using glass compression and no cryogen cooling, the long-pulsed dye laser cleared 83% of lesions compared with 70% with the Q-switched ruby laser. No hyperpigmentation was noted in the areas treated with the long-pulsed dye laser as opposed to four patients with the Q-switched ruby laser. A long- pulsed 532-nm Nd:YAG laser has been successfully used in Asian patients with facial lentigines. Chan et al. compared the long-pulsed dye laser to a conventional Q-switched 532-nm laser showing no significant difference in degree of clearing.[47] Hyperpigmentation was the most common complication and cleared with topical bleaching agents and glycolic acid creams.

Intense pulsed light (IPL), which emits broadband visible light from a noncoherent light source, has been used to treat lentigines. Multiple treatments at 2- to 4-week intervals are often required to achieve maximal results. This treatment modality offers the advantage of minimal to no downtime for the patient. There are several studies showing its efficacy and safety in Asian patients.[42,48] A study reported a greater than 50% improvement in 40% of patients with lentigines after an average of four IPL treatments at 2- to 3-week intervals. No hyperpigmentation or scarring occurred.[48] IPL should be used with extreme caution in patients with skin types V and VI, given the high frequency of dyschromias in such patients.

A study comparing TCA 35% peel and QS Nd:YAG (532-nm, 10-ns, 2-mm spot) laser therapy in 20 patients with skin types III to IV with facial lentigines demonstrated greater improvement with laser therapy. Sixty-five percent of patients showed better improvement on the laser-treated areas, 14% had superior improvement on the TCA-treated areas, and 21% showed similar improvements with both treatments. No scarring or dyspigmentation was seen.[52]

Café au lait macules

Café au lait macules (CALMs) are coffee-colored birthmarks that occur anywhere on the body and frequently darken with age. Although multiple lesions can be markers for underlying diseases such as neurofibromatosis, isolated CALMs are commonly encountered. Ten to twenty percent of the population have them, with an increased prevalence in darker skin types.[44] On histopathology, the melanin is found in giant melanosomes mainly within the basal layer of the epidermis.

The main treatment modality is laser therapy. In general, multiple laser treatments are necessary to achieve clearance of lesions. The Q-switched laser systems have generally

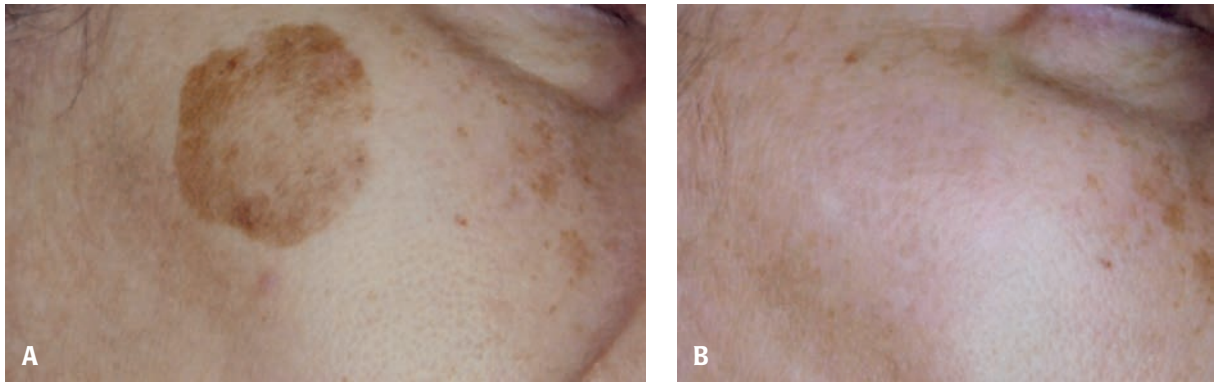

Figure 13-2 Frequency doubled Q-switched Nd:YAG (532 nm) treatment of facial lentigines. **A:** Before treatment with Q-switched Nd:YAG laser. **B:** After treatment with Q-switched Nd:YAG laser.

been considered safe; however the effect of treatment can be inconsistent, as some CALMs may even darken after treatment. Thus, a test spot should be performed using conservative parameters that produce a visible response. The treatment area is re-evaluated 4 to 8 weeks later for clinical response and adverse effects. Hyperpigmentation can occur but usually improves over several months with topical bleaching regimens. Hypopigmentation is a potential risk, particularly with the shorter wavelength lasers. The risk of dyspigmentation is especially higher in darker-skinned individuals and should be taken in consideration when treating CALMs in patients with skin types IV through VI in whom the initial lesion may already be less apparent.

The Q-switched ruby, alexandrite, and Nd:YAG lasers have been shown to treat CALMs with varying degrees of efficacy. Grossman et al. found variable response in treating CALMs with a 694-nm QS ruby laser and a 532-nm frequency doubled Q-switched Nd:YAG laser.[50] Nine lesions were treated, half with each laser. At 6 months, five of the lesions showed lightening, and one resolved. One lesion resolved after the first month, but recurred at the 3-month follow-up, whereas two lesions darkened 1 month after the first treatment. Clinical experience with multiple Q-switched laser treatments has yielded inconsistent results, with 50% of the cases achieving total clearance and repigmentation occurring in the other half.[45] Other reports suggest a single laser treatment may lighten up to 50% of café au lait spots and almost clear 20% to 50% of lesions. However, one third of these showed repigmentation.[51–53]

Longer-pulsed lasers have been used in treating CALMs, but have also yielded inconsistent long-term results. The 510-nm pulsed dye laser has been used to treat café au lait macules. A report described its use to successfully treat a facial café au lait macule in a patient with Fitzpatrick skin type V using the following parameters: 2.5 J/cm^2, 300 nsec, with single, nonoverlapping laser pulses every 2 months for six treatments.[54] In another study using the QS alexandrite laser to treat CALMs, 9 out of 10 patients had 60% to 100% response after a mean of 6.7 treatments. Three patients had partial or complete recurrence. One patient had PIH, and another had hypertrophic scarring. A preliminary study described a lower risk of recurrence with the normal-mode ruby laser (42% recurrence) in 33 patients with café au lait patches compared with the Q-switched ruby laser (82% recurrence).[41] The data were limited to a 3-month follow-up after a single treatment. The authors proposed that the longer pulse width may reduce the recurrence rate by affecting the follicular melanocytes.

Nevus of Ota

Nevus of Ota is a benign pigmentary disorder that usually manifests as blue-brown or gray patches over facial skin innervated by the first and second trigeminal nerve. Associated lesions include scleral melanocytosis as well as involvement of the nasopharynx, auricular mucosa, tympanic membrane, palate, and dura. It is seen most commonly in Asians and is typically congenital or acquired by adolescence. The use of the Q-switched lasers is the current treatment of choice for the cutaneous component (Fig. 13-3).

Several studies have reported successful clearing after multiple treatments using various Q-switched laser systems. A study of 114 patients with Ota's nevi treated with the QS ruby resulted in good to excellent clearing after three or more treatment sessions.[55] Transient hyperpigmentation after the first treatment was the most common complication. A Japanese study also reported the safe and successful use of the Q-switched ruby laser in treating nevi of Ota in 106 adults and 46 children using the following parameters: 30-ns pulse duration, 4-mm spot size, and 5- to 7-J/cm^2 fluence at 3- to 4-month intervals.[56] They found the average number of sessions to achieve significant clearing was less in the younger age group (3.5 sessions) than the older age group (5.9 sessions).

In a study of 55 Korean patients with Ota's nevi treated with the Q-switched alexandrite laser for three sessions every 3 months, 49% of patients had excellent pigment

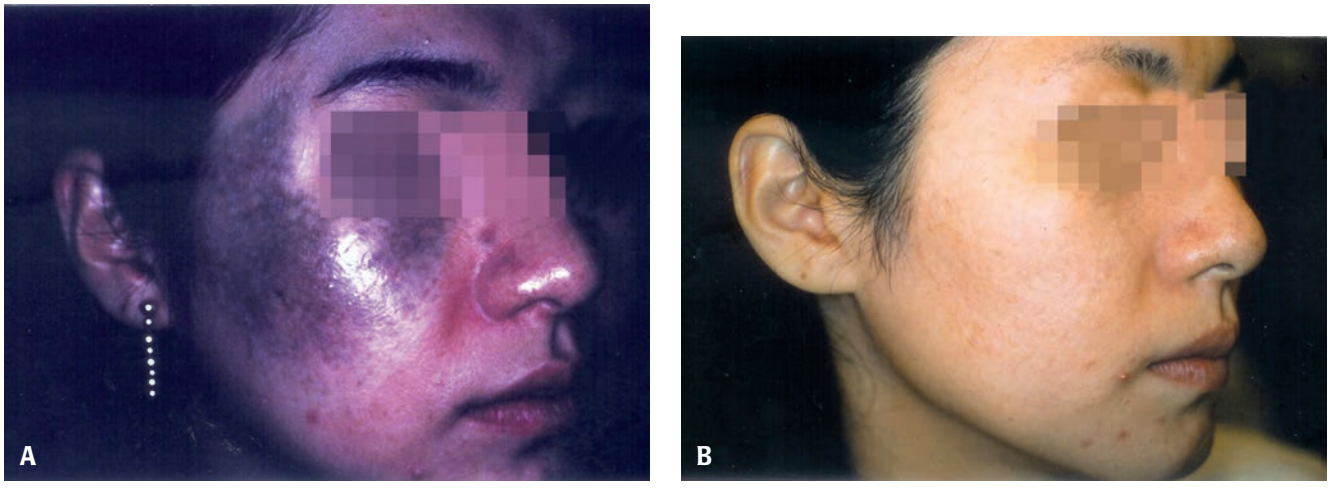

Figure 13-3 Nevus of Ota treatment with Q-switched laser. **A:** Initial treatment with Q-switched laser. **B:** After treatment with Q-switched laser.

clearing, and 31% had good pigment clearing. PIH developed in 55% of patients, which resolved within 4 months.[57] Chan et al. compared the use of the Q-switched alexandrite and the Q-switched Nd:YAG for nevi of Ota in 40 Asian women, noting the Nd:YAG to be more effective as evaluated by two independent clinicians. However, scores by only one clinician was found to be statistically significant.[58]

Although excellent clearing of nevus of Ota can be achieved with multiple laser treatment lesions, patients should be counseled on the potential for incomplete clearing, erythema, postinflammatory hyper- and hypopigmentation, recurrence of condition, and scarring. In a retrospective study of 211 Q-switched alexandrite and Nd:YAG laser-treated sites, Chan et al. noted the following complications: 15.3% had hypopigmentation, 2.9% had hyperpigmentation, 2.9% had textural changes, and 1.9% had scarring.[59] Recurrence after laser clearance of nevi of Ota is approximately 0.6% to 1.2%.[60]

Hori's nevus or acquired bilateral nevus of Ota-like macules

Hori's nevus is an acquired bilateral nevus of Ota-like lesions that usually presents symmetrically on the face. It is seen most commonly in middle-aged women of Asian descent. Unlike nevus of Ota, it does not have mucosal involvement. Histologically, irregular-shaped melanocytes are seen in the middle and upper dermis similar to that seen in nevus of Ota. Electron microscopy demonstrates dermal melanocytes that contain many singly dispersed melanosomes in stages II, III, and IV of melanization.[61]

As in treatment of Ota's nevi, Q-switched lasers have been successfully used to treat Hori's nevi. Multiple treatments are typically required. A study evaluated the Q-switched alexandrite laser for the treatment of Hori's nevi in 32 Chinese women, noting more than 50% clearing in more than 80% of patients after a mean of seven treatment sessions every 4 weeks. Temporary erythema was seen in 41% of patients and transient hypopigmentation in up to 50% of patients. Hyperpigmentation occurred in 12.5% of patients. This was treated with topical bleaching agents.[62] In a study of 66 Asian patients treated up to seven times with the Q-switched Nd:YAG laser, Polnikorn et al. found 50% of patients had good to excellent clearing.[63] Another study using the Q-switched Nd:YAG laser (fluence of 8–10 J/cm[2], spot size 2 or 4 mm) demonstrated 100% clearance of Ota's nevi after two to five sessions in 68 out of 70 patients. Fifty percent of patients had temporary hyperpigmentation. The results persisted at 3 to 4 years follow-up.[64]

Table 13-1

Laser therapies for disorders of hyperpigmentation

Diagnosis	Lasers/light source used	Outcomes
Melasma	CO_2 laser	Poor
	Erbium laser	Poor
	QS lasers	Poor
	Fractional photothermolysis	Variable
Postinflammatory hyperpigmentation	QS lasers	Poor
Medication-induced hyperpigmentation	QS Alexandrite	Variable
	QS Nd:YAG	Variable
Lentigines	QS Alexandrite	Variable
	QS Nd:YAG	Variable
	Long pulsed dye laser	Variable
	Long pulsed Nd: YAG laser	Variable
	Intense pulsed light	Variable
Café au lait macules	QS Alexandrite	Variable
	QS Nd:YAG	Variable
	Long pulsed dye laser	Variable
Nevus of Ota	QS Alexandrite	Positive
	QS Nd:YAG	Positive
Acquired bilateral nevus of Ota-like macules	QS Alexandrite	Positive
	QS Nd:YAG	Positive

Combination treatment with lasers has also been used to treat Hori's nevi. A scanned carbon dioxide laser followed by a Q-switched ruby laser was found to be effective in 13 Thai patients with skin types III to IV. However, all patients had posttreatment erythema at 1 month follow-up, which persisted in two patients at 3-month follow-up.[65] Recently, in a split-face study of 10 Asian women with Hori's nevi, combination treatment using the Q-switched 532-nm Nd:YAG laser followed by the Q-switched 1,064-nm laser showed a greater degree of lightening compared with the 1,064-nm alone at 6 months follow-up. However, this combination had a higher incidence of mild postinflammatory adverse effects, which lasted for 2 months.[66] Laser therapies for disorders of hyperpigmentation are summarized in Table 13-1.

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14

Cosmetic Leukodermas: Therapeutic Approaches

Pearl E. Grimes

Persistent leukoderms or hypopigmentation caused by a variety of aesthetic procedures are indeed dreaded complications. Hypopigmentation can occur after ablative or nonablative resurfacing procedures, chemical peels, dermabrasion, and laser hair removal. In addition, hypopigmented and/or depigmented splayed facelift scars are particularly distressing for many patients. Of these conditions, pigmentary alterations are most often associated with laser resurfacing procedures. Such complications have been reported in all skin types. However, it is most distressing in darker racial ethnic groups. Hyperpigmentation and hypopigmentation are relatively common side effects of ablative laser resurfacing.[1–5] The frequency of hyperpigmentation varies from 2% to 37%. It is primarily observed in darker skin types and in some instances is amendable to topical bleaching agents. In contrast, hypopigmentation is more often a late sequela, usually occurring after 6 or 7 months. Published studies report frequencies ranging from 1% to 20%.[1–5] Many physicians have considered cosmetic leukoderma a permanent sequela of resurfacing procedures; however, in my experience, these conditions are amenable to therapeutic intervention.

PATHOGENESIS OF HYPOPIGMENTATION

The precise mechanism of pigment loss is unknown. It has been reported that after every resurfacing procedure, there is some loss of melanocytes.[6] Hypopigmentation is a common occurrence after phenol peeling, which causes a deep dermal wound. In addition to the induction of dermal fibrosis, phenol and thymol are toxic to melanocytes[7,8]. Liew et al.[9] described the histologic changes of hypopigmentation in nine patients treated for hair removal using the ruby laser. S-100 positive melanocytes remained constant, whereas DOPA oxidase activity appeared to decrease. These findings suggested that the ruby laser caused hypopigmentation by blocking melanin synthesis rather than destroying melanocytes. Laws et al.[10] assessed the histologic features of hypopigmentation after CO_2 resurfacing in a 62-year-old woman. There was no decrease in the number of melanocytes compared with a pretreatment biopsy. However, there was a decrease in the content of epidermal melanin as assessed with Fontana-Masson staining.

Grimes et al.[11] assessed the histopathological features of hypopigmentation caused by laser resurfacing. Biopsies were taken from the affected areas of pigment loss and normal skin for comparison in four patients. All biopsy specimens demonstrated varying quantities of epidermal melanin as well as residual epidermal melanocytes. Mild perivascular inflammation was evident in two specimens (Fig. 14-1). There was superficial dermal fibrosis in all specimens. These findings suggested that laser resurfacing pigment loss was due to a suppression of melanogenesis rather than loss of melanocytes. In addition, dermal fibrosis is also a contributing factor.

THERAPEUTIC APPROACHES

Albeit challenging, there are several therapeutic regimens that have proven beneficial for patients with hypopigmentation caused by aesthetic procedures.

Topical photochemotherapy

The use of psoralens as repigmenting agents for vitiligo was described as early as 1400 B.C.E.[12] In the Indian sacred book *Atharva Veda,* there is discussion of a plant that produced even skin color. Psoralens are furocoumarin compounds: Photodynamically active drugs that are capable of absorbing radiant energy. They are also found in limes, lemons, celery, figs, and parsnips.[12]

Psoralens were introduced into the field of modern dermatology by El Mofty in 1947. El Mofty observed repigmentation of vitiliginous lesions after the use of powdered seeds prescribed by native herbalists in Egypt. Early clinical studies in Egypt further documented the effectiveness of the *Ammi majus* plant extract 8-methoxypsoralen (8-MOP) taken orally or applied topically in combination with

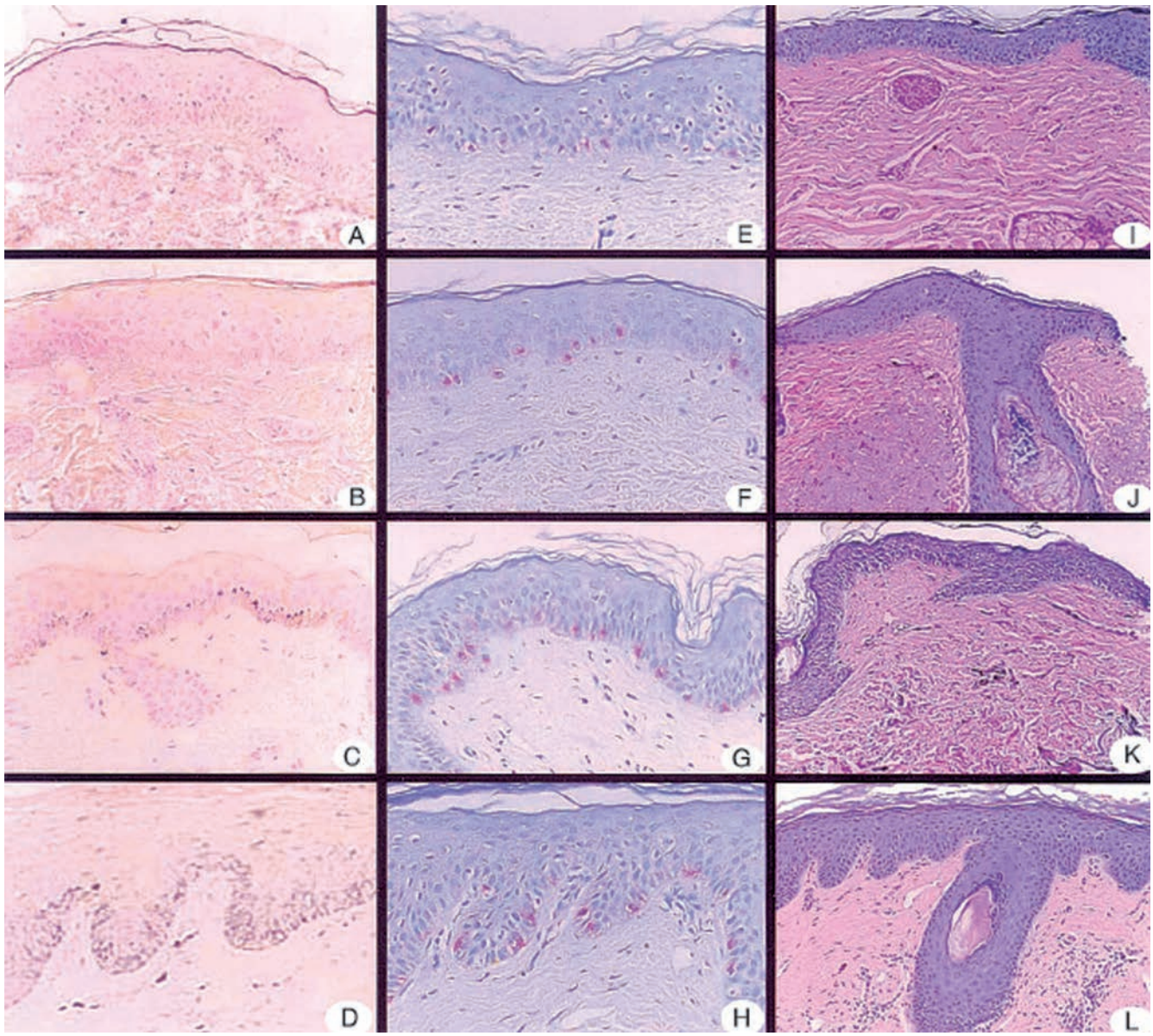

Figure 14-1 Histopathological features of laser-induced hypopigmentation. Composite photomicrographs showing representative areas of four patients **(A–D)**. Sparse **(A,B)** to moderate **(C,D)** epidermal melanin. Note melanophages in upper dermis **(C,D)** (Fontana-Masson; magnification 40X). Basal melanocytes on immunostaining with Mel-5. Note slightly reduced numbers in **(E)** but normal appearing in **(F,G)** (**H**, magnification 40X). Upper dermal fibrosis is seen in all patients **(I–L)**. Note mild to moderate perivascular lymphoid cell infiltrate and melanophages in **(K)** and **(L)** (hematoxylin and eosin; magnification 20X). From Grimes PE, Bhawan J, Kim J, et al. Laser resurfacing–induced hypopigmentation: histologic alterations and repigmentation with topical photochemotherapy. *Dermatol Surg* 2001;27:515–520.

sunlight or ultraviolet (UV) lamps. The acronym *PUVA* (psoralens + UVA) was introduced in 1974 to describe the use of oral psoralen (8-MOP) with the newly invented high-intensity long-wave (320–400 nm) ultraviolet phototherapy units. More than 30 skin conditions, including vitiligo, have been successfully treated with PUVA therapy.[12]

Although initially used for treatment for vitiligo, topical photochemotherapy has proven efficacious for treatment of cosmetic leukodermas. Grimes et al.[11] reported the efficacy of topical photochemotherapy treatments for treatment of laser resurfacing induced hypopigmentation. Seven patients were treated twice a week using 0.001% and 0.01% methoxsalen followed by exposure to artifical UVA light sources. The treatment induced moderate to excellent repigmentation in 71% of the treated patients. Side effects were minimal.

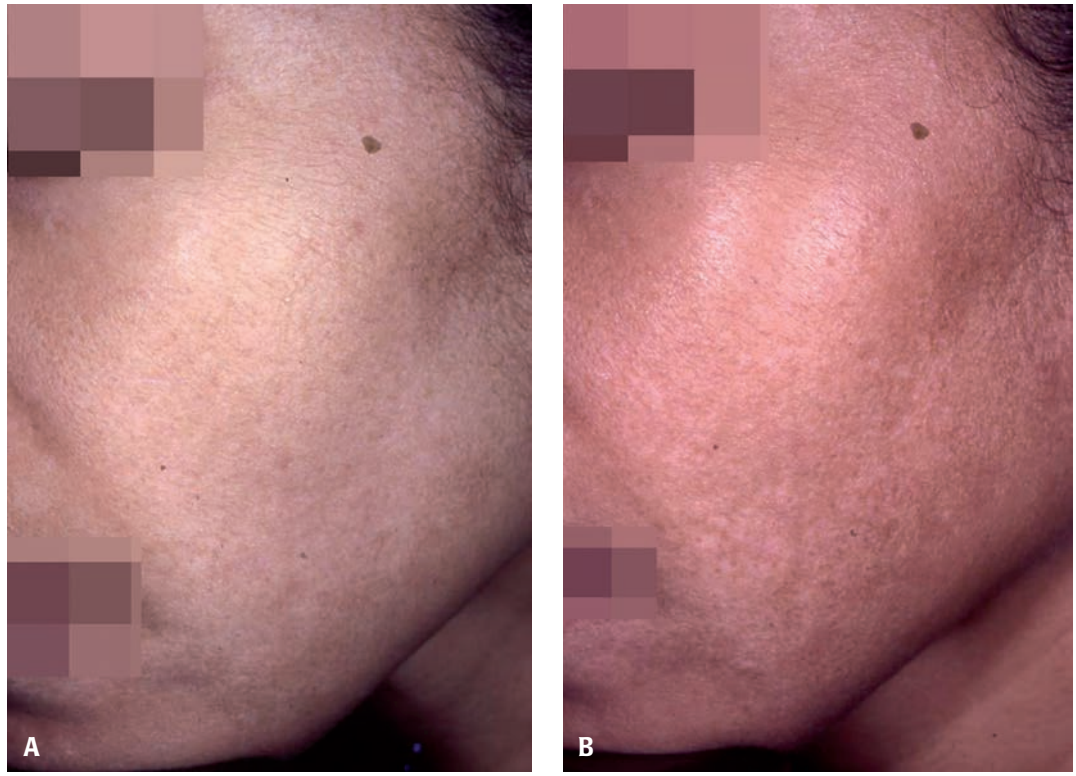

Figure 14-2 Hypopigmentation from a medium depth TCA peel. **A:** Baseline. **B:** After twice-weekly topical photochemotherapy treatments (methoxsalen 0.01%).

The author's standard protocol uses methoxsalen lotion 1% (Oxsoralen, Valiant Pharmaceuticals, Costa Mesa, CA). Methoxsalen stimulates melanocyte proliferation and melanogenesis. The lotion is diluted to a concentration of 0.001% and 0.01% in Aquaphor. A thin coat of 0.001% concentration is applied to hypopigmented areas 30 minutes before UVA exposure. Patients are treated with an initial UVA fluence of 0.20 J/cm^2. The fluence is then increased by 0.20 to 0.50 J per treatment, according to skin type and sensitivity. Lower initial doses and increments are indicated for skin types I and II. After mild to moderate asymptomatic erythema achieved, UVA fluence is maintained at a level sufficient to retain erythema. Treated areas are then cleansed with Cetaphil and water. A broad-spectrum sunscreen is applied after treatment. Patients are treated twice weekly. After 8 to 10 treatments, the concentration of methoxsalen can be increased to 0.01% if therapeutically indicated. High-intensity UVA light sources, such as the Daavlin Spectra 311/350, are used. However, smaller high-intensity UVA units can be used for small areas. Unaffected areas are protected with sunscreen or clothing (Fig. 14-2A,B and Fig. 14-3A,B).

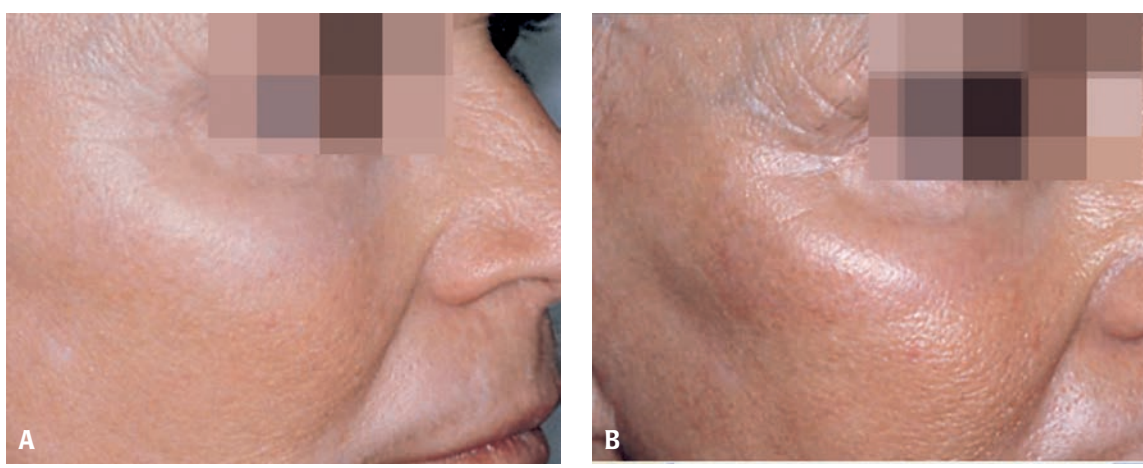

Figure 14-3 Hypopigmentation from CO_2 laser resurfacing in skin type II. Before **(A)** and after **(B)** 28 topical photochemotherapy treatments.

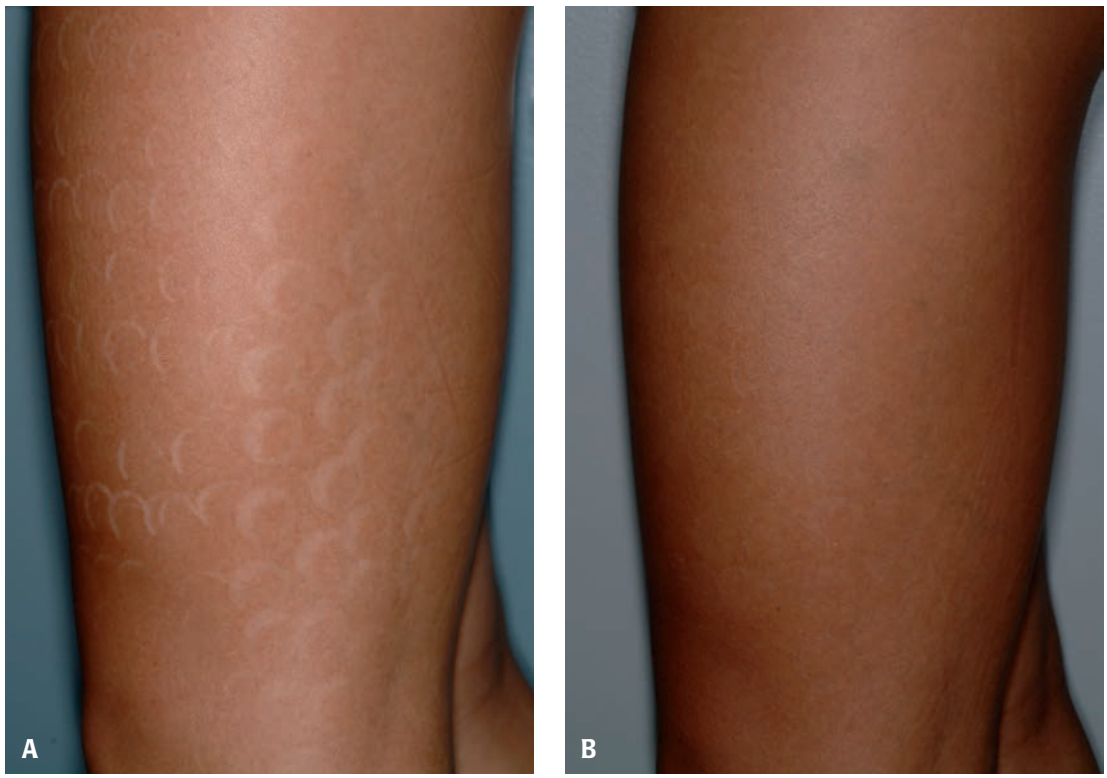

Figure 14-4 Severe hypopigmentation from laser hair removal. Before **(A)** and after **(B)** 17 narrowband UVB treatments.

For some patients who find it difficult to travel to an office for twice-weekly treatments, topical photochemotherapy with daily sunlight exposure is a viable alternative regimen. A thin coat of 0.001% methoxsalen is applied to hypopigmented areas. After an interval of 20 to 30 minutes, the affected areas are exposed to sunlight for 10 to 20 minutes. For lighter skin types (I–II), initial exposure to sunlight is for 5 to 10 minutes. After 2 weeks, exposure time can be increased to 30 minutes if mild erythema has not occurred. Following sun exposure, the treated sites are washed with soap and water. A broad-spectrum sunscreen is applied after treatment.

The author has treated many patients with this regimen. It is efficacious with minimal complications.

Narrowband UVB

Narrowband UVB (NB-UVB) involves the use of TL01 UV lamps with a peak emission around 311 nm.[13] The shorter wavelengths provide high-energy fluences and induce less cutaneous erythema. NB-UVB induces local immunosuppression and stimulation of melanocyte-stimulating hormone, and increases melanocyte proliferation and melanogenesis. NB-UVB has shown substantial efficacy for treatment of vitiligo. Westerhof and Nievweboer-Krobotova[14] were the first investigators to assess the efficacy of NB-UVB for pigment loss. They compared the efficacy of NB-UVB with topical PUVA in a series of 67 patients with vitiligo. Significantly enhanced repigmentation was achieved in patients with NB-UVB as compared with those treated with topical PUVA. Studies have further confirmed the efficacy of NB-UVB phototherapy for cosmetic leukoderma, such as striae distensae.[15]

Patients with leukodermas induced by cosmetic procedures are treated two or three times weekly with NB-UVB. Normal skin areas are protected with clothing and/or broad-spectrum sunscreen. The initial NB-UVB dose of 150 mJ is usually given with increments of 10% to 15% each visit. Broad-spectrum sunscreens are applied to the affected areas following NB-UVB exposure (Fig. 14-4 A,B). Excellent results have been achieved in patients with extensive pigment loss from laser hair removal.

Targeted light therapy

Targeted phototherapy systems deliver high-intensity light only to the affected areas through a controlled handpiece. Hence, ultraviolet light exposure is avoided on normal skin. Targeted light systems decrease cumulative UV light doses to affected areas. Such units include the excimer laser, broad band UVB units, and combination UVA/UVB systems. These units are commonly used for repigmentation of vitiligo. Friedman and Geronemus[16] treated two patients with the 308-nm excimer laser for postresurfacing

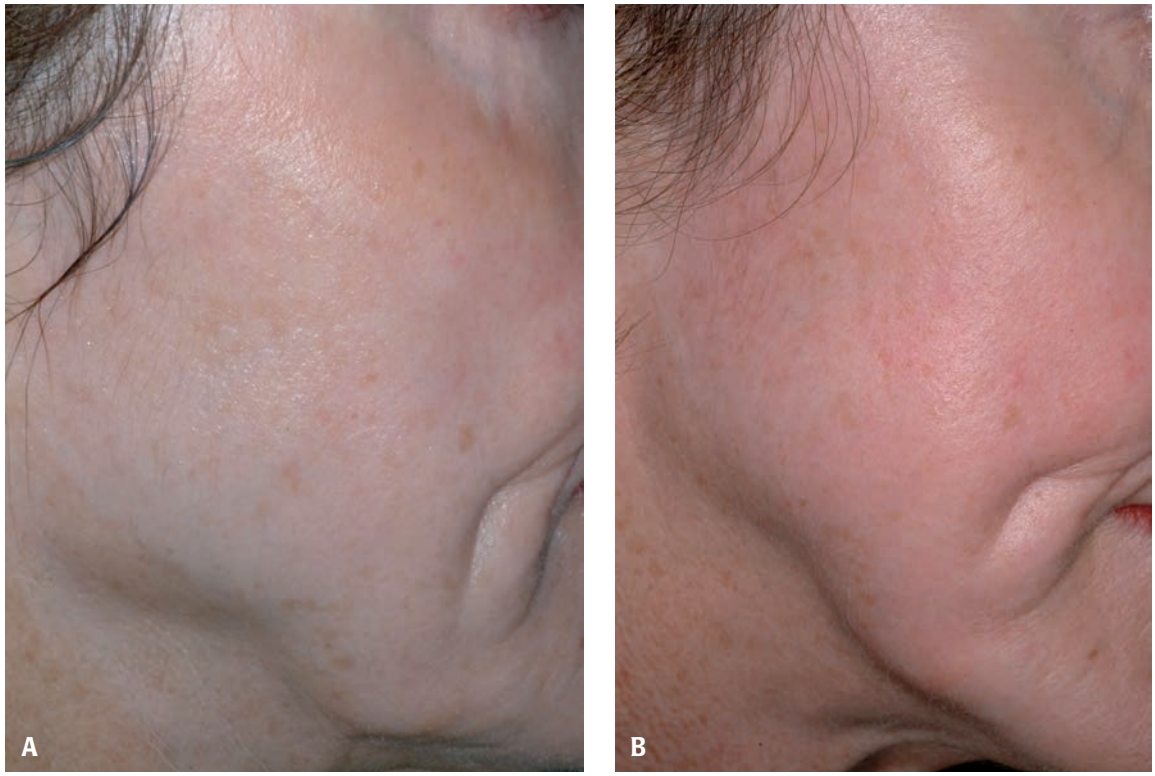

Figure 14-5 Hypopigmentation from ablative resurfacing. Baseline **(A)** and after **(B)** 30 treatments with XeCl excimer laser.

leukoderma. Sites treated included the upper lip and the cheek. The authors reported improvement in both patients. A subsequent study by Alexiades-Armenakas et al.[17] assessed the efficacy of the 308-nm excimer laser for hypopigmented scars and striae alba. The hypopigmented scars are distributed on the face, torso, or extremities. Lesions were randomized to receive treatment or not with site-matched control lesions. Therapy was initiated with a minimal erythema dose minus 50 mJ/cm^2 to affected lesions. Treatments were performed biweekly until 50% to 70% repigmentation was achieved, then every 2 weeks thereafter. The mean percentage pigment correction by visual assessment compared with control skin was 61%. Pigmentation gradually faded during the 6-month follow-up, suggesting that maintenance treatment every 1 to 4 months may be necessary to maintain the cosmetic benefit.

Goldberg et al.[15] treated hypopigmented striae with either the 308 nm excimer laser or a UVB targeted light device (ReLume). After 6 months, all subjects showed clinical evidence of some persistence of clinically significant pigmentation. Analysis of biopsy specimens showed an increase in the number of melanocytes as well as the content of epidermal melanin. Hypertrophy of melanocytes was also evident.

The author has also observed improvement for cosmetic leukoderms treated with the excimer laser (Fig. 14-5A,B). The standard protocol involves an initial excimer laser dose of 100mJ/cm^2 for skin types I through III and 150 mJ/cm^2 for skin types IV through VI. The fluence is then increased by 50mJ per treatment until mild erythema is achieved. Treatments are given twice weekly.

COMPLICATIONS

Side effects of topical photochemotherapy, narrowband UVB, and targeted light treatment include temporary perilesional hyperpigmentation, blistering reactions, erythema, erosions, and pain.[11–17] The perilesional hyperpigmentation resolves on cessation of treatment. It is never a permanent sequela. It can be minimized by avoiding overlapping treatments with normal skin. Blistering reactions caused by targeted light systems, topical photochemotherapy, or narrowband UVB systems are treated for 2 to 5 days with midpotency to high-potency topical steroids and cool compresses. Patients are usually able to resume treatment in 7 to 10 days. At that time, dosing should be lowered to 50% of the dose at the time of blistering (Fig. 14-6).

SURGICAL INTERVENTION

Autologous grafting procedures have been used extensively in patients with stable, localized areas of vitiligo

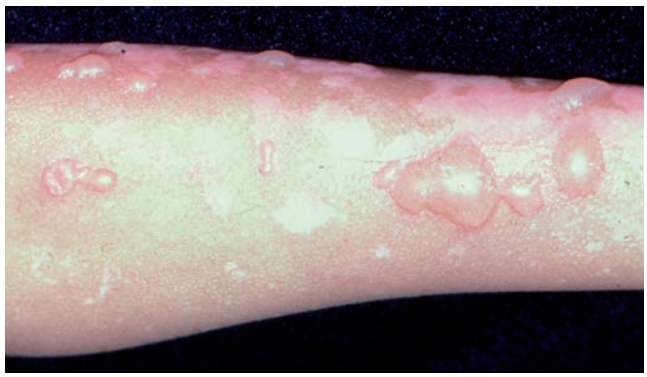

Figure 14-6 Blistering reactions from topical photochemotherapy.

since the 1980s.[18] For localized areas of hypopigmentation that fail to respond to the aforementioned medical approaches, autologous 1-mm punch grafts are viable. The technique is described in detail in Chapter 15. In brief, the technique involves harvesting 1-mm grafts from the hip, removing 1-mm grafts from the recipient area, and transplanting the graft to recipient areas. Sites are covered with Steri-strips and gauge dressings, which are removed in 7 days. I have had success in using this technique in patients who do not respond to phototherapy regimens (Fig. 14-7; Table 14-1).

MICROPIGMENTATION

Micropigmentation is a process of uniform implantation of minute iron oxide pigment granules into the dermis using a variety of tattoo machines/units. Although not a recommended therapeutic treatment for cosmetic leukoderma, micropigmentation has been used aesthetically to camouflage various medical conditions related to dermatology and plastic surgery. It is not a widely accepted modality for repigmenting hypopigmented skin. Immediate adverse effects include ecchymosis, crusting, and edema lasting 2 to 3 days, reactivation of herpes simplex virus infection, secondary bacterial infection, and contact allergy to pigments. Micropigmentation should be performed with caution in patients with cosmetic leukoderma given the likelihood of pigment oxidation and further discoloration over time (Fig. 14-8).

In addition, the Tyndall effect—characterized by a bluish discoloration of the treated area—can develop several months later.[19]

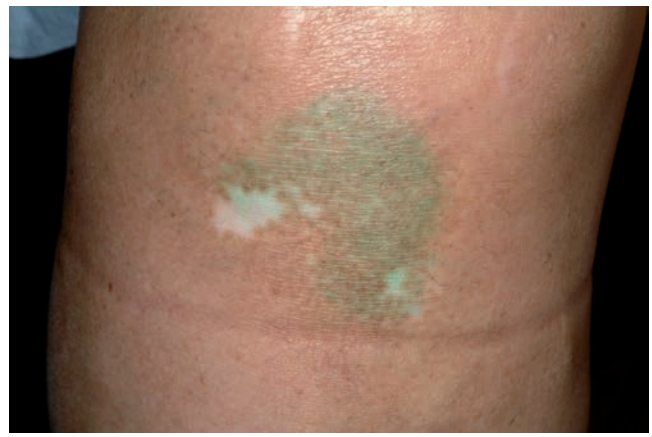

Figure 14-8 Micropigmentation for depigmented patch of the knee area. Note green discoloration of tattooed area.

CONCLUSION

Cosmetic leukoderma is a dreaded complication of aesthetic resurfacing procedures. Patients are often devastated by this side effect. Although pigmentary disorders are physically benign disorders, the psychosocial aspects of hypopigmentation and depigmentation are often malignant. Self-image, self-esteem, and emotional well-being are affected.[20–22]

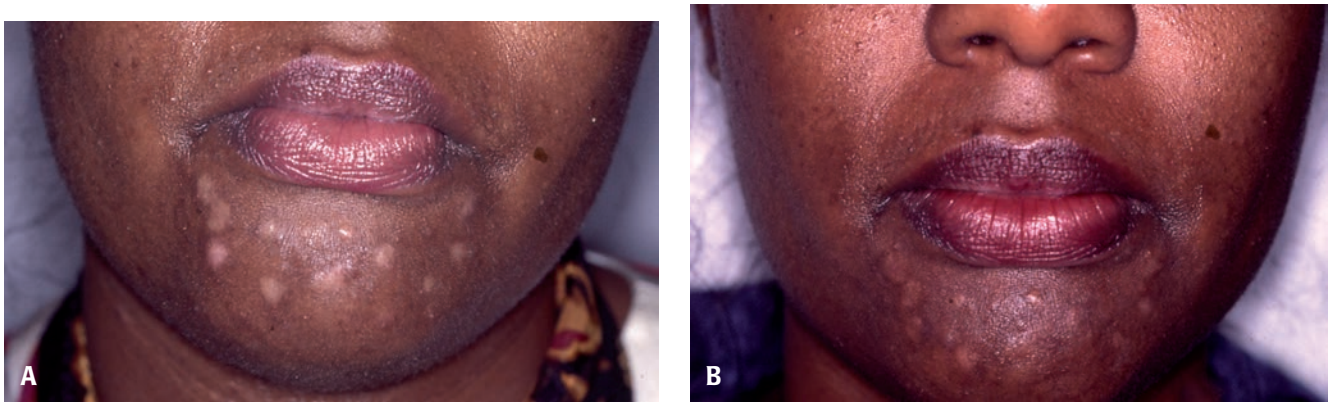

Figure 14-7 **A:** Hypopigmented scars from CO_2 laser resurfacing for acne scars. **B:** 1-mm autologous grafting.

Table 14-1

Therapeutic approaches for cosmetic leukodermas: mechanisms of action, advantages, and disadvantages

	Mechanism of action	Advantages	Disadvantages
Topical Photochemotherapy	Enhances type IV collagen production Stimulates proliferation and hypertrophy of Follicular border, and residual melanocytes Alters cell-mediated immune response Depletes of expression of epidermal growth factor receptor Inhibits degranulation of mast cells	Efficacious therapeutic option In office or sunlight Minimal practice expense 0.001% methoxalen well tolerated	Repigmentation rates vary considerably Accurate/precise formulations needed Blistering reactions Sometimes unpredictable border hyperpigmentation
Narrowband UVB	Decreases Langerhans cells Increases apoptosis Increases melanocyte proliferation and melanogenesis Increases αMSH Increases βFGF Increases ϵf-1 Increases endothelin 1	Ease and comparable efficacy Lack of systemic side effects No posttreatment ocular protection Excellent safety profile Minimal photoxicity	Requires three treatments per week for maximal efficacy Long-term carcinogenic effects unknown Permanency of repigmentation unknown
Excimer Laser 308 nm	Melanocyte proliferation Melanogenesis Activation of protein kinase C Alteration of cytokine production Stimulation of αMSH Formation of photoproducts	High-intensity light to affected skin areas Increased precision Avoids exposure to normal skin Rapid therapeutic responses Cumulative UV exposure decreased Synergistic effect with topical agents	Temporary hyperpigmentation Blistering similar to a sunburn Erythema Erosions Pain Expense Border hyperpigmentation
Combination UVA/UVB units (Theralight)	Melanocyte proliferation Melanogenesis Activation of protein kinase C Alteration of cytokine production Stimulation of αMSH Formation of photoproducts	High-dose therapy yields rapid result Fewer treatments required No need to fully disrobe Healthy skin not exposed to UV light Minimal side effects Greater convenience	Temporary hyperpigmentation Blistering similar to a sunburn Erythema Erosions Pain Expense Border hyperpigmentation
Surgical Grafting	New reservoir of melanocytes Immature melanocytes express c-kit protein Melanocyte migration Melanocyte proliferation Melanogenesis increased	Transfer of healthy melanocytes to areas of hypopigmentation for migration, proliferation, and repigmentation Adequate repigmentation Available procedures in most anatomic locations	Contraindications are hypertrophic scars and keloids Poor repigmentation in acral areas Infection Scarring Postinflammatory hyperpigmentation Cobblestoning Expense

Data from references 11, 12, [23–34].

FGF, fibroblast growth factor; MSH, melanocyte-stimulating hormone; UV, ultraviolet; UVB, ultraviolet B.

Cosmetic leukodermas are amenable to treatment via topical photochemotherapy, narrowband UVB, excimer laser, targeted UVA/UVB light sources, and surgical grafting. Clinical evidence indicates that substantial improvement can be achieved with minimal side effects. However, for some patients, intermittent retreatment may be required to maintain pigment in the affected areas. Additional studies are necessary to further substantiate the efficacy of these modalities in both the duration of improvement and the mechanism of action.

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15

Surgical Approaches for Vitiligo

Rafael Falabella

Vitiligo is a relatively common pigmentary disorder characterized by patches of depigmentation. The disease affects 1% to 2% of the population and shows no racial or ethnic predilection. Vitiligo is indeed a disfiguring and psychologically devastating disease. The disorder may be imperceptible in people with Fitzpatrick skin types I and II but is striking in darker racial ethnic groups (Fig. 15-1). Patients with vitiligo experience profound psychological trauma relating to the cosmetic deformity. Psychological profiles have documented perceived job discrimination, low self-esteem, suicidal ideation, and difficulty in interpersonal relationships.[1,2] The effects of vitiligo are particularly devastating in darker racial ethnic groups.

The precise cause of vitiligo is unknown. Autoimmune, genetic, neural, biochemical, self-destructive, and viral mechanisms have been suggested.[1] Myriad clinical observations and studies support an immune mediated pathogenesis of vitiligo. Vitiligo has been reported in association with autoimmune endocrinopathies and autoimmune diseases. Thyroid disorders, in particular Hashimoto Thyroiditis and Grave Disease, are the most common associated diseases. Other disorders have included diabetes mellitus, alopecia areata, pernicious anemia, rheumatoid arthritis, autoimmune polyglandular syndrome, and psoriasis. In a recent survey of 2,624 vitiligo probands in North America and the United Kingdom, a significant increase in six autoimmune diseases was reported in vitiligo probands and first-degree relatives.[2] These diseases included vitiligo, thyroid disease (predominantly hypothyroidism), pernicious anemia, Addison Disease, systemic lupus erythamatosus, and inflammatory bowel disease. Despite the difficulties inherent in replenishing the epidermis with melanocytes, recent significant advances have been made in the treatment of vitiligo. The best therapies for vitiligo include medical and surgical approaches (Table 15-1). These include topical steroids, vitamin supplementation, topical immunomodulators (e.g., tacrolimus, pimecrolimus), narrowband ultraviolet B (UVB) phototherapy, and targeted light units. Grafting has been shown to be effective for localized lesions. Most recently, targeted phototherapy systems have proved effective in the treatment of localized vitiligo. About 70% repigmentation may be achieved with medical therapies, either topically or systemically, but there are difficult areas to repigment, such as the acral part of the extremities, lips, and genitalia. When vitiligo becomes refractory to medical treatment, surgical techniques become an important alternative.

In this chapter, a review of repigmentation in vitiligo by surgical methods is described, emphasizing the peculiarities of ethnic skin in regard to these treatments. The basic principles of melanocyte transplantation, indications, contraindications, description of the surgical techniques, and complications are discussed.

UNDERSTANDING VITILIGO FROM THE SURGICAL POINT OF VIEW

It is not simple to understand why surgical interventions are useful in vitiligo, a condition that was treated medically for many years. However, about 25 years ago, transplantation of melanocytes were added to the armamentarium of vitiligo therapies after observing that appropriate selection of patients was an essential condition sine qua non for repigmentation success.

Vitiligo is, in general terms, a progressive disease, and it is frequently observed that lesions enlarge gradually, leading to depigmentation that may affect any anatomical area in a symmetrical distribution. In time, after years of progression, some lesions become stationary and may spontaneously repigment, at least partially—a phenomenon that can be seen around or within depigmented areas as multiple spots or pigmentation islands. On the other hand, a smaller percentage of patients, usually younger than the previous group, develop unilateral lesions that have a faster course and after several months may come to a halt without having further depigmentation; some of these lesions may also develop some degree of spontaneous and partial repigmentation.

During medical therapy, pigment cells arise and proliferate from three different sources: (i) the pilosebaceous

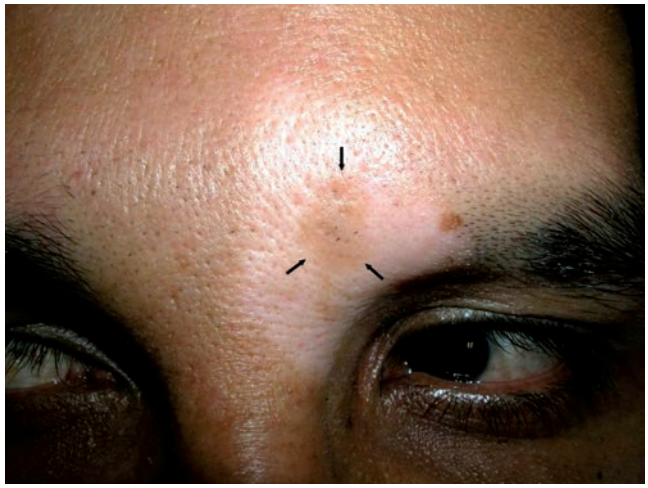

Figure 15-1 *Minigrafting test.* A 36-year-old man with refractory unilateral vitiligo on the forehead had a minigrafting test in 1990 with three minigrafts of 1 mm each. Although repigmentation surrounding minigrafts was achieved in 3 months and remained unchanged as depicted by arrows, he only came back for definitive grafting 15 years later.

unit, providing the highest number of cells, which migrate from the external root sheath toward the epidermis;[3] (ii) spared epidermal melanocytes not affected during depigmentation;[4] and (iii) the border of lesions, migrating up to 2 to 4 mm from the edge. Immature melanocytes around the follicular ostium, expressing the C-kit protein, may also be an important part of the melanocyte reservoir and could replace pigment cells in vitiligo that disappeared by destruction or apoptosis.[5] When pigment cells are no longer available from these sources, medical therapy is no longer useful. Under conditions of stability, however, repigmentation may be possible by melanocyte grafting or transplantation, because the pathogenic mechanisms causing depigmentation are arrested; hence, melanocyte destruction will not occur when new cells are implanted. Nevertheless, if depigmentation is still in progress or new lesions develop, the condition is active, and melanocyte transplantation must not be considered as a therapeutic option.

ETHNIC SKIN AND VITILIGO

Vitiligo is a socially difficult condition to deal with in patients with fair complexions, because hypopigmentation is easily detected by other persons, some of whom may have a feeling of rejection toward affected individuals. This situation may be more difficult for patients with dark ethnic skin, because depigmented lesions are similar to that of Caucasians, but their appearance as compared with adjacent normally pigmented skin discloses a remarkable contrast that make this condition much more noticeable and unsightly. Social rejection leading to difficulties in daily life and job opportunities may provoke anxiety, depression, and impaired self-image. In some cultures, discrimination, familial stigmatization, and sometimes divorce problems may affect patients with vitiligo.[6] Dark-ethnic-skin patients with vitiligo deserve

Table 15-1

Medical and surgical therapies for vitiligo

Localized/limited	Moderate/severe	Recalcitrant
Topical steroids	Narrowband ultraviolet-B	*Recalcitrant-Localized*
Topical psoralens	Systemic psoralens	Surgical
PUVAsol	Systemic steroids	Sheet grafts
Topical immunomodulators	Oral, intramuscular	Autologous punch minigrafts
Tacrolimus	Calcipotriol	Split-thickness grafts
Pimecrolimus	Pseudocatalase	Melanocyte transplants
Targeted light/excimer laser	Phenylalanine	Cocultured epidermis
Pseudocatalase	Khellin	
Antioxidants/vitamins	Antioxidants/vitamins	
Tar emulsions	*Recalcitrant-Severe (>50%)*	
	Depigmentation	
	Monobenzone	

to be treated with the best of our knowledge to improve their appearance and reincorporate them into an active social life.

PATHOGENIC ASPECTS: ACTIVE VERSUS INACTIVE VITILIGO

Although the cause of vitiligo is unknown, we are not completely in darkness, because multiple factors have been identified in the last 3 decades in relation to its pathogenesis. It is remarkable that an asymptomatic disease such as vitiligo—without significant inflammation and producing a "minor" change such as loss of pigmentation—is so complex that to date, the secrets of its pathogenesis have not been completely unraveled.

Immunological alterations, both humoral and cellular;[7] autocytotoxic damage to pigment cells;[8] generation of free radicals and hydrogen peroxide;[9] intrinsic damage of the rough endoplasmic reticulum leading to melanocyte damage;[10] pathologic changes of fine nerve endings and neuropeptide disturbances;[11] associated endocrine ailments and organ specific antibodies;[12,13] and other related findings have been described as pathogenic factors, some of which are inducers of toxic and/or inhibitory effects on pigment cells; nevertheless, the sequence of events leading to depigmentation is yet to be determined. It may also be possible that all of these, as well as other unknown factors, may contribute to depigmentation. It is not clear either if there are vitiligo subsets that correspond to clinical presentations with different pathogenic mechanisms. To summarize, although the ultimate cause of vitiligo is not completely known, this condition reflects profound immunological alterations and other molecular defects originating pigment cell destruction.

When lesions are enlarging or new lesions appear, we may speak of active or unstable vitiligo, which is resistant to any type of surgical therapy. After complete stabilization, vitiligo becomes inactive or stable and may be treated by grafting or transplantation. It is interesting that melanocytes may be present in depigmented skin after years of onset[4] and may still respond to medical therapy under appropriate stimulation.

CLINICAL FORMS OF VITILIGO

Several classifications for vitiligo have been proposed, but for practical purposes, most patients can be classified in two major forms: Unilateral and bilateral vitiligo.[14]

Unilateral vitiligo (segmental, asymmetric vitiligo) may develop in 10% to 20% of affected individuals, and it is more commonly observed in young patients before the age of 20. Depigmentation occurs on one side of the cutaneous surface, running a rapid course during several months; following stabilization, it does not progress thereafter. The depigmented areas are limited to one anatomical region in a quasidermatomal distribution. Repigmentation is not always possible with medical treatment, but surgical techniques are the best indication for this vitiligo type, with most publications disclosing high rates or complete repigmentation.[15,16]

Bilateral vitiligo (vitiligo vulgaris, symmetrical vitiligo) accounts for about 80% to 90% of vitiligo patients. In the majority of them, lesions begin as small depigmented macules, slowly enlarging during several years, in a bilateral and often symmetric distribution, sometimes with partial regression but more commonly in a progressive manner. In a relatively small group of individuals so affected, the condition becomes stable, and in about 50% of such cases, repigmentation may be obtained by melanocyte transplantation.[17]

Recently repigmentation of stable vitiligo lesions on genitalia was successfully reported in three patients with noncultured melanocyte keratinocyte transplantation. Although this is an important achievement, appropriate selection is an important issue when treating such patients at this anatomical site.[18]

SELECTION OF PATIENTS FOR SURGICAL REPIGMENTATION

Melanocyte transplantation is only useful and indicated when lesions become refractory to medical treatment but particularly when stabilization and no further progression of vitiligo occurs. It is important to consider several items to be evaluated in patients when surgical treatment becomes an option.

Stable vitiligo

So far, there is no objective manner to detect complete vitiligo stability, but there are several ways to suggest that vitiligo has reached this point:

- No progression of lesions during at least 2 years (although a nonprogressive macule may be active and may not respond to surgical treatment, and a slow-progressing macule is difficult to evaluate).
- Spontaneous repigmentation (stable vitiligo is highly possible in this case).
- Results of minigrafting test: When repigmentation around 4 to 5 minigrafts (1 or 1.2 mm), implanted 3 to 4 mm apart within a depigmented lesion, occurs, the possibilities of repigmentation may be high, and a successful response may be anticipated in 95% of patients (Fig. 15-1).[19] Sometimes it is advisable to perform an extended test with multiple minigrafts, particularly on poorly responsive anatomical locations (Fig. 15-2). So far, this test is the most accurate evidence of vitiligo stability, and recent studies suggest its reliability and validation.[20]

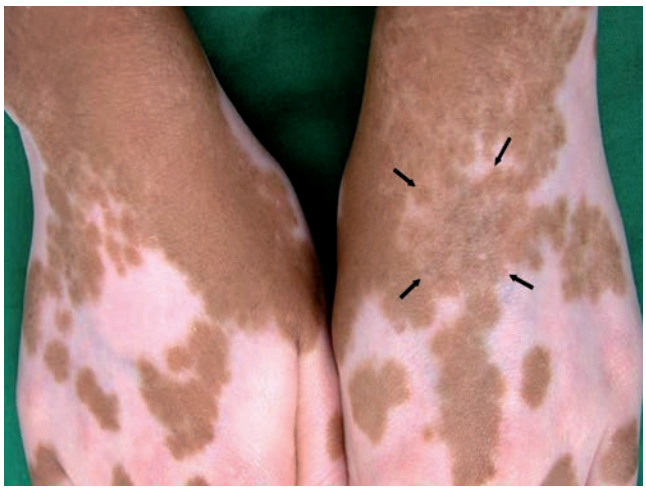

Figure 15-2 *Extended minigrafting test.* A 32-year-old woman with refractory stable bilateral vitiligo received multiple minigrafts on the dorsum of the left hand. Complete repigmentation of the tested site (*arrows*) after 6 months suggests high possibilities for future surgical therapy. Notice a symmetric, depigmented, untreated area on the right hand.

- No new Koebner phenomenon developing, including the donor site for the minigrafting test.
- Unilateral vitiligo, which is by definition the most stable form of the disease with excellent repigmentation response after surgical treatment, as demonstrated in numerous publications.[21] In bilateral vitiligo, only half of these patients may improve with surgical therapy[16,19] after reaching the point of stability, which usually occurs many years after onset.

New proposals for defining stable vitiligo are needed, but until they become valid, the previous parameters should be kept in mind.

Age for procedures

Although transplantation methods are invasive procedures and not recommended in children, sometimes motivated patients around the age of adolescence can be treated under sedation or general anesthesia. Adults can be treated at any time depending on their interest in surgical repigmentation.

Treatment of the dorsum of hands

Most patients are interested in having treatment for their lesions on exposed areas; one of the most important refractory anatomic regions, the dorsum of the hands and fingers, can be sometimes successfully repigmented in patients with stable disease.[21–23]

Surgical methods and size of lesions

For small- or medium-size lesions, simple methods, such as minigrafting and suction epidermal grafting, are useful. For extensive depigmented defects, in vitro culture techniques may be required,[24] but serial treatments with simple methods can also be appropriate.

Patient's expectations

Repigmentation is not always comparable with normally pigmented skin, and the final results vary considerably from patient to patient. However, most individuals are pleased with the achieved results; minor imperfections are far less important than the noticeable repigmentation of vitiliginous skin, mainly in ethnic skin patients with dark complexion. Sometimes, surgical repigmentation may look even better than what is observed in many patients after medical therapy.

Psychological aspects

Some patients with high emotional trauma because of depigmentation may seek advice for invasive procedures. However, a psychological evaluation may be needed to ascertain the real need for surgical treatment.

Photographic records

Illustrations are recommended to help in determining the percentage of improvement, quality of repigmentation, and possible side effects.

Achromic versus hypopigmentated lesions

The best lesions to treat are those completely depigmented in patients with skin types III to VI. Hypopigmented lesions do not repigment as well, and sometimes moderate and permanent hyperpigmentation occurs.

Serial procedures to complete repigmentation

Most procedures require more than one intervention,[25] and several sessions may be needed to accomplish full recovery or to complete repigmentation of minor depigmented defects that remain untreated. Combination methods may be of value for this purpose[26] and should always be considered for future treatment.[27] When some spots within a repigmented area remain depigmented in spite of an appropriate procedure, the intervention may be repeated if these areas are large enough; but if small, minigrafting is a very useful method for residual depigmented spots. In addition, combination of surgical methods with psoralens + UVA (PUVA) therapy[28,29] may enhance the repigmentation process after surgery.

Cost and facilities

Costs depend on the method, but they may be similar to other surgical skin procedures, depending on the time involved in the procedure. Although culture techniques are the most expensive, at present they are usually covered by research centers. Perhaps the most important fact for reimbursement purposes is to provide all the necessary

information, explaining to health providers that this is not merely a "cosmetic" repair.

EXPERIENCE WITH VITILIGO SURGERY

Vitiligo therapy has changed dramatically with the surgical approach. Since initial attempts for repigmentation of vitiligo and leukoderma with thin Thiersch grafts in 1960,[30] and later on with epidermal grafting in 1971,[31] minigrafting in 1988,[15,32] epidermal suspensions in 1992,[33] and in vitro cultured epidermal sheets in 1989,[34,35] many publications have proven beyond doubt that surgical methods with transplantation of melanocytes have a place in vitiligo therapy in patients with refractory disease.

The highest repigmentation figures have been found for unilateral (segmental, asymmetric) vitiligo, the most stable form of the disease.[36] On the contrary, in bilateral vitiligo (vulgaris, symmetrical), only half the patients so treated have such rates of repigmentation, provided that they are completely stable when surgery is performed;[37] nevertheless, success and quality of repigmentation is dependent on the appropriate selection of cases and technique used.

REIMBURSEMENT IN VITILIGO: AN "INVENTED DISEASE" ARISING FROM A COSMETIC PROBLEM?

Vitiligo is a painless and symptomless condition; at the most, slight pruritus is a symptom in a few patients. However, patients face many difficulties when dealing with their medical plans, because it is frequently claimed that their illness is not covered for reimbursement because they suffer from no disease but just developed a "harmless cosmetic problem."

There are several reasons to disregard vitiligo as a cosmetic problem and consider it as a true disease as any other—with important implications interfering with normal life activities and employment:

- It is an acquired disease, not congenital.
- Patients are frequently segregated and stigmatized because of their unsightly appearance.[2,17]
- As opposed to cosmetic problems that refer mostly to the normal aging process, vitiligo affects profoundly the self-image of patients who suffer it.
- In particular for vitiligo surgery, some patients can be cured definitively if the condition belongs to the group of refractory and stable disease.

Therefore, appropriate selection of patients who are good candidates for surgical interventions with high possibilities of permanent repigmentation is encouraged. Dermatologists should provide all the necessary information to patients to assure their medical care and reimbursement.

REFRACTORY AREAS TO SURGICAL TREATMENT

For unknown reasons, some areas may become very difficult to repigment with surgical interventions, even though treatment is reasonably indicated. Areas with much mobility or prone to slight or mild daily trauma—such as joints, lips, dorsum of hands and feet, and especially fingers and toes—are the most resistant and "hard" areas for repigmentation. Although no explanation can be given for this difficulty, it is conceivable that a "take" failure may be one of the probable explanations. Other areas such as eyelids, genitalia, and cutaneous folds are not easy to treat because of anatomical difficulties placing the grafts. Regrafting and combination methods are indicated after initial surgical failure, and appropriate immobilization and protection of treated sites may enhance the possibilities of a good graft survival.

SELECTING THE SURGICAL TECHNIQUE

The surgical method is chosen according to the dermatologist's preference, training, and experience. Expertise in a given method may be achieved with any of the available methods, and high repigmentation figures can be obtained if performed appropriately. Comparison among different methods has been done and frequently published in the literature in favor of one method in particular, but this may also reflect the expertise of a given author in such method.

Another basic issue is that the less invasive the method, the better cosmetic results will be achieved. Procedures with much dermal manipulation, in terms of depth and area, have a tendency to originate scarring and unsightly repigmentation.

DONOR AREAS

When performing any transplantation procedure, it is of prime importance to select the appropriate donor site, usually a hidden anatomical area, but also with sufficient donor skin as required. The gluteal region is an excellent donor site for minigrafting and epidermal grafting. The skin folds or gluteal region may be used for in vitro culturing, and flat skin surfaces may be used for thin dermoepidermal grafts harvested with dermatome as well as for skin cultures. In general, the achieved

improvement by surgical methods should be far more satisfactory for the patient than the possible damage inflicted to the donor site when harvesting melanocytes for repigmentation.

SURGICAL TECHNIQUES FOR REPIGMENTATION

Although many articles have been published about multiple techniques for melanocyte transplantation, many on them deal with modifications of the five basic surgical techniques that may be used for repigmentation in vitiligo: Noncultured epidermal suspensions, thin dermoepidermal grafts, suction epidermal grafting, punch minigrafting, and in vitro cultured epidermis with melanocytes or cultured melanocyte suspensions.[26]

Noncultured melanocyte suspensions (by trypsin digestion)

This method is performed by grafting noncultured epidermal suspensions with keratinocytes and melanocytes on depigmented skin. A donor skin piece is digested with 0.25% trypsin during 2 hours at 37°C until separation of epidermis from dermis occurs. By vigorous pipetting, keratinocytes and melanocytes separate to constitute a cell suspension, and by centrifugation, a pellet is obtained. The cells are washed with phosphate buffer saline and reconstituted in a cell suspension that is injected into blisters raised by liquid nitrogen freezing[33,38] or "seeded" on a denuded recipient site previously prepared by removal of the depigmented epidermis with superficial dermabrasion. The treated area is covered for 7 days with nonadherent dressings. If a good take occurs, repigmentation will begin 2 to 3 weeks later and continue gradually during the following months. The epidermal cells may be enriched by adding a melanocyte culture medium to the cell suspension, which may enhance the activity of melanocytes; therefore, larger depigmented defects may be treated.[39] The repigmentation yield is approximately a 1:2 ratio or higher according to the dilution used in the cell suspension. Advantages of this method are the evenness of repigmentation and absence of scarring if recipient sites are appropriately manipulated.

Thin dermoepidermal grafts (by dermatome harvesting)

Very thin dermoepidermal grafts harvested with a suitable dermatome from the donor site, not thicker than 0.1 to 0.3 mm, are grafted onto depigmented recipient sites that were prepared by very superficial dermabrasion. To get the best results, only the epidermis and papillary dermis should be removed when harvested, and the thin dermoepidermal sheets are grafted directly onto abraded areas. Grafts are placed close to each other, leaving no space between them; covered with nonadherent dressings; and secured with surgical wrappings during 7 days. Thin grafts and appropriate immobilization are essential for good results in this procedure. Repigmentation is achieved in a few weeks because melanocytes are present within grafts. With this method, refractory areas, as the dorsum of hands and fingers, have been grafted with success.[40] Although simple to perform, the yield is only that of a 1:1 ratio. A similar miniprocedure of this technique has been published as the "flip-top" graft by inserting small 3- to 5-mm, thinly shaved, dermoepidermal fragments under very thin flaps raised on the recipient site. There is a coalescence of pigment spread arising from multiple grafts implanted at a distance similar to the graft diameter. The treated areas should be repigmented within several months postgrafting.[41]

Epidermal grafting (by suction harvesting)

This is a method that has gained popularity, probably because of the excellent results and lack of scarring. In addition, donor sites may be reused for future procedures, allowing treatment of relatively extensive areas.

The technique requires a suction device for harvesting the epidermal grafts. Different publications illustrate several types of custom-made suction devices,[23,28,29,31] some of which are diverse types of syringes successfully used as suction devices.[42,43] The best suction diameter for individual blisters should not be larger than 1 cm to avoid excessive bulging of the skin within the suction device that may interfere with blistering. Blister grafts are obtained in 2 to 4 hours, but timing may be reduced to 30 minutes if heat at 42° to 43°C is provided during suction.[28,44]

Removal of vitiliginous epidermis may be achieved by liquid nitrogen freezing on small 5- to 10-mm spots 2 days before surgical interventions, so that grafting is performed after inflammation subsides; the blistered epidermis is removed just before implanting the epidermal grafts. Similar and faster results for epidermis removal include superficial dermabrasion[40] or ultrapulse CO_2 laser.[45]

When recipient sites are ready, blister grafts are cut with iris scissors; transferred with a thin transparent spatula, glass slide, or acetate films;[46] and grafted onto the recipient site.[29] The grafted surface is dressed with nonadherent gauze and wrapped with elastic bandages for 5 to 7 days. Pigment spread will gradually occur around grafts until repigmentation is complete. By adding PUVA, repigmentation occurs deeply and faster.[28,29] The repigmentation yield is about 1:5 or even higher when grafts are placed at a distance similar to the diameter of grafts. An advantage of this method is the absence of scarring in donor and recipient sites.

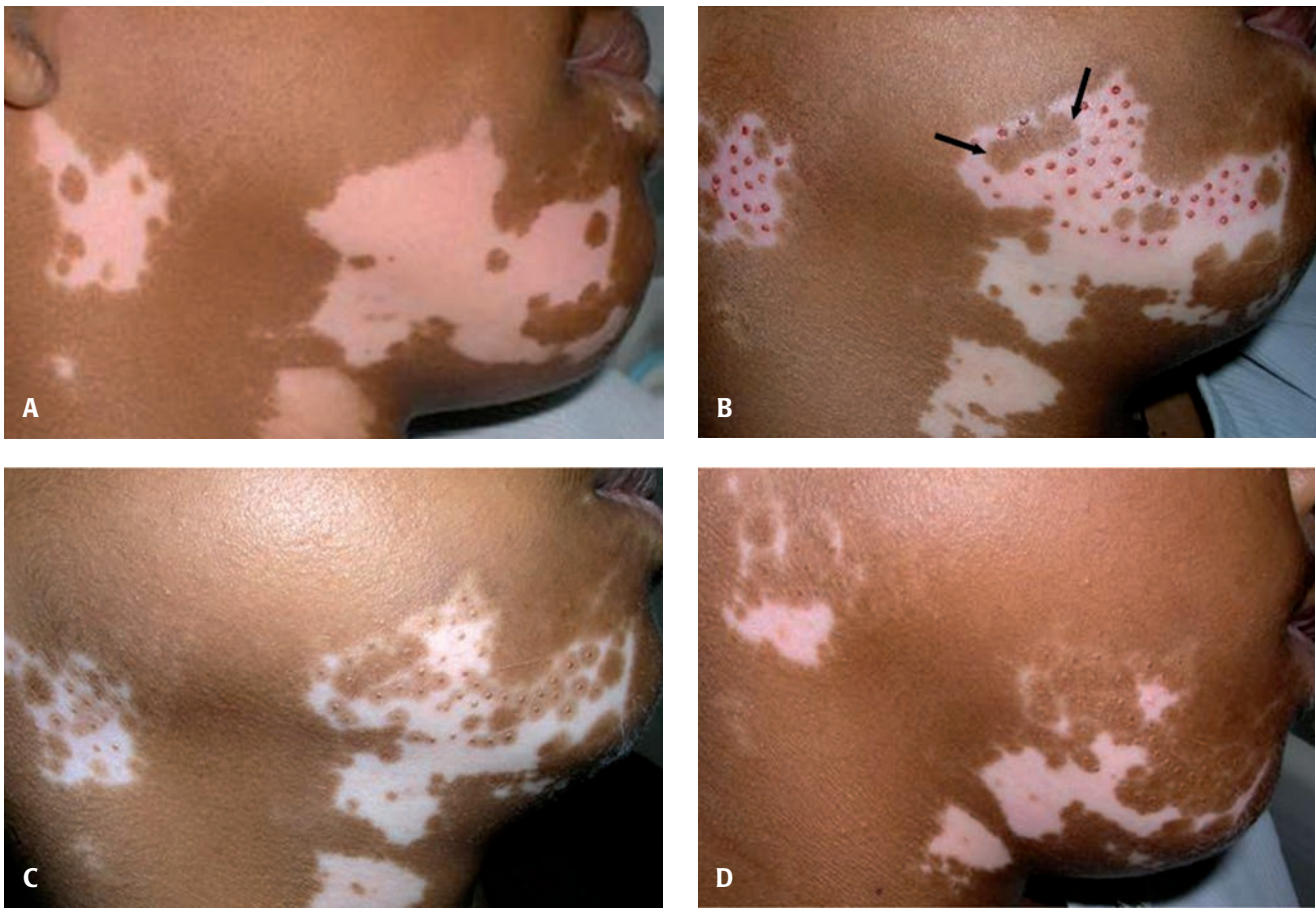

Figure 15-3 *Minigrafting sequence*. A 13-year-old boy of dark ethnic skin with refractory unilateral vitiligo illustrates the results of a single minigrafting session: **A:** Preoperatory aspect. **B:** Minigrafts immediately postgrafting (*arrows* depict minigrafting test done 4 months before). **C:** Partial repigmentation in progress 2½ months postgrafting. **D:** Six months after surgery, 95% repigmentation of treated areas was achieved.

Minigrafting (by small punch grafting)

Among all methods of melanocyte transplantation, minigrafting is the most popular technique used by many dermatologists, probably because of its simplicity.

Initially, after infiltration with 1% lidocaine without epinephrine, multiple perforations on depigmented skin are performed with a small 1- to 1.2-mm punch, separated at a distance of 3 to 5 mm apart from each other; the depigmented skin punches are discarded. The area under treatment is covered with compresses moistened with normal saline solution, allowing protection from contamination and facilitating blood clotting while harvesting minigrafts.

Minigrafts of similar size are then harvested very close to each other from the donor site with iris scissors and a fine-tipped forceps, placed onto a nonadherent dressing moistened with normal saline solution and kept sterile until grafting.

For grafting, minigrafts are transferred to the recipient site with the fine forceps, and when grafting is complete, Micropore tape is directly applied on the surgical surface to assure adequate immobilization of minigrafts. After 14 days, the dressings are removed carefully to avoid detachment of grafts.[15] Semipermeable or nonadherent dressings may also be used according to the surgeon's experience.

For facial and neck lesions in young patients, a 1.0-mm punch is recommended, leading to good repigmentation and no scarring at all; 1.2-mm minigrafts can be used in the trunk and extremities. Larger-size grafts may provoke an unsightly "cobblestone" appearance.[26] Repigmentation occurs gradually around each minigraft up to 2 mm from the edge of grafts, and by coalescence originated by pigment spread, the total area becomes repigmented (Fig. 15-3A–D and Fig. 15-4A–D).[15,32,47]

Repigmentation rates vary from 1:10 to 1:20. Advantages of this method are its simplicity and the few instruments required: Minipunch, iris scissors, and a fine-tipped forceps. However, expertise should be good enough to avoid "cobblestoning," particularly by using very small punches.

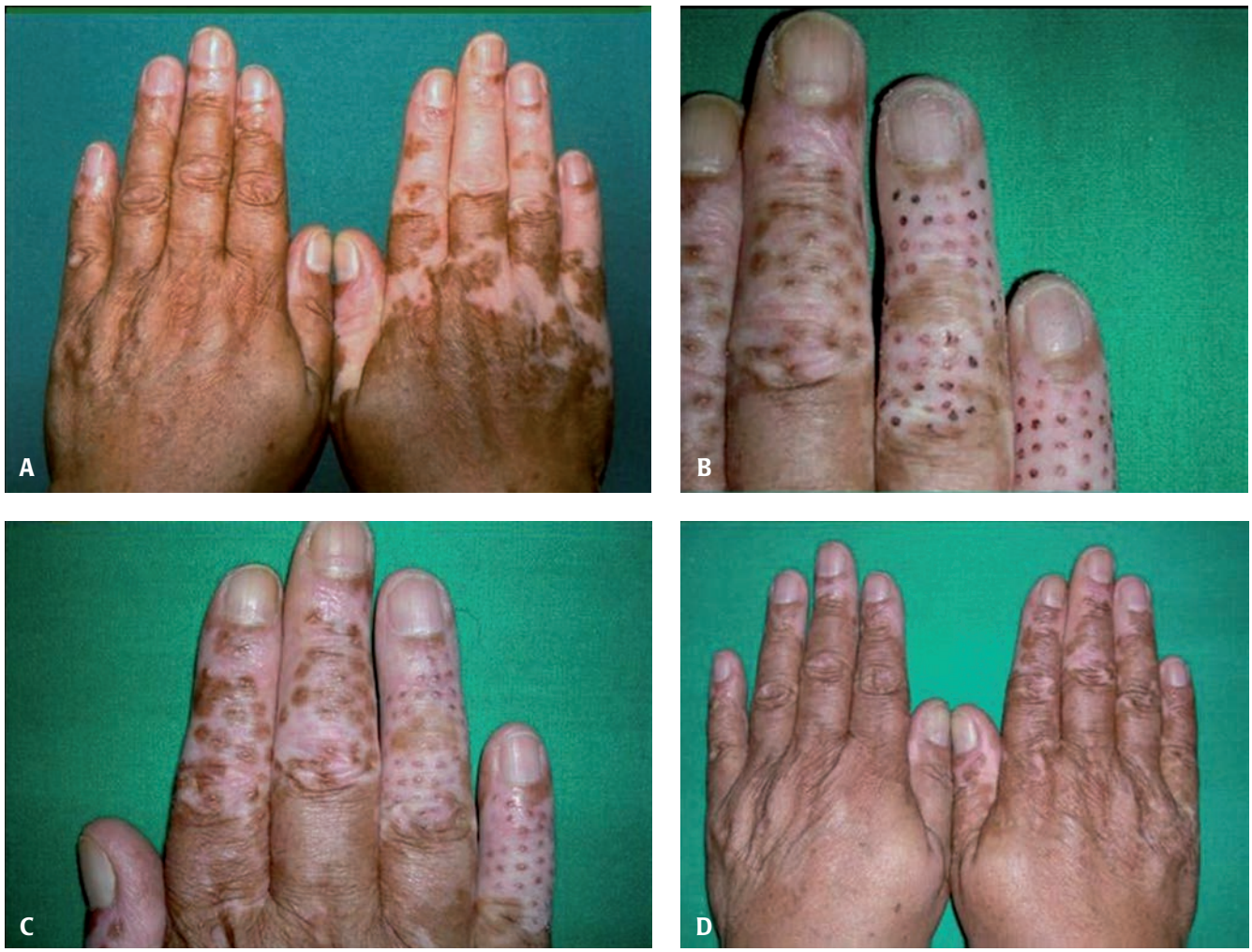

Figure 15-4. *Difficult areas for repigmentation.* **A:** This 50-year-old man had bilateral vitiligo since age 20. Lesions became stable after a few years, and at age 34, he had an in vitro cultured epidermal sheets transplantation on the left hand, with nearly 100% recovery (see reference 22). **B** and **C:** The patient came back 15 years later for additional treatment on his right hand, and after two minigrafting sessions with 1.2-mm grafts, pigment spread began shortly after each procedure. Different stages of repigmentation are observed. **D:** Six months later, 95% repigmentation was achieved. Notice that repigmentation effects are similar with two different techniques.

Cultured epidermis with melanocytes and melanocyte suspensions (by in vitro culture techniques)

A small donor skin sample provides the appropriate number of cells to be cultured in vitro and to be used as pigmented grafts for vitiligo. The skin piece is digested with 0.25% trypsin, and an epidermal suspension is obtained. Next, the cell suspension is seeded in culture flasks with appropriate culture media, and in 3 weeks thin epidermal sheets are achieved. These sheets are removed from the culture vessels using nonadherent polyestirene gauze as a graft carrier and transferred to the recipient site, previously denuded with liquid nitrogen freezing (or superficial dermabrasion, CO_2 lasers, pulsed Erbium-YAG lasers, or diathermosurgery).[48,49]

Pure melanocyte suspensions may be cultured with melanocyte culture media in a similar manner; melanocytes replicate exponentially, and the enriched cultured cell suspension is spread onto the recipient depigmented surface previously prepared by epidermal removal. Next, the area is covered with semipermeable or nonadhering dressings for 5 to 7 days until a good cellular take occurs.[50,51] Repigmentation is followed after surgery in both types of grafts during the next weeks and becomes complete after several months. Other methods providing good results include a hyaluronic artificial matrix for growing keratinocytes and melanocytes,[52] and melanocyte suspensions kept under freezing for several months and recultured after thawing; this latter method speaks in favor of the enormous potential of this technology for vitiligo therapy in the future.[53]

The most important advantage with in vitro culturing techniques is the exponential population of cells obtained from a small donor site, which solves the problem of treating extensive areas in a single session. Cost and infrastructure are the main restrictions at present for a wider use in clinical practice.

POSTSURGICAL CARE AND ADDITIONAL PROCEDURES

Neomelanogenesis depends on the type of technique used. Thin dermoepidermal grafts and epidermal grafts usually provide a full amount of melanocytes, and repigmentation is practically immediate if grafts are placed next to each other. On the contrary, epidermal suspensions, minigrafts, and in vitro cultured grafts or cultured suspensions depend on melanocyte proliferation before reaching full repigmentation. For faster and deeper repigmentation, either natural sunlight, 10 to 15 minutes daily, or PUVA are used; sessions can be initiated 2 weeks after healing takes place and continued until full repigmentation is reached. It is frequently observed that if no UV exposure is additionally administered, repigmentation may be slow, incomplete, or may even fail.

The grafted surface sometimes exhibits a slight hyperpigmented appearance, but this effect usually subsides, matching the surrounding skin aspect in most patients. Additional procedures may be tried with the same or different technique if repigmentation is not complete. Minigrafting is an easy technique for repigmenting small areas not improved in previous interventions.

COMPLICATIONS OF VITILIGO SURGERY

Vitiligo surgery involves invasive methods of donor and recipient sites. When performing such procedures, it is always important to consider to what extent additional defects may be provoked in a patient having a pigmentation disturbance. A careful evaluation of the patient's possibilities for appropriate repigmentation or side effects should be performed before therapy is accomplished. The main difficulties are described.

Postinflammatory hyperpigmentation

Some patients, especially those of darker ethnic skin groups with phototypes III to VI, may develop significant hyperpigmentation with surgery for vitiligo. The cause is not known, but in vitro experiments have demonstrated increased dendricity and edema; higher levels of tyrosinase and immunoreactive b-locus protein in pigment cells cultured with prostaglandin D2 (PGD2); leukotrienes B4, C4, D4, and E4; thromboxane B2; and 12-hydroxy eicosatetraenoic acid (HETE), suggesting a possible role of these arachidonic acid metabolites in the pathogenesis of postinflammatory hyperpigmentation.[54,55] Prostaglandin E2 has also been described having similar effects.[48] Most patients undergo spontaneous resolution, but some of them develop permanent hyperpigmentation; in those patients, it is also conceivable that genetic factors may be implicated. When permanent areas with hyperpigmentation secondary to local trauma are found in a patient, surgery for vitiligo may be contraindicated.

Cobblestoning

Cobblestoning is a complication of minigrafting when large punches are used. Punch grafts of 3 to 4 mm are not recommended, because the cobblestoning aspect may overweight the benefits of repigmentation achieved.[56] The preferred sizes are 1.2 mm for trunk and extremities and 1 mm for facial areas, particularly in young patients.

Scarring

When performing thin dermoepidermal grafts, hypertrophic scars, thick grafts, and irregular surfaces may occur at donor or recipient sites. An adequate dermatome for harvesting thin dermoepidermal sheets is important to avoid this side effect. Surgical blades manipulated by hand for shaving large grafts do not provide thin and even graft thickness, resulting in poor cosmetic results.

Infection

Infection is infrequent in most procedures, but a good aseptic technique must always be carried out.

Keloids

A previous history of keloids, either personal or familial, should be evaluated, and patients under this category should not be treated. This complication can be prevented by a careful evaluation and adequate past history. When still in doubt, a minigrafting test should be tried and evaluated before performing any procedure.

CONCLUSIONS AND FUTURE DIRECTIONS

At present, surgical techniques provide acceptable repigmentation for patients with stable and refractory vitiligo not responding to medical therapy. Results vary from patient to patient, but the most important factor to get a high repigmentation percentage is the appropriate selection of patients.[19] Unilateral vitiligo is the type responding better than any other form of vitiligo, and approximately 50% of those with bilateral disease, after reaching the stage of stability, may also achieve good results. Most areas respond to repigmentation procedures, but acral areas do so poorly. Several cytokines have been identified as having important effects on melanocyte migration *in vitro,* and in

time, they may have a future role in clinical practice to enhance repigmentation in combination with medical therapy.[57,58] Surgical interventions could also facilitate repigmentation by selectively providing additional melanocytes implanted within depigmented lesions, which would act as multiple repigmentation foci that could contribute to pigmentation spread and coalescence for complete and faster repigmentation of vitiligo lesions.[59,60] In addition, combination therapy of medical and surgical methods, together with eximer lasers, could enhance the repigmentation rates by stimulating different stages of the repigmentation process. However, it is important that future studies should include control patients to ascertain the validity of findings, as recently demonstrated with epidermal suspensions for treating vitiligo.[61]

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PART

4

Resurfacing Procedures

16

Microdermabrasion

Joyce Teng Ee Lim

Microdermabrasion is a popular superficial skin resurfacing procedure performed by both physicians and nonphysicians. It is a simple, safe, and easy-to-perform cosmetic procedure with almost no downtime. This procedure is suitable for all ages. It is well tolerated with minimal side effects in darker racial ethnic groups (Fitzpatrick's skin type IV through VI). Microdermabrasion is indicated for various cosmetic skin problems, including photodamage,[1,2] facial rejuvenation,[3] cutaneous hyperpigmentation,[4] acne,[5] striae,[6] and acne scars.[7] Although little is known about the exact mechanism of action, there is evidence of dermal remodeling with minimal epidermal disruption. However, most of the studies involved small groups of patients. Despite the paucity of solid scientific data, most patients and some physicians are happy with microdermabrasion and perceived benefits from it.

MICRODERMABRASION PROCEDURE

The first reported microdermabrasion was performed in Italy in 1985 by Marini and Lo Brutto, who reported both micro- and macroscopic improvement in the skin.[2] They used a closed-loop negative pressure system that used microcrystals to abrade the skin. Since then, there have been many different machines using different types of crystals and different types of suction pressure systems. Initially, aluminum oxide crystals were used, but in later units, sodium chloride, sodium bicarbonate, or magnesium oxide crystals are used to minimize the risks from chronic inhaled aluminum oxide microcrystals. Some units do not use crystals; instead they use a firm diamond wand to microabrade the skin. Other units use positive instead of negative pressure systems.

During the procedure, the microcrystals strike the skin surface at an angle, and these are drawn across the surface of the skin by negative pressure airflow. Each crystal produces microtrauma to the skin, resulting in microabrasion. The used crystals and the skin debris are simultaneously aspirated by negative pressure from the skin surface into a container, and these are then discarded. The process is repeated as the handpiece is rapidly moved across the skin. Between each pass, a soft brush is used to wipe away excess crystals. The repetitive movement of the microcrystals across the skin causes intraepidermal injury to the skin, and this in turn causes a dermal response. Patients have to undergo several treatments to achieve the desired results. The time interval between treatments varies from 1 to 4 weeks, depending on the skin type and patient's tolerance. Each session lasts from 20 to 30 minutes.

There are several factors that affect the depth and hence the efficacy of microdermabrasion (Table 16-1). The pressure used, the flow rate of the crystals, the crystal size, and the angle at which the crystals hit the skin will determine the amount of microtrauma to the skin. The larger the crystal size, the greater will be the skin trauma, and the more acute the angle at which the crystals hit the skin, the greater will be the skin abrasion. Increasing the flow rate of crystals and the vacuum suction increases the depth of microdermabrasion. Other factors affecting the depth of microabrasion are the movement of the handpiece across the skin (the longer the dwell time, the greater the injury) and the number of passes.

There are three levels of microdermabrasion that can be achieved (Table 16-2). Level 1 corresponds to a superficial epidermal abrasion. The handpiece is passed across the skin in one to two passes to achieve a cosmetic cleaning of the skin. This is usually done on the whole cosmetic unit. Level 2 is achieved when a higher vacuum pressure and more passes are used to get to the level of the papillary dermis. Here one can see minute pinpoint bleeding. This is usually

Table 16-1

Factors affecting depth of microdermabrasion

- Skin type: thin/thick
- Size of crystals
- Impact of the crystals (angle)
- Amount of crystal flow (particle/sec)
- Amount of vacuum created (suction)
- Amount of passes of handpiece
- Dwell time

Table 16-2
Depth of microdermabrasion

Level 1:	Down to level of epidermis
Level 2:	Down to level of epidermis and in some areas to papillary dermis
Level 3:	Down to level of papillary dermis and in some areas of reticular dermis

used for improving fine wrinkles, superficial scars, and striae. Level 3 will remove the whole epidermis, as well as a part of the dermis. This is used to improve striae, as well as wrinkles around the lips. Both levels two and three are associated with a higher incidence of side effects and should be performed by the physician. Level 2 and 3 microdermabrasion should be used with extreme care and caution in darker skin types to avoid complications, including hyperpigmentation, hypopigmentation, and scarring (Table 16-3).

INDICATIONS

Microdermabrasion is used to treat a variety of skin problems, including photodamage,[1,2] facial rejuvenation,[3] cutaneous hyperpigmentation,[4] acne,[5] striae,[6] and acne scars.[7]

Photodamage

Microdermabrasion can improve photodamaged skin, especially those with Glogau photoaging class I and II. Tan et al.[1] analyzed the effect of microdermabrasion on skin surface roughness, topography, elasticity, stiffness, compliance, temperature, sebum content, and histology. Ten patients, Fitzpatrick skin types I through III, with photodamage (Glogau scale II and III) were treated at weekly intervals for five to six treatments using the Parisian Peel (Aesthetic Technologies Inc., Colorado Springs, CO). Nine patients had at least five treatments. The face received four passes at a vacuum pressure of 30 mm Hg while the periorbital skin received two passes at a pressure of 15 mm Hg. Improvement was seen in seven patients, six had mild improvement, and one had moderate improvement. The remaining three with no improvement had Glogau photoaging class III. Immediately after the procedure, there was a temporary increase in skin roughness, corresponding to the superficial abrasion, and in skin temperature, consistent with increased blood flow. Surface sebum decreased immediately after the procedure, but this effect did not persist between treatments. Skin stiffness decreased and skin compliance improved where microdermabrasion was done on the cheeks. Histologic studies did not show any change in collagen or elastic content. The epidermis showed some orthokeratosis and reduced rete ridge pattern. The upper reticular dermis showed a perivascular mononuclear cell infiltrate and vascular ectasia.

Microdermabrasion as shown by Shim et al.[2] significantly improved skin roughness/textural irregularities, mottled pigmentation, and overall skin complexion in photodamaged skin. It did not significantly improve fine skin wrinkles.

Table 16-3
Side effects of microdermabrasion

Transient erythema
Transient increased sensitivity
Transient skin dryness
Petechiae or purpura
Worsening of telangiectasia or erythema
Posttreatment hyperpigmentation
Corneal trauma
Reactivation of herpes simplex infection
Urticarial reaction

Facial rejuvenation

Microdermabrasion can improve facial aging and is often used as part of a program for facial rejuvenation. Hernandez-Perez and Ibiett[3] treated seven women, six with Glogau's photoaging class II and one with Glogau's photoaging class III. All had five microdermabrasion sessions, each having three passes per session, repeated at weekly intervals. At the start of treatment, all patients had oily skin, dilated pores, fine wrinkles, and thick skin in varying severity. There were improvements in all clinical variables after each weekly session, and the improvements were considered good to excellent. Patients also reported improvement in their self-esteem. Biopsies taken from these women before and after the fifth microdermabrasion sessions showed histopathological improvements. There was mild to moderate improvement in dermal elastosis and mild improvement in dermal inflammation, edema, and telangiectasias.

Hyperpigmentation

Microdermabrasion can improve the mottled pigmentation associated with photodamaged skin.[2] Cotellessa et al.[4] treated 20 female patients with multiple hyperpigmented macules of the face. Eight patients had complete clearance of the pigmentation after four to eight treatments, whereas ten patients had partial clearance after eight treatments. Two patients did not respond after eight treatments. When 15% trichloroacetic acid peels were combined with microdermabrasion treatments, fewer treatments (four to six) were needed to clear or partially clear the pigmentation (Fig. 16-1 and Fig. 16-2). Microdermabrasion is often

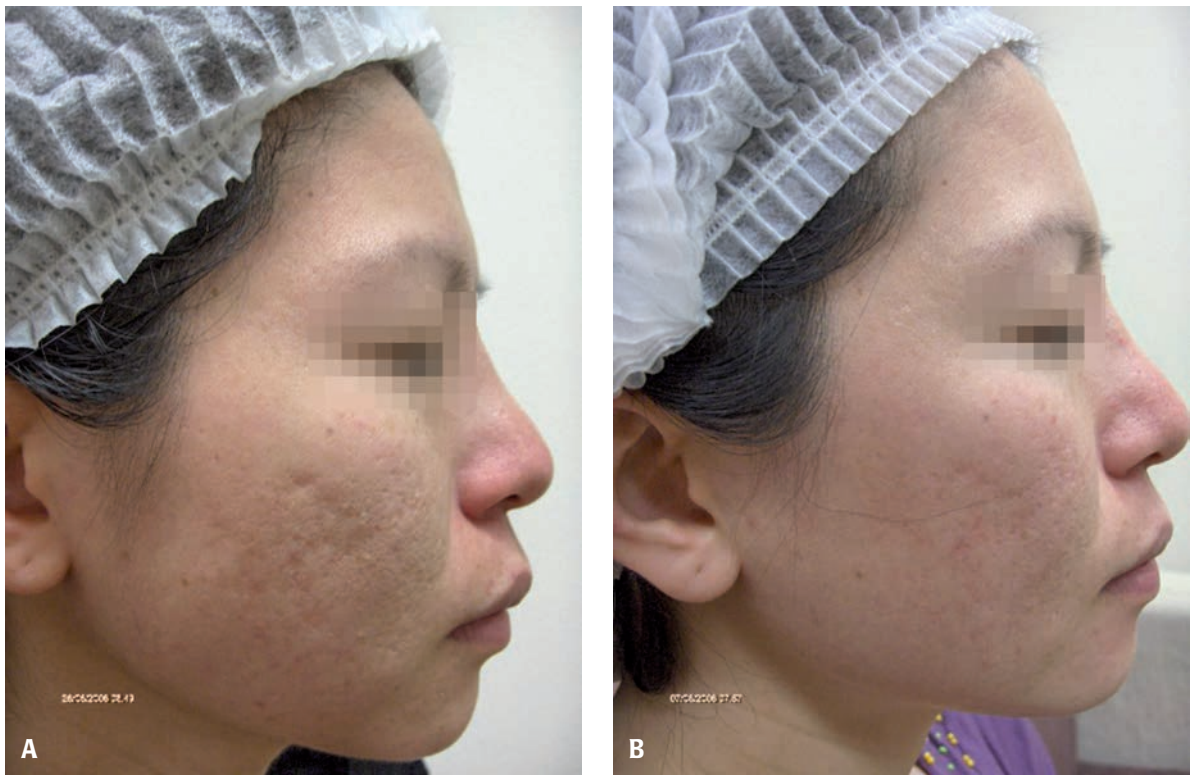

Figure 16-1 Acne scars **(A)** before and **(B)** after ten series of microdermabrasion treatments.

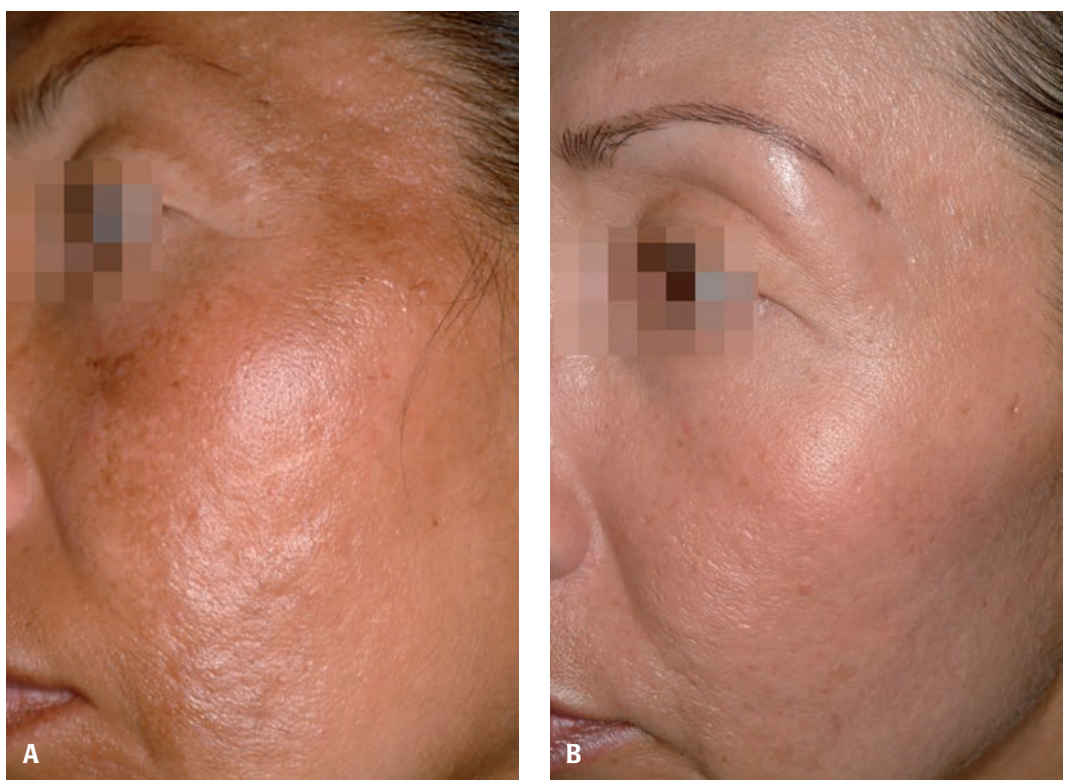

Figure 16-2 Asian woman with acne scarring and melasma. **A:** Baseline. **B:** After a series of three microdermabrasion treatments and triple combination bleaching applied twice daily. (Courtesy of Pearl E. Grimes, MD)

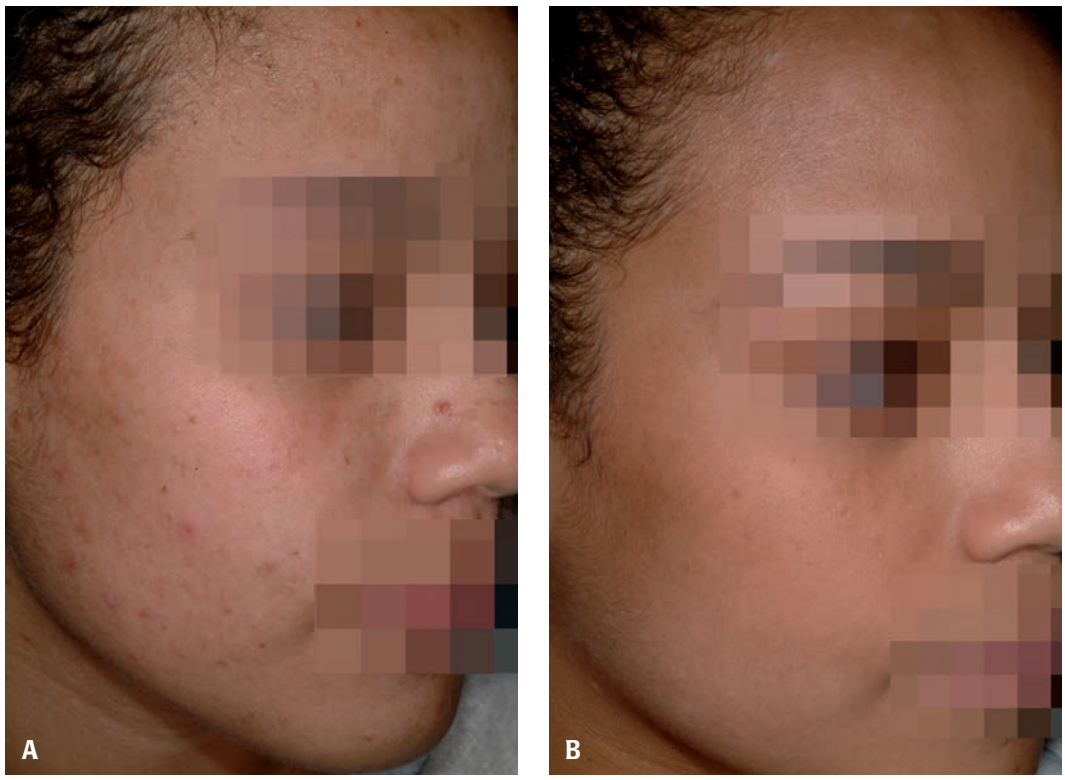

Figure 16-3 African American woman with acne. **A:** Baseline. **B:** After a series of five microdermabrasion treatments at 2-week intervals. (Courtesy of Pearl E. Grimes, MD)

used to treat melasma in conjunction with topical treatments. It probably works by enhancing the penetration of topical agents for melasma (Fig. 16-2A,B). However, Hernandez-Perez and Ibiett found no improvement in melasma in their series of seven patients from El Salvador.[3] Microdermabrasion should be used in conjunction with topical bleaching agents when treating disorders of hyperpigmentation, such as melasma and postinflammatory hyperpigmentation.

Acne

Superficial peeling agents are beneficial in the treatment of acne (Fig. 16-3A,B). The role of microdermabrasion for the treatment of acne was further studied by Lloyd.[5] Twenty-five patients with grade II to III acne had eight microdermabrasion treatments (using the Parisian Peel) at weekly intervals. Three passes were made, with additional passes over areas with comedonal acne. During the treatment, patients continued with their oral antibiotics and topical acne treatments. Twenty-four patients completed the study. Seventy-two percent (17 of 24) had good to excellent results, 17% (4 of 24) had fair results, and only 12% (3 of 24) had poor results. All tolerated the treatment well. The only side effect was erythema, which resolved within 24 hours. It was difficult to ascertain how much of the improvement was contributed by the microdermabrasion treatments or the concomitant acne treatments.

Striae

Microdermabrasion can improve striae by causing an aggressive wounding to the skin. A level-two or a level-three microdermabrasion down to the level of the papillary dermis is required to achieve results. Patients must be warned that such aggressive wounding is often accompanied by a higher risk of pigmentation or prolonged erythema.

Scars

Shallow and depressed scars will respond to microdermabrasion (Fig. 16-3). Multiple passes (often more than 20) and numerous treatments are needed. It must be performed to the level of the superficial papillary dermis, until pinpoint bleeding is achieved, corresponding to microdermabrasion level two. Tsai et al.[6] treated 41 patients of Asian origin with various types of facial scars, mainly acne, burns, varicella, and posttraumatic. They used the Harvey 91 (Mattioli, Italy) microdermabrasion unit with a pressure setting of 76 mm Hg and an average number of 9.1 treatments. All patients had good to excellent results.

SKIN RESPONSE AFTER MICRODERMABRASION

Several studies have been published on the clinical and histopathologic findings after microdermabrasion. Unfor-

tunately, most of these studies are small in numbers. There is a wide range of results from these studies, making direct comparison difficult. This can be explained by the different machines used, the different pressures used, the variability in the number of passes, and the operator-dependent nature of the procedure. However, despite these limitations, the studies show improvement in the clinical response as well as improvement in the epidermal and dermal structures.

Clinical skin response

Most patients have reported improvement in color, appearance, and texture of the skin.[1,2] The skin feels smooth, and there is increased luminescence immediately after the procedure. The skin is perceived to be less oily, with improvements in pore size, fine wrinkling, and skin thickness. Some patients reported significant improvements in skin roughness, mottled pigmentation, and overall skin appearance.

Histopathologic response

Most of the changes were seen in the epidermis. The most significant change is an increase in the thickness of the epidermis. In biopsies taken from facial skin with photodamage before and after a series of five microdermabrasion sessions, Hernandez-Perez and Ibiett[3] showed that the epidermis increased in thickness from as little as 0.01 mm to 0.06 mm in some patients and to 0.1 mm in one patient. In another study, the increase in epidermal thickness can be improved by increasing the number of passes of microdermabrasion. In their study, Freedman et al.[7] showed that after three passes, the epidermal thickness increased from 45+/−6 μm to 62+/−10 μm and to 65+/−7 μm after an additional three passes. Other authors[2,8] were able to show an increase in the epidermal thickness.

Microdermabrasion can achieve a mild to moderate improvement in the polarity of epidermal cells, basal cell liquefaction, horny plugs, and skin atrophy.[3] The stratum corneum resumed a "basket-weave" appearance, there was evidence of basal cell hyperplasia, and the rete pegs were flattened.[1,7,8] More regular distribution of melanosomes and less melanization of the epidermis had been seen.[2]

Histopathologic changes in the dermis have been documented from skin biopsy specimens.[2,7] Freedman et al.[7] showed that there was an increase in the thickness of the papillary dermis, from 81+/−8 μm to 108+/−11 μm after three treatments and increased further to 114+/−9 μm after six treatments. Elastic fibers and collagen fibers were seen in the papillary dermis. The collagen fibers were hyalinized, thicker, more tightly packed, and orientated horizontally after treatments. An increase in the elastic fibers was seen at the junction of the reticular and papillary dermis after three treatments, and an increase was seen in the reticular dermis after six treatments. These new elastic fibers were of normal caliber but were more vertically oriented. After microdermabrasion, dermal inflammation was seen. Blood vessels appeared ecstatic with perivascular infiltrates. Fibroblasts were more conspicuous, larger, and more densely distributed within the dermis, especially around dermal capillaries. Eighty-five percent of these dermal changes appear after the first three microdermabrasion treatments, with a further 15% change after the next three treatments. Collagen remodeling is not seen with conservative microdermabrasion,[2] and too aggressive treatments can result in fibrosis.[2,6]

Other investigators had shown the presence of lymphohistiocytic dermal infiltrates or mononuclear cellular infiltrates.[1,8] The vascular and cellular changes seen in the dermis might be due to the negative pressure[1] or be part of the reparative process of wound healing.[7,8]

Skin barrier response

Microdermabrasion enhances skin hydration and improves epidermal barrier function in a study conducted by Rajan and Grimes.[9] They enrolled eight patients (four men and four women) in a split-face study. Of the patients, three were African American and two were Hispanic. One half of the face was treated with negative-pressure aluminum oxide microdermabrasion, whereas the other was treated with positive-pressure sodium-chloride microdermabrasion. Each patient received three passes. Transepidermal water loss (TEWL), stratum corneum hydration, skin pH, and sebum production were measured at baseline, 24 hours, and 7 days. At 24 hours, TEWL was increased for both sodium chloride and aluminum oxide microdermabrasion, and after 7 days, the TEWL was less than baseline, suggesting improved epidermal barrier function. Stratum corneum hydration increased at 24 hours and remained elevated at 7 days for both sodium chloride and aluminum oxide microdermabrasion. There was no statistically significant difference in the skin response between the sodium chloride and the aluminum oxide groups. There was no significant change in the pH measurements and sebum production over the study period for both groups.

Molecular alterations

After a single microdermabrasion treatment, dermal remodeling or a wound healing cascade sets in. Karimipour et al.[10] showed that microdermabrasion did not alter stratum corneum structure or induce biochemical repair. They treated 49 patients with the Bellamed Microdermabrasion at 15 mm Hg and three passes on the buttock skin. Within an hour of microdermabrasion, both the c-jun component of transcription factor AP-1 and transcription factor NF-kB were seen elevated in the epidermis. This was followed by a 10-fold elevation of IL-1*B* and a fourfold elevation of TNF-*a*. Four hours posttreatment, matrix metalloproteinases (interstitial collagenase, stromelysin-1 and gelatinase-B) were increased and seen in the basal layer of the epidermis and the dermis. These matrix metalloproteinases could improve the skin in one of two ways. It could result in matrix remodeling and new collagen deposition, or it

could remove damaged collagen and allow skin to regain its normal tension.

MICRODERMABRASION COMPARED WITH CHEMICAL PEELS

Both microdermabrasion and superficial chemical peels are popular skin resurfacing procedures. In a study by Alam et al.,[11] ten volunteers had six sessions of paired microdermabrasion and glycolic acid peel treatments on the face. One half of the face was treated with microdermabrasion at a fixed mild setting, and the other half was treated with a 20% glycolic acid peel for 4 minutes. Both treatments were well tolerated, and patients had subjective improvements in the smoothness of the skin, brown spots, and fine wrinkles. The two types of treatments did not differ significantly in terms of efficacy. There was a relative preference for glycolic acid peels, but one must remember that the study sample is small.

The skin barrier function changes after both procedures were similar. Song et al.[12] compared the skin response for glycolic acid peels and microdermabrasion. Glycolic acid peels at 30%, 50%, and 70% were left on for 3 minutes while three passes of microdermabrasion at 530 mm Hg were done on the skin of the forearm.. The TEWL increased significantly 5 hours after the procedures and returned to normal within a day. Although not significant, microdermabrasion resulted in a lower TEWL compared with the glycolic acid peels. The moisture content measured with a corneometer decreased 5 hours after the procedure, and there was no statistical significance observed within each group. The erythema index measured after 5 hours increased with all procedures, with the lowest index after microdermabrasion. The increased erythema index returned to normal within 1 day after microdermabrasion and within 3 days after chemical peels.

ADVANTAGES OF MICRODERMABRASION

Unlike the other superficial skin resurfacing procedures, microdermabrasion is painless and does not require any pretreatment. The procedure is easy to learn and can be safely performed by nonphysicians. There is very little or almost no downtime, and patients can resume their normal activities right after the procedure. A mild posttreatment erythema may be seen, and this disappears quickly. It can be combined with other skin resurfacing procedures or chemical peels[4] and performed on patients who are on oral isotretinoin. The procedure can be safely performed on nonfacial areas like the neck, chest, abdomen, dorsa of hands, and forearms.[3] In darker racial ethnic groups, retinoids can be continued up to 24 to 48 hours before microdermabrasion without increasing the likelihood of complications such as postinflammatory hyperpigmentation.

SIDE EFFECTS AND COMPLICATIONS OF MICRODERMABRASION

Mild erythema and increased sensitivity are common, but these are transient and resolved within a few hours.[1,2] Moderate skin dryness can occur, but this resolves spontaneously.[1] Petechiae or purpura can occur if the vacuum suction pressure is too high, the dwell time too long, or the level of abrasion too deep. These usually resolve within a few days. The induction of petechiae and purpura from microdermabrasion in darker racial ethnic groups may result in postinflammatory hyperpigmentation. Telangiectasia or erythema may worsen after microdermabrasion. Posttreatment hyperpigmentation has been reported and is more likely with aggressive microdermabrasion on patients with higher Fitzpatrick skin types (IV-VI).[6] Posttreatment hypopigmentation or scarring has not been reported.

Ocular complications from the microcrystal leading to eye irritation and corneal trauma may occur. Patients should keep their eyes closed during the procedure, and contact lenses must be removed. There is the risk of transmitting bloody material from patient to patient, as this has been found on the handpiece after performing microdermabrasion on a patient with acne scarring.[13] The operator will therefore have to ensure that cross-contamination does not occur. Herpes simplex infection can be reactivated after microdermabrasion.[14] Prophylaxis with oral antiviral medications must be considered for any patients with a history of herpes simplex infection. An unusual case of a severe urticarial reaction immediately following aluminum oxide microdermabrasion had been reported.[15]

PROBLEMS ASSOCIATED WITH USE OF ALUMINUM OXIDE CRYSTALS

There has been conflicting evidence linking chronic aluminum oxide exposure to respiratory complications. Occupational exposure to aluminum oxide has been linked to interstitial pneumonia, pulmonary fibrosis, decreased lung function tests, and chest radiographic abnormalities.[16–18] However, to date no reports have been published linking microdermabrasion to any respiratory complications. Several reasons have been given for this [(3)]. The crystals used in microdermabrasion are larger (100 µm) compared with those in industrial use (5 µm), and these large crystals are unlikely to be airborne and thus inhaled. Patients with respiratory problems were exposed to other heavy metal dusts over prolonged periods. Aluminum oxide is considered as a "nuisance dust" and is not known to stimulate a biologic response.[19] Even though the risk is negligible, the operator is encouraged to wear a mask when performing microdermabrasion.

Aluminum oxide has been linked with Alzheimer disease and dementia, but a definite causative link has not

been established.[20,21] To overcome the risk from use of aluminum crystals, some machines use other crystals. Unfortunately, crystals like sodium chloride, being hygroscopic, tend to get stuck in the tubings. In Asia, crystal microdermabrasion units are slowly being replaced with noncrystal units that use a diamond-caped handpiece to abrade the skin. This has the advantage in reducing any perceived risks from inhaled crystals or eye injury. It is also more economical, as the handpiece is easily sterilized and reused without having to replace the used crystals.

CONTRAINDICATION TO MICRODERMABRASION

There are very few contraindications to the use of microdermabrasion. Patients with active skin infections, such as impetigo or viral warts, are relative contraindications. The presence of acute skin inflammation, such as pustular acne or acne rosacea, should be discouraged from the treatment until the skin condition has stabilized.

SUMMARY

Microdermabrasion is a safe and effective superficial resurfacing procedure that can improve a variety of skin problems in darker racial ethnic groups. The improvements are seen within the epidermis and dermis. Microdermabrasion is often used in conjunction with other resurfacing procedures to achieve better results. In addition, after superficially abrading the skin, it improves the penetration of adjuvant topical cosmeceuticals.

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17

Superficial Chemical Peels

Pearl E. Grimes, Marta I. Rendon, and Juan Pellerano

The ancient Egyptians were among the first civilizations in recorded history to use chemicals as exfoliating agents for aesthetic purposes. They used alabaster, animal oils, and salt.[1,2] The Greeks and Romans used pumice, myrrh, frankincense, mustard, and sulfur for lightening the skin and improvement of wrinkles. Early reports of chemical peeling in Europe were described by Fox, Hebra, and Unna.[3,4] In 1882, Unna described his experiences using a variety of peeling agents, including resorcinol, phenol, trichloroacetic acid (TCA), and salicylic acid. The experiences of the aforementioned dermatologists pioneered the use of chemical peels in dermatology.

Chemical peeling or chemical exfoliation is a form of skin resurfacing whereby exfoliating chemical agents are applied to the skin surface to induce epidermal and/or dermal injury/destruction. Peeling agents induce controlled wounding of the skin followed by organized repair. The desired outcome of peeling procedures is generation of a new epidermis and dermal collagen remodeling. Dyschromias, photodamage, and rhytides are often improved.

In 1982, Stegman reported the histologic effects of three peeling agents, including TCA, full-strength phenol, Baker's phenol, and dermabrasion on normal and sun-damaged skin of the neck.[5] This study demonstrated that 40% to 60% TCA caused epidermal necrosis, papillary dermal edema, and homogenization to the midreticular dermis 3 days after peeling. Findings were similar in sun-damaged compared with non–sun-damaged skin. Ninety days after peeling, Stegman observed an expanded papillary dermis, which he defined as the *Grenz zone*. The thickness of the Grenz zone increased as the depth of peeling increased. The investigative work of Stegman and others facilitated our understanding of the capacity of medium-depth and deep peeling agents to restore epidermal and dermal order.

Others have assessed the histologic and ultrastructural changes of chemical peeling. Nelson et al.[6] assessed the effects of a combination Jessner's solution and 35% TCA peel. Biopsies were performed at baseline, 2 weeks, and 3 months. Type I collagen increased after peeling. Ultrastructural features of the skin after peeling included markedly decreased epidermal intracytoplasmic vacuoles, decreased elastic fibers, and increased activated fibroblasts. These data further substantiated the effects of chemical peeling agents for improvement of photodamage and rhytides.

Chemical peeling agents are classified as superficial, medium-depth, or deep peels.[7] Superficial peels target the stratum corneum to the papillary dermis (Fig. 17-1). They include glycolic acid, salicylic acid, Jessner's solution, tretinoin, and TCA in concentrations of 10% to 30%. Medium-depth peels penetrate to the upper reticular dermis and include TCA (35%–50%), combination glycolic acid 70%/TCA 35%, Jessner's/TCA 35%, and phenol 88%. Deep chemical peels utilize the Baker-Gordon formula and penetrate to the midreticular dermis. The depth of the chemical peel determines the efficacy, outcome, and safety of the procedure.

INDICATIONS FOR CHEMICAL PEELING IN DARKER SKIN TYPES

Dark skin demonstrates significantly greater intrinsic photoprotection because of the increased content of epidermal melanin (see Chapter 2). Clinical photodamage, actinic keratoses, rhytides, and skin malignancies are less common problems in deeply pigmented skin. However, darker skin types are frequently plagued with dyschromias because of the labile responses of cutaneous melanocytes in deeply pigmented individuals (see Chapter 2). Despite major concerns regarding peel complications such as postinflammatory hyperpigmentation, hypopigmentation, and scarring in darker racial ethnic groups, recent studies suggest that peeling procedures, particularly superficial peeling, can be safely performed in darker skin.

Hence, peel indications differ between light and dark skin (Table 17-1). Key indications in Fitzpatrick's skin types I, II, and III include photodamage, rhytides, acne, scarring, and the dyschromias characterized by hyperpigmentation. In contrast, key indications in darker skin types include disorders of hyperpigmentation, such as melasma and postinflammatory hyperpigmentation, acne, pseudofolliculitis barbae, textural changes, oily skin and wrinkles, and photodamage.

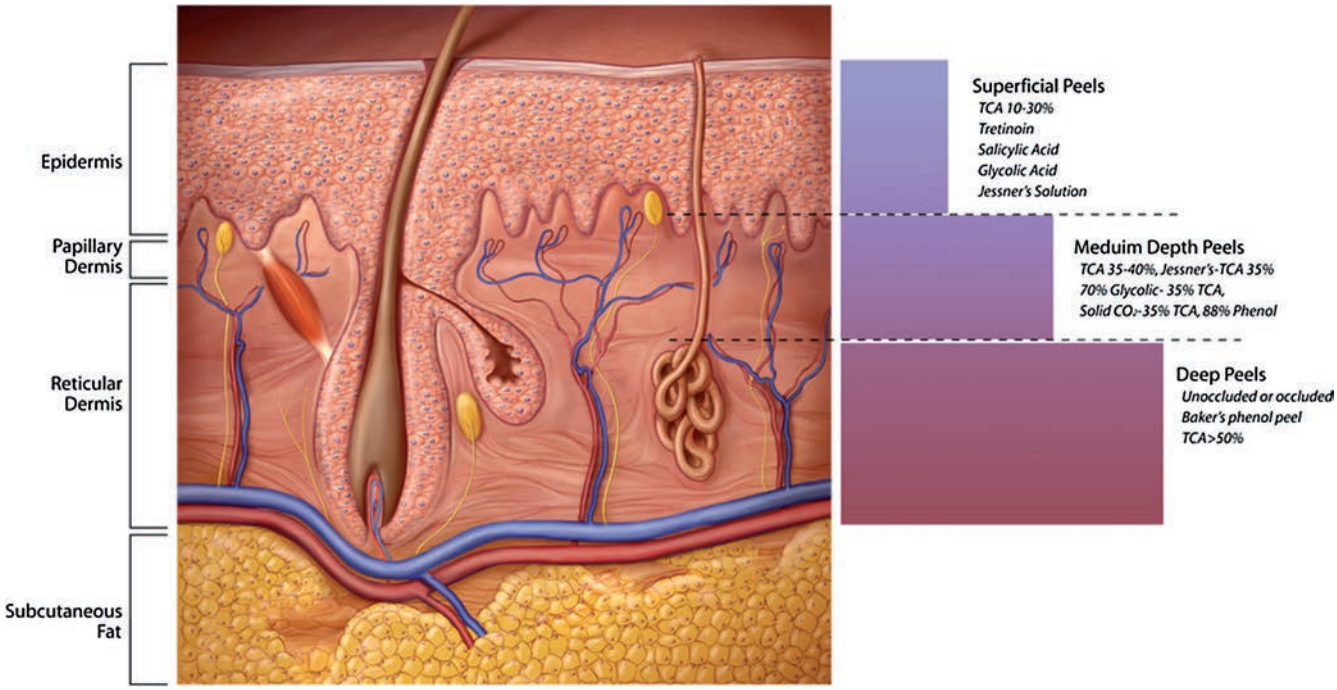


Figure 17-1 Cross section of skin illustrating the depth of wounding caused by chemical peeling agents.

Grimes[8] compared the histologic alterations induced by a variety of chemical peels in 17 patients with skin types IV, V, and VI, including glycolic acid 70%, salicylic acid 30%, Jessner's solution, and 25% and 30% TCA. Peels were applied to 4 × 4–cm areas of the back and 2 × 2–cm postauricular sites. Biopsies were performed at 24 hours (Fig. 17-2A–D). Glycolic acid induced the most significant stratum corneum necrosis. Compared with the other tested peels, salicylic acid and Jessner's peels caused mild lymphohistiocytic dermal infiltrates. The most severe damage was induced by 25% and 30% TCA, which caused deep epidermal necrosis and dense papillary dermal lymphohistiocytic infiltrates. TCA test sites developed postinflammatory hyperpigmentation. These findings corroborate our clinical experience using these agents. In general, glycolic, salicylic acid, and Jessner's peels induce a lower frequency of postpeeling complications compared with 25% and 30% superficial TCA peels.

Table 17-1

Chemical peel indications in skin types I–III versus skin types IV–VI

Skin types I–III	Skin types IV–VI
Fine wrinkles, rhytids	Postinflammatory hyperpigmentation
Solar keratoses	Melasma
Photodamage	Acne vulgaris
Melasma	Oily skin
Postinflammatory hyperpigmentation	Textural changes
Acne vulgaris	Acne scarring
Rosacea	Fine wrinkles
Superficial scarring	

GENERAL CONSIDERATIONS FOR PATIENT PREPARATION

Peel preparation varies with the condition being treated. Regimens differ for photodamage, hyperpigmentation (melasma and postinflammatory hyperpigmentation), acne vulgaris, and other conditions. In addition, there are special issues to be considered when treating darker racial ethnic groups. A detailed history and cutaneous examination should be performed in all patients before chemical peeling. Standardized photographs are taken of the areas to be peeled, including full-face frontal and lateral views.

Use of topical retinoids (tretinoin, tazarotene, retinol formulations) for 2 to 6 weeks before peeling thin the stratum corneum and enhance epidermal turnover. Such agents also reduce the content of epidermal melanin and

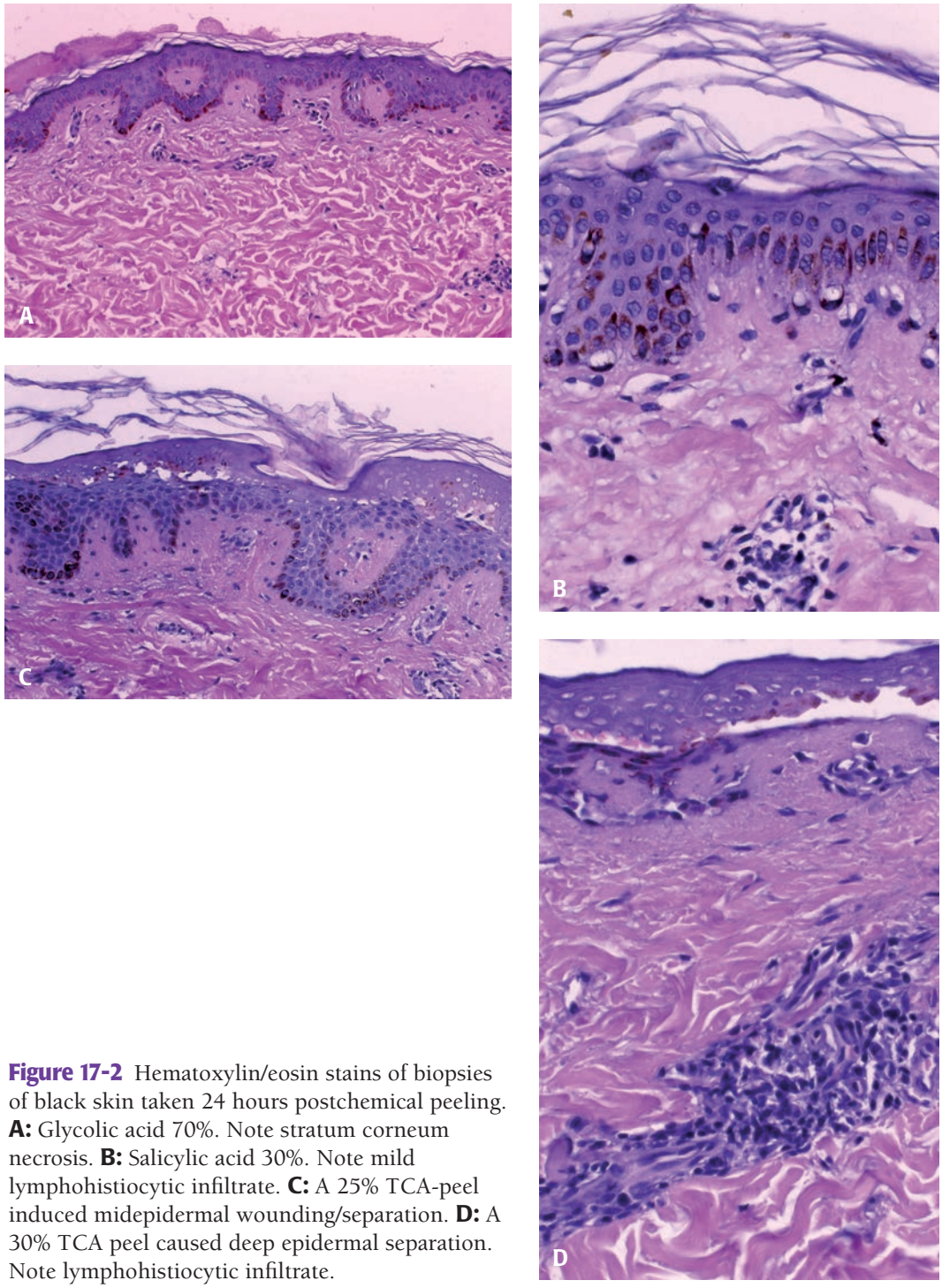


Figure 17-2 Hematoxylin/eosin stains of biopsies of black skin taken 24 hours postchemical peeling. **A:** Glycolic acid 70%. Note stratum corneum necrosis. **B:** Salicylic acid 30%. Note mild lymphohistiocytic infiltrate. **C:** A 25% TCA-peel induced midepidermal wounding/separation. **D:** A 30% TCA peel caused deep epidermal separation. Note lymphohistiocytic infiltrate.

expedite epidermal healing. Retinoids also enhance the penetration and depth of chemical peeling. Optimal effects are demonstrated with these agents when treating photodamage in Fitzpatrick skin types I to III. They can be used until 1 or 2 days before peeling. Retinoids can be resumed postoperatively after all evidence of peeling and desquamation subsides.

In contrast to photodamage, when treating conditions such as melasma and postinflammatory hyperpigmentation, retinoids should either be discontinued 1 or 2 weeks before peeling or completely eliminated from the peeling prep to avoid postpeel complications, such as excessive erythema, desquamation, and postinflammatory hyperpigmentation. These conditions are more common in darker

racial ethnic groups, populations at greater risk for postpeel complications. Similar precautions should be taken in acne patients with darker skin types (V and VI).

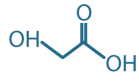
Topical alpha hydroxy acid or polyhydroxy acid formulations can also be used to prep the skin. In general, they are less aggressive agents in affecting peel outcomes. The skin is usually prepped for 2 to 4 weeks with a formulation of hydroquinone 4% or higher compounded formulations (5%–10%) to reduce epidermal melanin. This is extremely important when treating the aforementioned dyschromias. Although less effective, other topical bleaching agents include azelaic acid, kojic acid, arbutin, and licorice. Patients can also resume use of topical bleaching agents postoperatively after peeling, and irritation subsides. Broad-spectrum sunscreens (UVA and UVB) should be worn daily.

A flare of herpes following a superficial chemical peel is rare. Hence, pretreatment with antiviral therapy is usually not indicated. However, one can prophylactically treat with antiviral therapies including valacyclovir 500 mg twice a day, famciclovir 500 mg twice a day, or acyclovir 400 mg twice a day for 7 to 10 days beginning 1 or 2 days before the procedure.

GLYCOLIC ACID PEELS

Alpha hydroxy acid (AHA) peels have been shown to improve the skin surface by thinning the stratum corneum, promoting epidermolysis, dispersing basal layer melanin, and increasing collagen synthesis within the dermis[9] (Fig. 17-3). The most common AHAs used as peeling agents are glycolic acid, lactic acid, mandelic acid, and, recently, pyruvic acid. Glycolic acid peels decrease hyperpigmentation through a wounding and re-epithelization process. Glycolic acid is the best-known superficial peeling agent, having been used in clinical practice since the 1800s. It is part of the family of alpha hydroxy acids, which occur naturally in foods. Glycolic acid is used in strengths ranging from 20% to 70% to treat a variety of defects of the epidermis and papillary dermis on almost any area of the body.

Moy et al.[10] assessed the efficacy of several commonly used peeling agents, including glycolic acid in a mini pig model. The chemical peels were applied in different concentrations to 2 cm × 2 cm patches and left on the skin for 15 minutes. The following concentrations were used: phenol-Bakers, 25%, 50%, 75%, and 88%; TCA, 25%, 50%, 75%; glycolic acid, 50%, 70%; and pyruvic acid, 50%, 100%. Biopsies were taken from each site at 1, 7, and 21 days postpeel and evaluated for epidermal changes, inflammation, and collagen deposition. The Baker phenol peel caused the most inflammation and nonspecific reaction but also a large amount of new collagen deposition. At 1 day postpeel, larger concentrations of phenol and TCA caused the most epidermal sloughing and inflammation. The extent of the reaction was directly proportional to collagen deposition at 21 days.[10] Although the authors concluded that glycolic acid and pyruvic acid caused the least nonspecific reaction, they found the resulting collagen deposition to be disproportionately large. These findings suggest a direct stimulatory effect by the two acids on collagen production.



Glycolic acid

Figure 17-3 Chemical structure of glycolic acid.

Another study assessed the damage and recovery of skin barrier function after glycolic acid chemical peeling and crystal microdermabrasion.[9] Noninvasive bioengineering methods were used in the study. Superficial chemical peeling was conducted with 30%, 50%, and 70% glycolic acid and aluminum oxide crystal microdermabrasion on the forearms of 13 women. Skin response was measured by visual observation and use of an evaporimeter, corneometer, and colorimeter at set intervals before and after peeling. Results of this study suggest that the skin barrier function is damaged by glycolic acid peeling and aluminum oxide crystal microdermabrasion but recovers within 1 to 4 days. Therefore, repeating the superficial peeling procedure at 2-week intervals will allow sufficient time for the damaged skin to recover its barrier function.

Glycolic acid formulations

Glycolic acid peeling agents include buffered, partially neutralized, and esterified formulations. Generally, peeling strengths range from 20% to 70%. The efficacy of glycolic peels can depend on the pH, strength, and time of application. Unbuffered formulations with low pH have the potential to induce greater epidermal and dermal damage.

Indications

Glycolic peels can be used on all body areas and Fitzpatrick skin types. The main symptoms of skin types IV to VI are dyschromias, including melasma and post-inflammatory hyperpigmentation from acne or burns. Other indications are photodamage, rosacea, and pseudofolliculitis barbae.[11,12]

Several studies were conducted to evaluate whether a series of glycolic acid peels would provide improvement in dark-skinned patients when combined with topical regimens, such as hydroquinone, tretinoin, or topical steroids.

Sarkar et al.[13] assessed the efficacy of a series of glycolic acid peels when combined with a topical bleaching agent compared with use of the bleaching formula alone in a series of dark-skinned patients with melasma. The authors compared the efficacy of serial glycolic acid peeling with a series three 30% glycolic peels and three 40% peels in combination with the modified Kligman bleaching formulation (hydroquinone 5%, hydrocortisone acetate 1%, and tretinoin 0.05%) and with the bleaching formula alone. Forty women were included in each group.

Both groups showed a statistically significant improvement in the Melasma Area Severity Index (MASI) score at 21 weeks. However, maximal improvement occurred in the group treated with the series of glycolic acid peels in combination with the topical bleaching regimen.

An 8-week, split-face study of 21 Hispanic women with bilateral epidermal and mixed melasma found no significant difference between combination therapy using glycolic acid peels plus a topical regimen of hydroquinone compared with hydroquinone alone.[14] Patients underwent a glycolic acid peel every 2 weeks plus topical hydroquinone 4% twice daily. Only hydroquinone 4% was applied daily to the opposite side of the face. Both groups showed significant reduction in skin pigmentation compared with baseline. Unfortunately, these two studies used different measurement devices, product concentrations, and frequency of peels. This might explain the differences in results. In our experience, we have noted that the addition of glycolic acid peels to any hyperpigmentation regimen usually accelerates the rate of improvement as well as improves the tone, texture, and color of the skin (Fig. 17-4A,B and Fig. 17-5A,B).

A series of 10 Asian women with melasma and fine wrinkles were treated with 2% hydroquinone and 10% glycolic acid applied to both sides of the face.[15] A series of 20% to 70% glycolic peels were performed on one side for comparison. Greater improvement with minimal side effects were noted on the side treated with glycolic acid peels. In another study, 40 Asian patients with moderate to moderately severe acne were treated with a series of 35% to 70% glycolic acid peels.[16] The investigators noted significant improvement in skin texture and acne. Side effects were reported in 5.6% of patients.

Nineteen black patients with postinflammatory hyperpigmentation were treated with glycolic acid peeling.[17] The control group was treated with 2% hydroquinone/10% glycolic acid twice a day and tretinoin 0.05% at bedtime, whereas the active peel group received the same topical regimen plus a series of six serial glycolic acid peels. Although not statistically significant, greater improvement was noted in the chemical peel group.

The safety and efficacy of a series of glycolic acid facial peels were investigated in 25 Indian women with melasma.[18] Patients were treated with 50% glycolic acid peels monthly for 3 months. Improvement was noted in 91% of patients with maximal clearing occurring in patients classified with epidermal melasma. Side effects were observed in one patient who developed brow hyperpigmentation.

In patients with photodamage, AHA peels and topical products may be combined with retinoids and other antioxidants for maximum benefit. The synergistic effects of fluorouracil and glycolic acid have been observed in the treatment of actinic keratoses. For patients with melasma, AHA peels and combination products containing bleaching agents such as hydroquinone, kojic acid, and glycolic

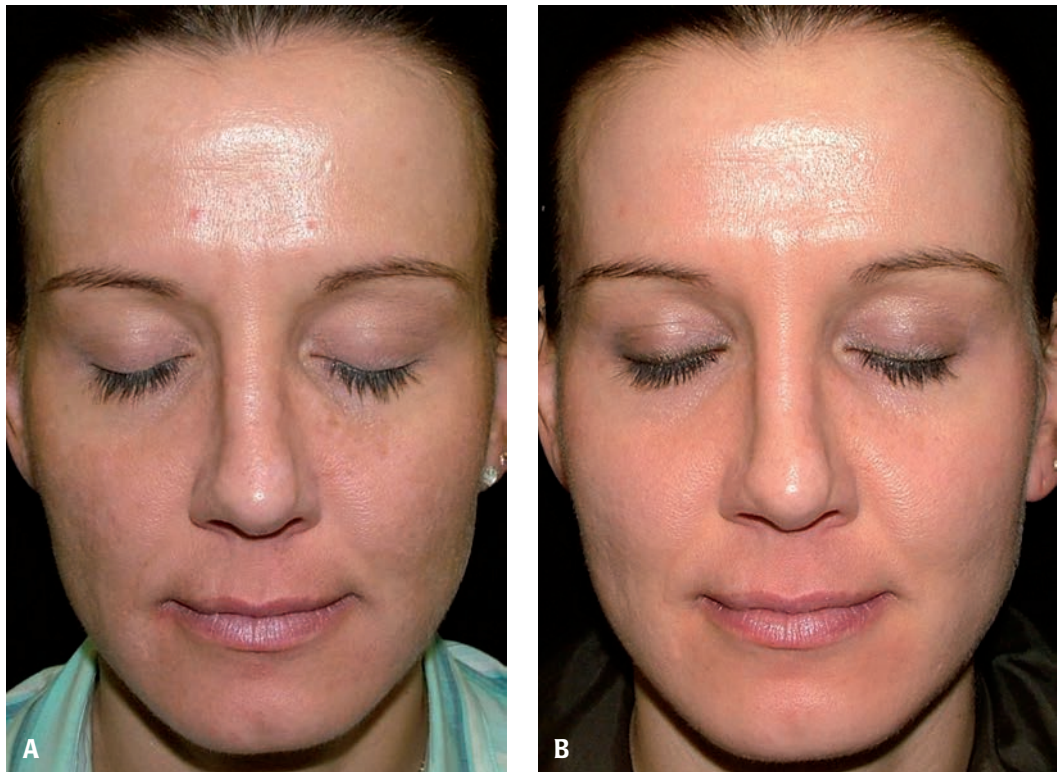


Figure 17-4 Patient with melasma treated with triple combination bleaching agent (Tri-Luma) and a series of glycolic acid peels. **A:** Before. **B:** After.

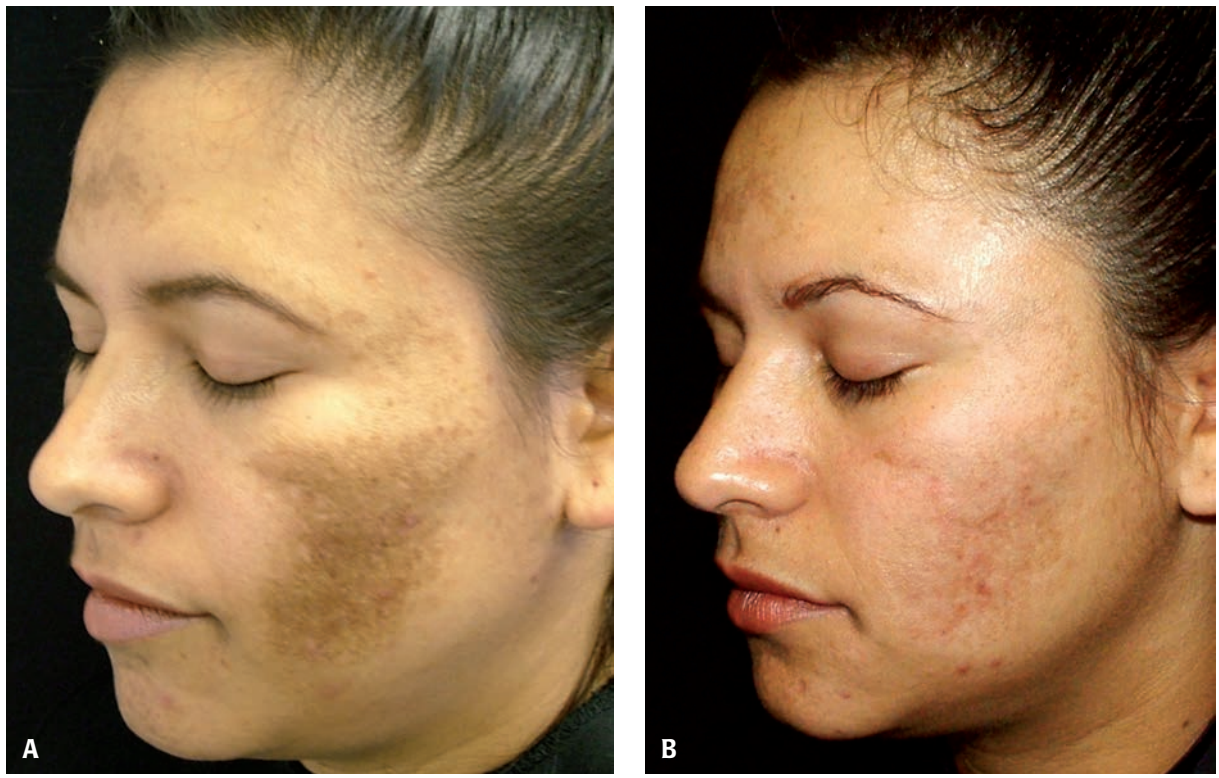


Figure 17-5 Patient with melasma and postinflammatory hyperpigmentation caused by acne. Treated with glycolic acid peeling and triple combination bleaching agent (Tri-Luma). **A:** Before. **B:** After.

acid have increased efficacy. Dark-skinned patients with acne, mild acne scarring, rosacea, and rhytids can obtain results with antibacterial agents and topical retinoids supplemented with AHA peels and lotions.[19]

Contraindications

Absolute contraindications to peels include history of allergy to the peeling solution, neutralizing agent, diluting agent, or any of their components. Relative contraindications can include photosensitization potentially caused from medications or supplements, prior cosmetic surgery, extensive exposure to sun, smoking, poor general physical or mental health, unrealistic expectations, and history of herpetic lesions. There are hypotheses both supporting and contraindicating their use in pregnant women, but evidence is lacking.

Peeling technique

There are general rules that should be followed when applying glycolic acid peels. The area can be cleansed with 70% isopropyl alcohol or acetone using cotton balls, 2 inch × 2 inch gauze, or sponges. The orbicular angles, nasolabial folds, and lips should be protected with white petrolatum. The eyes should be covered with moistened gauze. If working on the eyelids, tetracycline ointment should be applied at the lid margin to protect the eyes. The peeling agent can be applied with cotton balls, sable brush, or 3 inch × 3 inch gauze. The response of the skin should be monitored visually while remaining alert to mild discomfort, burning, and temporary mild darkening of the skin, which are common during the procedure. Skin contact with glycolic acid should take place for 2 to 6 minutes. Glycolic acid peels are neutralized with 10% sodium bicarbonate solution.

Complications

In general, glycolic acid peels are tolerated well in darker racial ethnic groups. However, hyperpigmentation, hypopigmentation, and scarring can indeed occur with aggressive use of glycolic peeling formulations.[11,19] Side effects can be minimized when concentrations are gradually titrated from the lower concentrations of 20% to 35% to full strength 70% glycolic acid (Fig. 17-6).

SALICYLIC ACID

Salicylic acid (ortho-hydroxybenzoic acid) is a beta hydroxy acid agent (Fig. 17-7). It is a lipophilic compound that removes intercellular lipids that are covalently linked to the cornified envelope surrounding cornified epithelioid cells.[20] Because of its antihyperplastic effects on the epidermis, multiple investigators have used salicylic acid as a peeling agent.[21–23] Recently, histologic assessments using salicylic acid peels in hairless mice reported loss of cornified cells followed by activation of epidermal basal cells and underlying fibroblasts. These findings suggest that salicylic

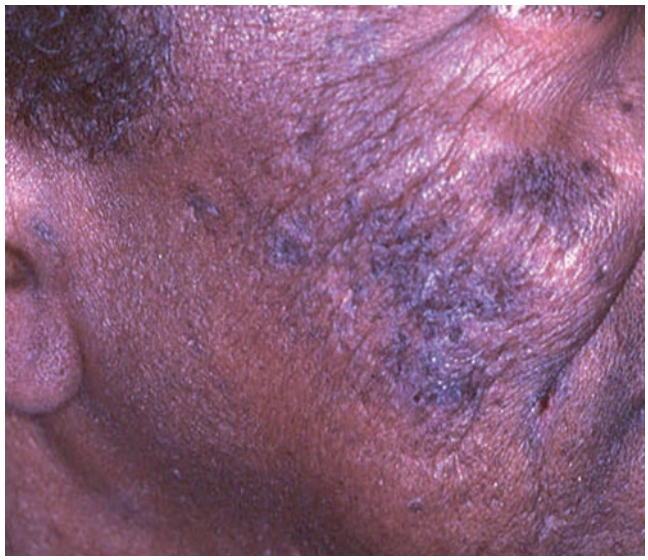


Figure 17-6 Transient hyperpigmentation following a glycolic acid 30% chemical peel in an individual with skin type V.

acid peeling can alter the underlying dermal tissue without directly wounding the tissue or causing inflammation.[24] Salicylic acid has also been shown to have anti-inflammatory and antimicrobial properties.

Formulations

A variety of formulations of salicylic acid have been used as peeling agents. These include 50% ointment formulations[21,22] as well as 10%, 20%, and 30% ethanol formulations.[23,25] More recently, commercial formulations of salicylic acid have become available (BioGlan Pharmaceuticals company, Malvern, PA; Bionet Esthetics, Little Rock, AR).

Indications

The efficacy of salicylic acid peeling has been assessed in several studies. Fifty percent salicylic acid ointment peeling was first used by Aronsohn to treat 81 patients who had freckles, pigmentation, and aging changes of the hands.[22] He reported excellent results. Subsequently, Swinehart[21] successfully used a methyl-salicylate buffered, croton oil-containing, 50% salicylic acid ointment paste for treatment of lentigines, pigmented keratoses, and actinically damaged skin of the dorsal hands and forearms. After pretreatment with topical tretinoin and localized TCA 20%, the 50% salicylic acid paste was applied to the affected area and occluded for 48 hours. Following dressing removal, peeling and desquamation occurred and was relatively complete by the tenth day. Overall results were described as excellent. Despite these results, salicylic acid peeling did not move into the arena of popular peeling techniques until the mid-1990s when Kligman and Kligman[23] ushered salicylic acid into the current arena of superficial peeling agents. They treated 50 women with mild to moderate photodamage, reporting improvement in pigmented lesions, surface roughness, and reduction in fine lines. Grimes[26] reported substantial efficacy and minimal side effects in 25 patients treated with 20% and 30% salicylic acid peels in darker racial ethnic groups. Conditions treated included acne vulgaris, melasma, and post-inflammatory hyperpigmentation. Thirty-five Korean patients with facial acne were treated biweekly for 12 weeks with 30% salicylic acid peels.[27] Both inflammatory and noninflammatory lesions were significantly improved. In general, the peel was well tolerated with few side effects.

Given these findings, some of the indications for salicylic acid peels include acne vulgaris (inflammatory and noninflammatory lesions), acne rosacea, melasma, postinflammatory hyperpigmentation, freckles, lentigines, mild to moderate photodamage, and texturally rough skin.

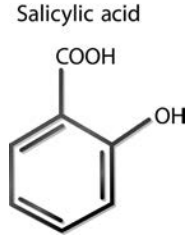


Figure 17-7 Chemical structure of salicylic acid.

Contraindications

In general, there are few contraindications to salicylic acid chemical peeling. Salicylic acid peels are well tolerated in all skin types (Fitzpatrick's I through VI) and all racial ethnic groups. General contraindications include salicylate hypersensitivity/allergy; unrealistic patient expectations; active inflammation/dermatitis or infection at the salicylic acid peeling site; acute viral infection; pregnancy; and isotretinoin therapy within 3 to 6 months of the peeling procedure. One of the authors (Grimes) has performed more than 1,000 salicylic acid peels without observing any evidence of salicylate allergy/hypersensitivity afterward.

Peeling technique

Despite some general predictable outcomes, even superficial chemical peeling procedures can cause hyperpigmentation and undesired results. Popular standard salicylic acid peeling techniques involve the use of 20% and 30% salicylic acid in an ethanol formulation. Salicylic acid peels are performed at 2- to 4-week intervals. Maximal results are achieved with a series of three to six peels.

The initial peel is always performed with a 20% concentration to assess the patient's sensitivity and reactivity. A standard peel tray setup includes a fan, alcohol or acetone for prepping, a spray bottle for water, gauze sponges, cotton-tipped swabs, a soapless cleanser, a bland moisturizer, and a timer. Before treatment, the face is thoroughly cleansed with alcohol and/or acetone to remove oils. The peel is then applied with wedge sponges, 2 inch × 2 inch

gauge sponges, or cotton-tipped applicators. Cotton-tipped swabs can also be used to apply the peeling agent to periorbital areas. A total of two to three coats of salicylic acid is usually applied. The acid is first applied to the medial cheeks working laterally, followed by application to the perioral area, chin, and forehead. The peel is left on for 3 to 5 minutes. Most patients experience some mild burning and stinging during the procedure. After 1 to 3 minutes, some patients experience mild peel-related anesthesia of the face. Portable handheld fans substantially mitigate the sensation of burning and stinging.

A white precipitate, representing crystallization of the salicylic acid, begins to form at 30 seconds to 1 minute following peel application (Fig. 17-8A–E). This should not be confused with frosting or whitening of the skin, which represents protein agglutination. Frosting usually indicates that the patient will observe some crusting and peeling following the procedure. This may be appropriate when treating photodamage. However, it is best to have minimal to no frosting when treating other conditions. After 3 to 5 minutes, the face is thoroughly rinsed with tap water, and a bland cleanser, such as Cetaphil, is used to remove any residual salicylic acid precipitate. A bland moisturizer is applied after rinsing. Efficacious bland moisturizers include Cetaphil, Purpose, Theraplex, and SBR Lipocream (Fig. 17-9A,B, Fig. 17-10A,B, and Fig. 17-11A,B).

Bland cleansers and moisturizers are continued for 48 hours or until all postpeel irritation subsides. Patients are then able to resume the use of their topical skin care regimen, including topical bleaching agents, acne medications, and/or retinoids. Postpeel adverse reactions, such as excessive desquamation and irritation, are treated with low- to high-potency topical steroids. Topical steroids are extremely effective in resolving postpeel inflammation and mitigating the complication of postinflammatory hyperpigmentation. Any residual postinflammatory hyperpigmentation usually resolves with use of topical hydroquinone formulations following salicylic acid peeling.

Side effects

Side effects of salicylic acid peeling are mild and transient (Fig. 17-12). In a series of 35 Korean patients, 8.8% had prolonged erythema that lasted more than 2 days.[27] Dryness occurred in 32.3%, responding to frequent applications of moisturizers. Intense exfoliation occurred in 17.6%, clearing in 7 to 10 days. Crusting was noted in 11.7%. There were no cases of persistent postinflammatory hyperpigmentation or scarring. In a series of 25 patients comprising 20 African Americans and 5 Hispanics, 16% experienced mild side effects.[26] One patient experienced temporary crusting and hypopigmentation that cleared in 7 days. Three patients had transient dryness and hyperpigmentation that resolved in 7 to 14 days.

Salicylism, or salicylic acid toxicity, is characterized by rapid breathing, tinnitus, hearing loss, dizziness, abdominal cramps, and central nervous system reactions. It has been reported with 20% salicylic acid applied to 50% of the body surface, and it has also been reported with use of 40% and 50% salicylic acid paste preparations.[28] One of the authors (Grimes) has peeled more than 1,000 patients with the current 20% and 30% marketed ethanol formulations and has observed no cases of salicylism.

Advantages and disadvantages

Salicylic acid is one of the best peeling agents for patients who have skin types IV to VI in that it is efficacious with minimal complications. It is an excellent peeling agent in patients with acne vulgaris. Given the appearance of the white precipitate, uniformity of application is easily achieved. After several minutes, the peel can induce an anesthetic effect, increasing patient tolerance. However, the agent has a limited depth of peeling and minimal efficacy in patients with significant photodamage.

JESSNER'S PEEL

Jessner's solution has been used for more than 100 years as a therapeutic agent to treat hyperkeratotic epidermal lesions.[29] This superficial peeling agent constitutes a mixture of salicylic acid, resorcinol, and lactic acid in 95% ethanol (Fig. 17-13). Jessner's solution causes loss of corneocyte cohesion and induces intercellular and intracellular edema. Jessner's typically induces wounding to the level of the papillary dermis. Historically, resorcinol (a key component of Jessner's peels) was used in concentrations of 10% to 50% in the early 20th century. High concentrations of resorcinol were associated with side effects such as allergic contact dermatitis, irritant contact dermatitis, and skin discoloration. Subsequently, Jessner's solution was formulated by Dr. Max Jessner to lower the concentrations of any one agent contained in the mixture and to enhance its overall effects as a keratolytic agent.

Each component of Jessner's solution has specific effects. Salicylic acid (orthohydroxy benzoic acid) is a beta-hydroxy acid agent.[30] It is a lipophilic compound that removes intercellular lipids that are covalently linked to the cornified envelope surrounding epithelial cells.[20] It also enhances penetration of other agents. Resorcinol (m-dihydroxy benzene) is structurally and chemically similar to phenol. It disrupts the weak hydrogen bonds of keratin.[31] Lactic acid is an alpha hydroxy acid that causes corneocyte detachment and subsequent desquamation of the stratum corneum.[32] It has been used to treat acne, melasma, postinflammatory hyperpigmentation, lentigines, freckles, and photodamage.

Formulations

The standard formulation of Jessner's solution contains resorcinol (14 g), salicylic acid (14g), and lactic acid (85%, 14 g) mixed in a sufficient quantity of ethanol to make 100 mL. Solutions are also available that do not contain resorcinol (Delasco, Council Bluffs, IA). Modified Jessner's

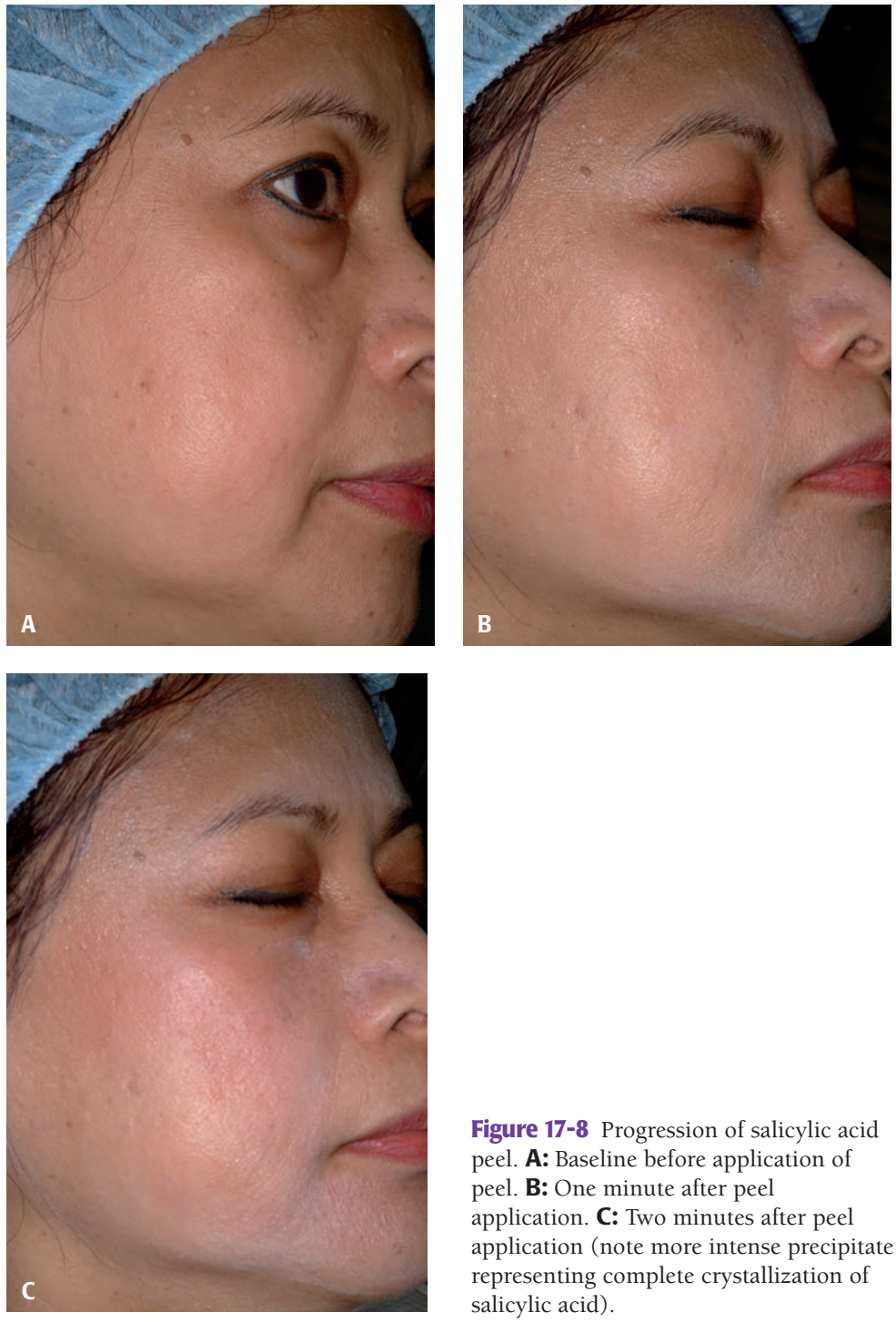


Figure 17-8 Progression of salicylic acid peel. **A:** Baseline before application of peel. **B:** One minute after peel application. **C:** Two minutes after peel application (note more intense precipitate representing complete crystallization of salicylic acid).

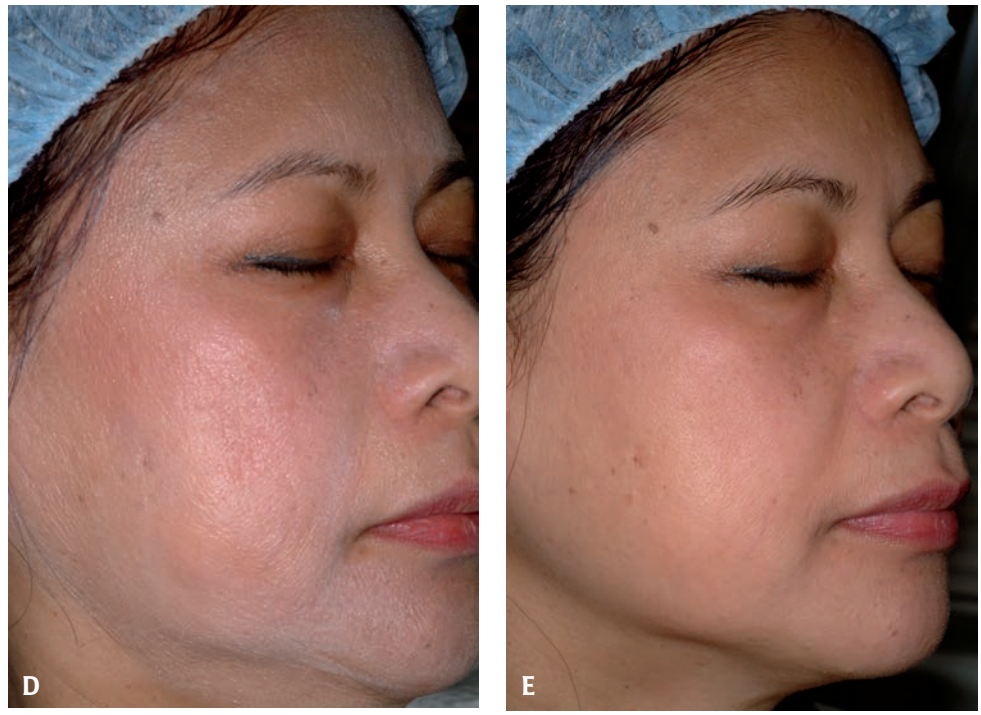


Figure 17-8 (*Continued*) **D:** Complete crystallization of salicylic acid precipitate achieved 4 minutes after peel application. **E:** Postpeel after salicylic acid precipitate removed.

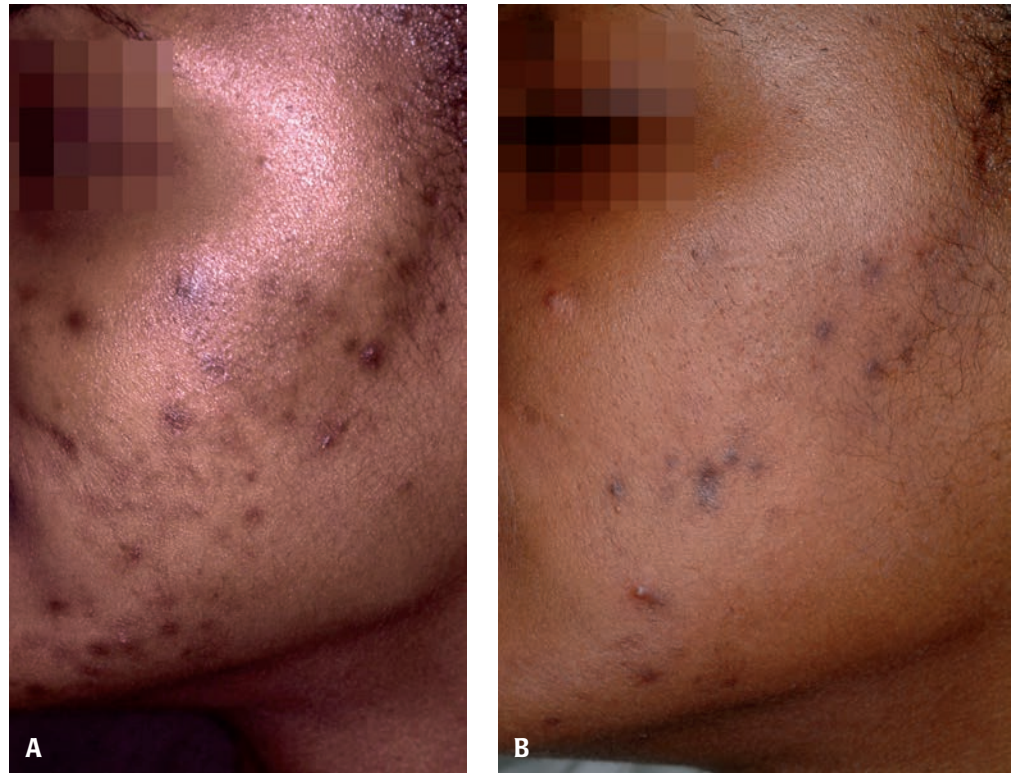


Figure 17-9 Before and after series of five salicylic acid peels for postinflammatory hyperpigmentation. **A:** Baseline. **B:** After.

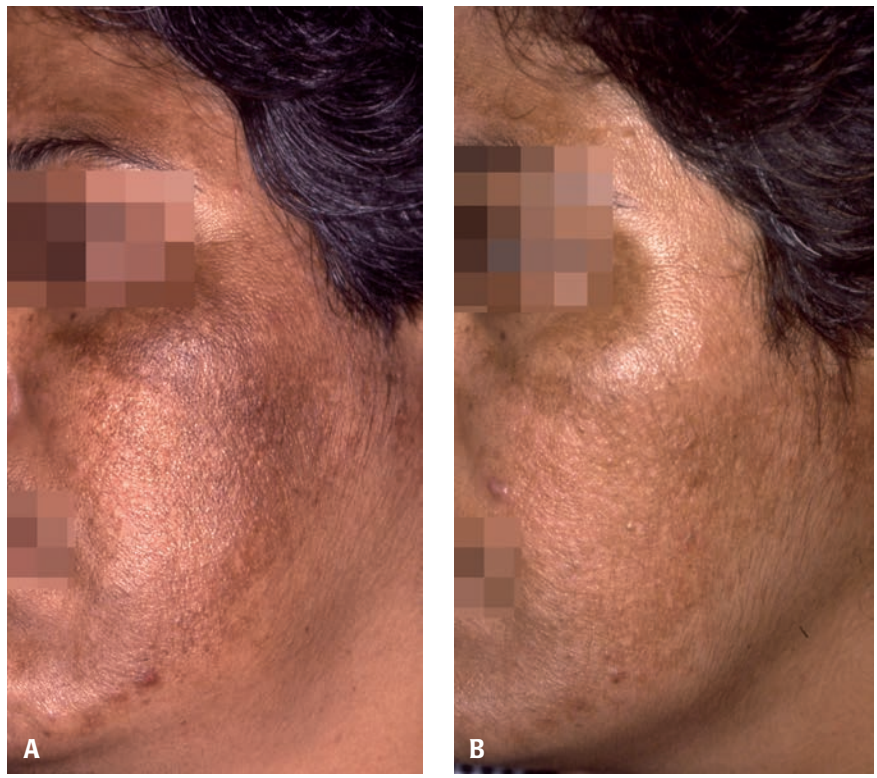


Figure 17-10 Before and after series of five salicylic acid peels for treatment of melasma. **A:** Baseline. **B:** After.

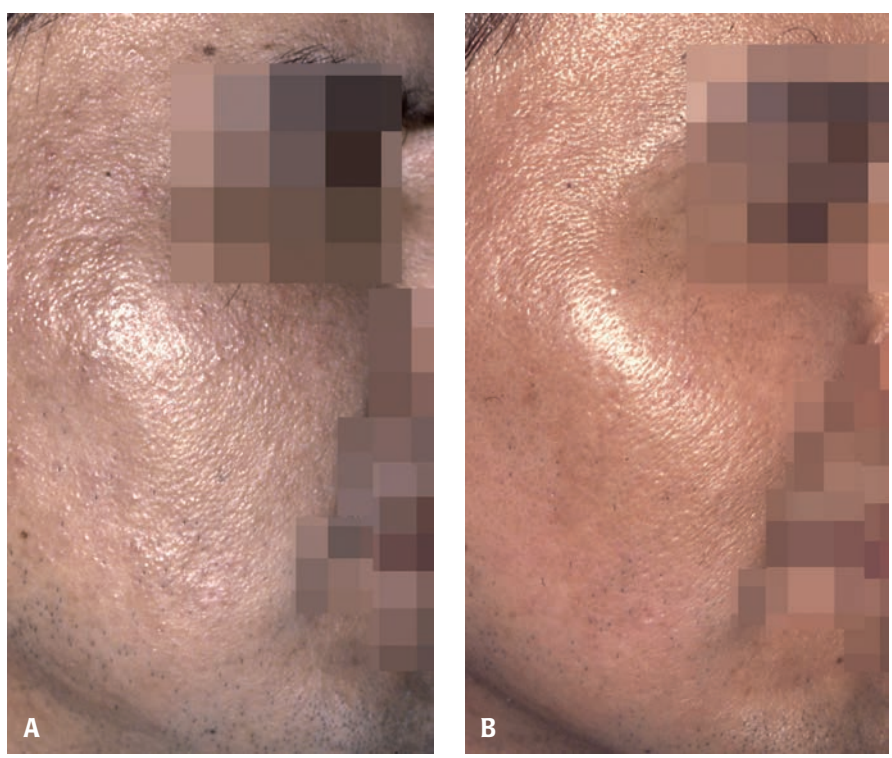


Figure 17-11 Before and after series of five salicylic acid peels for textural changes in oily skin. **A:** Baseline. **B:** After.

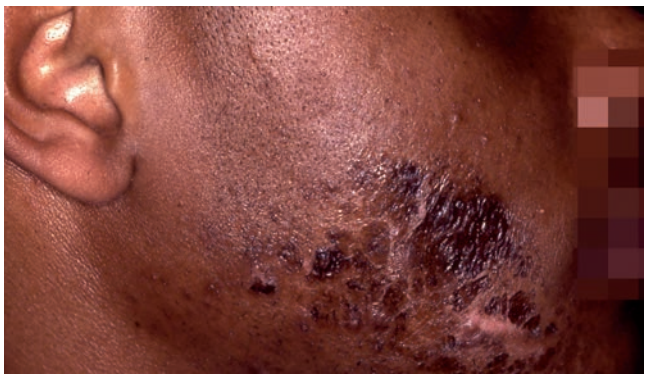


Figure 17-12 Transient crusting and hypopigmentation occurring after a 20% salicylic acid peel which cleared in less than 7 days.

solution contains 17% lactic acid, 17% salicylic acid, and 8% citric acid mixed in a sufficient quantity of ethanol to make 100 mL. Solutions are also available that do not contain resorcinol (Delasco, Council Bluffs, IA).

Contraindications

As with other superficial peeling agents, Jessner's peels are well tolerated in Fitzpatrick's skin types IV to VI with few contraindications. However, there is scant published information on the use of Jessner's peels in these groups. General contraindications include active inflammation, dermatitis, or infection of the area to be treated, isotretinoin therapy within 6 months of peeling, and delayed or abnormal wound healing. Jessner's peels are also contraindicated during pregnancy. Allergy to resorcinol, salicylic acid, or lactic acid are absolute contraindications. Patients should not have unrealistic expectations regarding peel outcomes.

Peeling technique

The skin is usually degreased with alcohol followed by a mild acetone scrub. After cleaning, Jessner's solution is applied to the face with a sable brush, cotton-tipped applicators, cotton balls, or 2 inch × 2 inch gauze sponges. One of the authors (Grimes) prefers the use of cotton-tipped applicators. Typically, the cheeks are treated first, working from medial to lateral areas, followed by application to the chin and forehead area. For superficial peeling, two coats are usually applied. Additional coats increase the depth of peeling.

Neutralization or dilution with Jessner's solution is not indicated. After application of product, some visible precipitate may appear on the skin surface. This should be distinguished from true frosting, which correlates with the depth of peeling. Extent of erythema and desquamation following a Jessner's peel correlates with extent of and type of prepeel prepping, number of coats of product applied, and level or degree of frosting during the procedure (Fig. 17-14A,B).[33] Postpeel care is the same as salicylic acid.

Side effects

Despite concerns regarding resorcinol and salicylate toxicity, Jessner's solution has been extremely well tolerated with minimal side effects. Allergic reactions to resorcinol are reported to be rare.[34,35] Although the potential to induce thyroid disease has been reported, a recent toxicological review on the risk of resorcinol in inducing thyroid abnormalities did not support an association. Resorcinol administered at high doses to rodents can disrupt thyroid hormone synthesis and can produce goitrogenic effects.[34] Clinical case reports from patients undergoing resorcinol therapy for dermatological indications reveal thyroid side effects in instances in which copious amounts of resorcinol-containing ointments are applied to integrity-compromised skin for months to years. However, a risk assessment comparing potential worst-case exposures to resorcinol through its use in dermatological preparations supports the conclusion that under real-life conditions, human exposures to resorcinol are not expected to cause adverse effects on thyroid function. In addition, we are aware of no case reports of salicylism from Jessner's formulation. Resorcinol has also been implicated in the induction of exogenous ochronosis in Africa. However, resorcinol has not been implicated in the rare cases of ochronosis in the United States.[36]

Advantages and disadvantages

Jessner's solution has an excellent safety profile and can be used in all skin types. It has substantial efficacy with minimal "downtime" and enhances the penetration of TCA. However, there are concerns regarding resorcinol toxicity, including thyroid dysfunction. In addition, there are manufacturing variations. There may be some instability with exposure to light and air. Some darker-skinned patients experience increased exfoliation with Jessner's peeling.

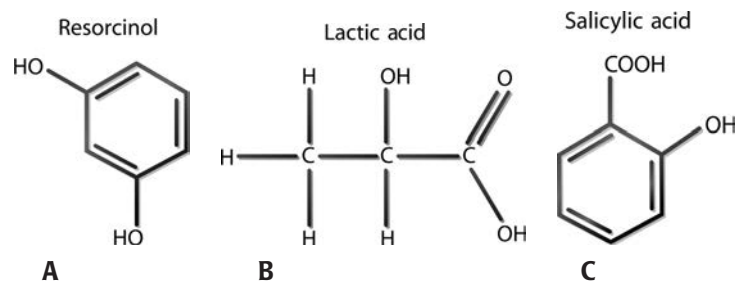


Figure 17-13 Chemical structure of Jessner's peel.

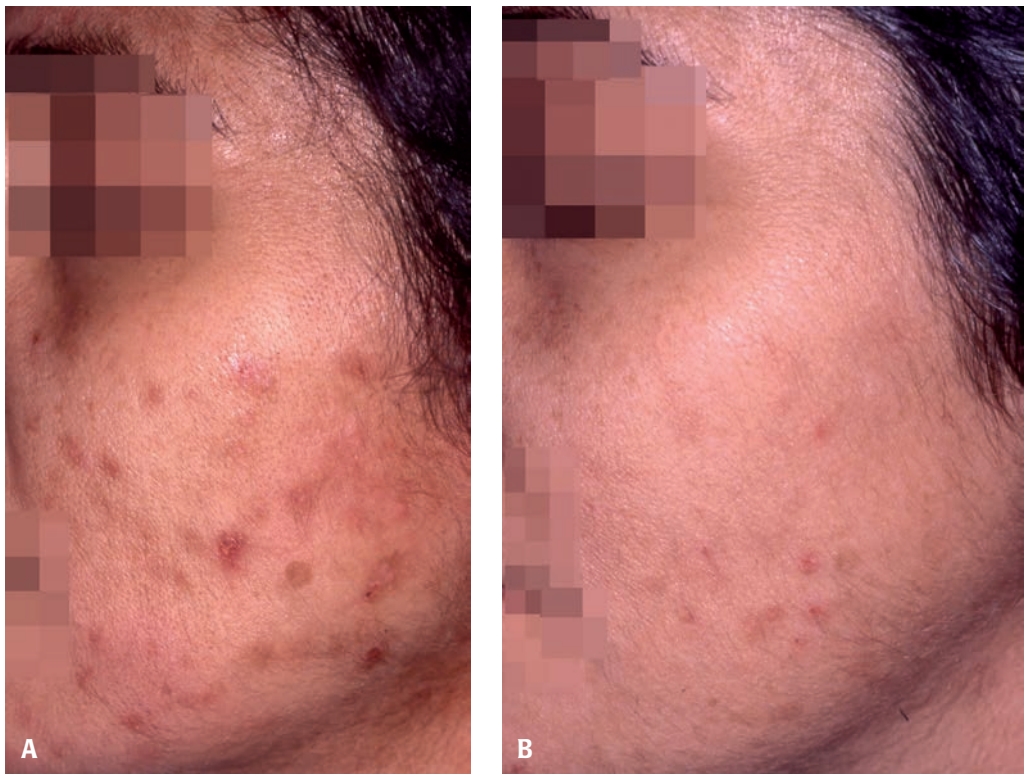


Figure 17-14 Jessner's peel for postinflammatory hyperpigmentation. **A:** Baseline. **B:** After three peels.

TRICHLOROACETIC ACID PEELING

TCA peels have long been considered the gold standard by which the efficacy of other peels are measured. Superficial peeling is usually accomplished with concentrations of 10% to 35%. TCA precipitates epidermal proteins, causing sloughing and necrosis of the treated areas in a concentration-dependent manner. Although TCA may be safely used in darker skin, there is a smaller margin of safety compared with glycolic acid and salicylic acid or Jessner's peels. The incidence of TCA-induced hyperpigmentation is significantly more common in deeply pigmented skin (skin types V and VI) and may best be left for use in patients in whom severe pigmentation and wrinkles are a major issue of cosmetic concern (see Chapter 18). TCA can be used in combination with salicylic acid as a superficial peeling agent.

COMBINATION TRICHLOROACETIC ACID/SALICYLIC ACID PEELING

Indications

Despite the benefits of superficial peeling agents, such as glycolic acid or salicylic acid, it is not uncommon to observe treatment failures. Some patients may require a more aggressive peeling regimen while minimizing the risk of side effects, such as hyperpigmentation or hypopigmentation. While TCA remains the gold standard of peeling agents, it is maximally efficacious in Fitzpatrick's skin types I through III.[37] In darker skin types, even TCA 15% or 20% can be fraught with postpeel complications. One of the authors (Grimes) utilizes a combination of salicylic acid 20% and 30% and low-strength TCA. This combination peeling produces additional efficacy compared with salicylic acid peels or TCA 10% peels while minimizing complications reported with higher concentrations of TCA or glycolic acid, particularly in darker racial ethnic groups (Fig. 17-15A,B and Fig. 17-16A,B).

The combination of salicylic acid and TCA 15% is also an effective treatment for mild to moderate photodamage, acne, and melasma in types I through III. Moderate to excellent improvement has been observed. Hence, the combination salicylic acid/TCA peeling protocol can be used in all skin types.

Contraindications

There are few contraindications to combination salicylic acid/TCA peeling. The combination regimen is tolerated in all skin types and all racial ethnic groups. General contraindications include salicylate hypersensitivity, unrealistic patient expectations, active inflammation/dermatitis of the site to be peeled, acute viral infection, pregnancy, isotretinoin therapy within 6 months of peeling, or history of poor or delayed wound healing.

Peeling technique

After thorough cleansing of the face with alcohol and acetone, two or three coats of salicylic acid (20% or 30%) are

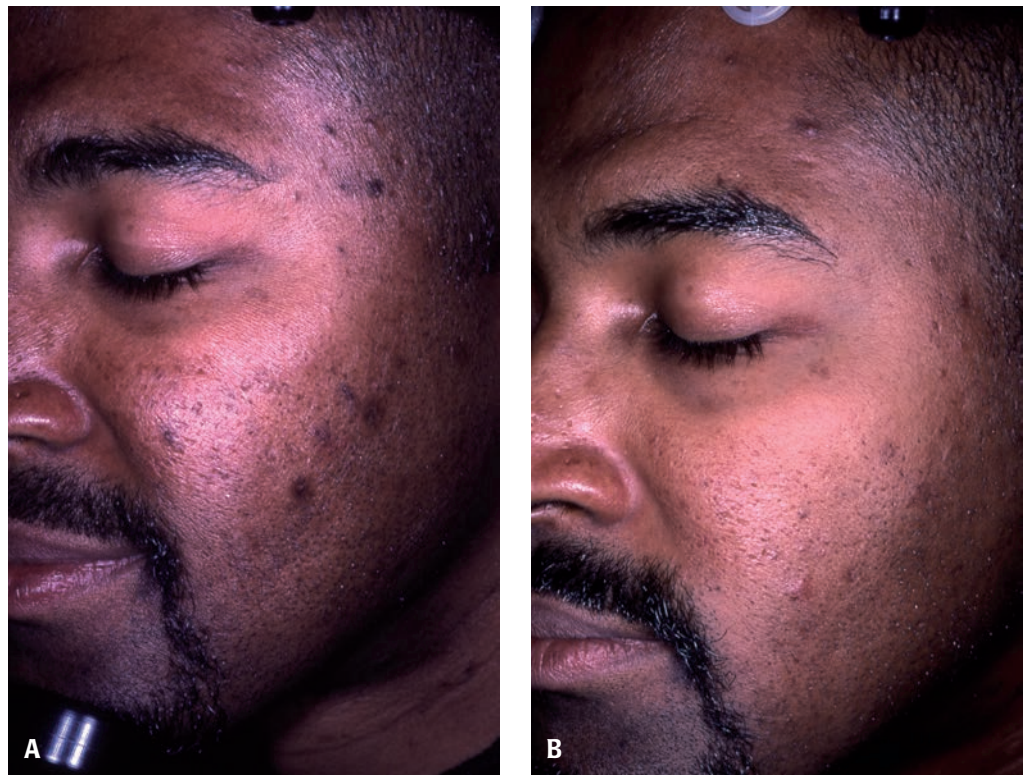


Figure 17-15 Combination salicylic acid/TCA 10% peel for treatment of melasma. **A:** Baseline. **B:** After.

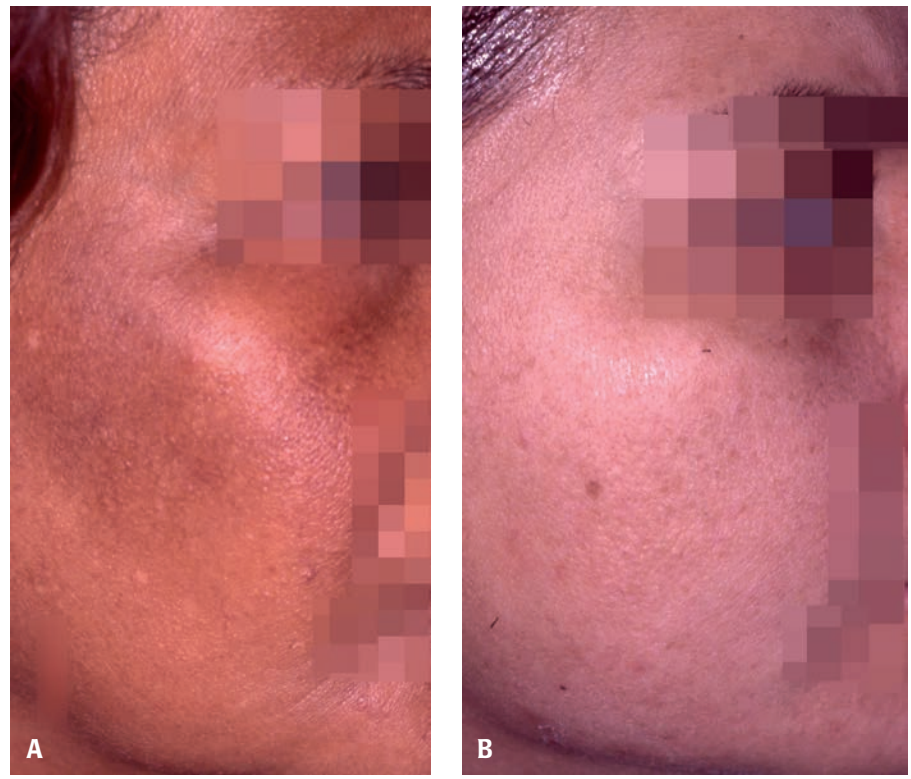


Figure 17-16 Before and after combination salicylic acid/TCA 10% peel for treatment of melasma. **A:** Baseline. **B:** After.

applied to the entire face with a 2 inch × 2 inch wedge sponge, 2 inch × 2 inch gauze sponge, or cotton-tipped applicator for 3 to 5 minutes. Typically, the cheeks are treated first, applying the peel from medial to lateral areas, followed by application to the chin and forehead. Most patients experience some mild burning and stinging during the procedure. Some patients experience a sensation of peel-related facial anesthesia. Portable handheld fanning during the procedure substantially mitigates the sensation of burning and stinging.

A white precipitate, which represents crystallization of the salicylic acid, begins to form at 30 seconds to 1 minute following peel application. After 3 to 5 minutes, the face is thoroughly rinsed with tap water to remove salicylic acid crystals. The face is gently blotted to remove excess water. When treating hyperpigmentation, TCA 10% or 15% is then applied to the areas of hyperpigmentation with a cotton-tipped swab for 2 to 3 minutes, producing minimal (level 1) or no (level 0) frosting. The face is again rinsed with tap water. If treating photodamage, acne, or texturally rough skin, TCA is applied to the entire face. This protocol usually involves a regimen of two or three combination peels performed at 2- to 4-week intervals.

Side effects

As with salicylic acid peeling, the incidence of side effects is usually low. However, given the combination effects, erythema and desquamation can last longer than the usual changes observed with salicylic acid peels or TCA 10%. In a larger series of 50 patients treated by Grimes with combination peeling, six patients exhibited mild postinflammatory hyperpigmentation that resolved within 1 to 2 weeks after the use of mid- to high-potency topical steroids. One patient experienced hypopigmentation for 1 month.

Advantages and disadvantages

The advantages of combination salicylic acid/TCA peeling include its efficacy in all skin types. The peel is well tolerated in darker racial ethnic groups and is beneficial in treating recalcitrant melasma and postinflammatory hyperpigmentation. However, there is increased desquamation in some patients lasting for 7 to 10 days. Postinflammatory hyperpigmentation is more common than with salicylic acid peeling.

TRETINOIN PEELS

Multiple studies have documented the efficacy of tretinoin for improvement of fine lines, wrinkles, sallowness, and the dyschromia of photoaging. Histological studies have documented its effects in increasing epidermal thickness, increasing the thickness of the granular cell layer, decreasing melanin content, and improving stratum corneum compaction.[38–41] Several studies have assessed the efficacy of tretinoin peels. Cucé et al.[42] assessed clinical and histologic changes in 15 women after treatment with a series of tretinoin peels. Peels were performed twice weekly in concentrations of 1% to 5%. The peel solution was left in contact with the skin for 6 to 8 hours. Of the patients treated, three were classified as skin type IV. Punch biopsies of treated areas were performed before and after treatments. The authors reported improvement in skin texture and appearance. Histologic assessments showed a decrease in the stratum corneum and increase in the thickness of the epidermis. Patients experienced no side effects.

A subsequent study compared the efficacy of tretinoin peeling with glycolic acid peeling in darker skinned patients.[43] Ten female patients with melasma were treated weekly in a split-face trial: 70% glycolic acid was applied to one side of the face, and 1% tretinoin to the opposite side. A modified MASI score and photographs were used to assess clinical responses. A significant reduction in the modified MASI score was noted at 6 and 12 weeks on both sides of the face. There was no difference between responses for each peel, suggesting that tretinoin peels are well tolerated in darker-skinned patients with melasma. However, to achieve a comparable effect to glycolic acid, tretinoin must be left in contact with the skin for 4 to 6 hours. Additional studies are necessary to situate tretinoin in our overall hierarchy of superficial peeling agents.

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18

Medium-Depth Chemical Peels and Deep Chemical Peels

Rashmi Sarkar

Chemical peeling is a cosmetic procedure that involves the application of one or more exfoliating agents to the skin to wound the epidermis and dermis in a controlled fashion. The goal is to cause subsequent regeneration of portions of epidermis or dermis with long-lasting improvement in the aesthetic quality and appearance of the skin. The use of chemical peels for beautifying the skin dates back to ancient Egypt when sour milk (lactic acid) was used by Cleopatra to produce a more cosmetically elegant appearance of the skin.[1] Over the years, dermatologists pioneered chemical peeling for therapeutic uses.[1–6] In 1882, Unna introduced the use of salicylic acid, resorcinol, phenol, and trichloroacetic acid (TCA) as skin peels, and in 1952, Mackee published his work on phenol peels for acne scarring.[2] But it was Stegman's benchmark work in the early 1980s, on the histological changes of wound injury after chemical peeling, that provided a scientific basis for the classification of chemical peels and paved the way for their application in a controlled and scientific way on the human skin.[3] This further influenced the development of medium depth and chemical peels.[4,5]

A medium-depth chemical peel refers to a peeling agent or a combination of agents that cause destruction of the epidermis and the papillary dermis and may extend to the upper reticular dermis.[6] Deep chemical peels produce destruction to the deeper reticular dermis and also induce new collagen and ground substance production. Rubin has provided a simplified working classification based on the depth of the wound created by the chemical peeling agent Table 18-1.[7] The medium-depth peels, according to his classification, are glycolic acid 70% (applied for a variable time, 3 to 30 minutes); TCA 35% to 50%; and combinations of 35% TCA, with either CO_2 snow, Jessner's solution, or 70% glycolic acid, as well as unoccluded 88% phenol. Eighty-eight percent phenol and Baker-Gordon phenol formula are used as deep chemical peels. The most suitable candidates for medium and deep chemical peels are those who have fair (type I or II) photodamaged skin with actinic elastosis, fine facial wrinkles, and extensive actinic keratoses.[8] Medium-depth peels are used sparingly in darker-skinned individuals because of a greater risk of postinflammatory hyperpigmentation. Darker-skinned patients are unsuitable candidates for a deep chemical peel because of more pronounced complications, namely hypopigmentation, hyperpigmentation, uneven skin pigmentation, and scarring, which can cause great emotional distress.[9] As the risks of deep chemical peels far outweigh the advantages, they are best avoided in darker-skinned individuals.

MEDIUM-DEPTH CHEMICAL PEELS

Medium-depth chemical peels are done by some experienced dermatologists in darker-skinned patients for diffuse or multiple actinic keratoses; pigmentary dyschromias, especially blotchy hyperpigmentation; postinflammatory hyperpigmentation or recalcitrant melasma that have not responded well to medical treatment or repeated light chemical peeling; fine to medium rhytides; and superficial acne scars (Table 18-2). Although TCA 35% to 50%, glycolic acid 70% (applied for 3 to 30 minutes), and phenol 88% can be used as solo medium-depth peeling agents, the new popular trend is to combine two less potent peels to minimize the risks by first penetrating the epidermis with a superficial peeling agent, which allows a more even and complete penetration of the medium-depth peel, 35% TCA.[10,11]

Each dermatologist must standardize the peeling procedure in the way he or she primes, cleans, and degreases the patient's skin and applies the chemical agent to the skin to achieve optimum results. The factors affecting the depth of the peel are the peeling agent; the concentration of the peel; the number of coats applied; the technique of application; the method of priming, cleaning and degreasing the skin; the skin type; the anatomic site of the lesion; and the duration of contact with the agent.[12] Before the procedure, it is important to perform a prepeel evaluation of the patient. A detailed history—including prior history

Table 18-1

Classification of medium-depth and deep chemical peeling agents

Medium depth	
TCA 35% to 50%	
Glycolic acid 70% applied for 3 to 30 minutes	
Combinations:	CO_2 snow + 35% TCA
	Jessner's + 35% TCA
	Glycolic acid 70% + 35% TCA
Phenol 88%	
Deep	
Phenol 88%	
Baker-Gordon phenol formula	

Table 18-2

Indications for medium-depth and deep chemical peeling

Medium depth

- Actinic keratoses
- Moderate photoaging skin: Glogau II
- Pigmentary dyschromias (lentigines blotchy hyperpigmentation, postinflammatory hyperpigmentation, melasma)
- Fine to medium rhytides
- Superficial acne scars
- Blending photoaging skin with laser resurfacing and deep chemical peeling

Deep

- Photoaging skin (severe)
- Acne scars
- Perioral wrinkles

of abnormal scarring, use of medications such as isotretinoin and photosensitizing drugs, occupation, smoking, sun exposure, immunosuppression, and a history of herpes simplex—must be elicited. Cutaneous examination would include assessing the quality, texture, and tone of the skin; the skin type; and the amount of photodamage present. One may also make a reasonable assessment of the patient's expectations. The contraindications to medium and deep chemical peels are abnormal scarring, active herpes simplex or bacterial infections, immunosuppression, uncooperative patient, unrealistic expectations, open cuts or scratches on the face, history of delayed wound healing, any facial surgery within 3 months, a mentally unstable patient, and use of isotretinoin therapy within the last 6 months.[7,9,12,13] Some authors recommend using acyclovir orally in all patients, from the start of the procedure for the next 2 weeks.[12]

Trichloroacetic acid

TCA (35%–50%) is considered to be the gold standard for chemical peeling agents because of its long history of usage, stability, low cost, and versatility.[8,13] As compared with phenol peels, it does not require lengthy consultation with the patient, has few medical contraindications, has no systemic toxicity, and, as pain is less severe and of a shorter duration, anaesthesia—whether intramuscular, intravenous, or general—is optional.[14]

It is usually prepared by a weight-to-volume aqueous solution. One hundred percent TCA is available in crystal form, which is colorless and ready to be diluted with water. To prepare a 30% concentration, 30 g of TCA crystals are added to distilled water to get a total volume of 100 mL. Similarly, various other concentrations can be prepared. The solution must be prepared fresh every 6 months. As the crystals are hygroscopic, they have to be stored in tightly capped, acid-resistant plastic or glass bottles. Once prepared, the TCA solution is light sensitive and therefore has to be stored in amber-colored bottles. To avoid contamination, the solution should be poured from a master bottle into a separate container for each peel procedure.

The mechanism of action of TCA in chemical peeling is that it precipitates epidermal proteins and causes dermal inflammation, necrosis, and sloughing. This is visualized as white frosting on the skin surface. The white frost signifies the completion of the reaction and may also correlate with the depth of peel. Because of the increased risk of complications in darker-skinned patients in the form of postinflammatory hyperpigmentation, hypopigmentation, and scarring, strengths above 50% have been discontinued.[12,13] In the author's experience, a good prepeel preparation with a sole priming agent or their combination followed by a good cleansing and degreasing of the face can be effective for carrying out 35% TCA peels in selected and well-motivated darker-skinned patients only. Currently, the popular trend in medium-depth peeling is to combine two less potent agents to minimize complications of a single medium-depth peel. Penetration of the epidermis is achieved with a superficial peeling agent, and this is followed with 35% TCA application.[14] These are done as single procedures with a healing time of 7 to 10 days.

Solid CO_2 and 35% trichloroacetic acid

Brody first developed the combination of solid CO_2 and 35% TCA as a medium-depth combination peel in 1986.[4] Acetone is used to degrease the skin. A hand-sized piece of solid CO_2 is dipped in a 3:1 solution of acetone and alcohol and then applied to the affected areas with varying degrees of pressure. The preliminary freezing with solid

CO_2 helps to break the epidermal barrier and allows a more even and complete penetration of the deeper 35% TCA.[15] To the edges of the depressed scars and to larger actinic keratoses, hard pressure can be applied for a better clinical result. Erythema with microvesiculation is the end point. After wiping the skin with acetone, 35% TCA is applied with cotton applicators to complete the procedure. This is considered a potent combination peel.

Jessner's solution and 35% trichloroacetic acid

Monheit introduced the use of Jessner's solution before the application of 35% TCA in 1989.[5] The Jessner's solution acted as a keratolytic and destroyed the epidermal barrier to allow a deeper and more even penetration of 35% TCA. Although most of the studies evaluating the efficacy of medium-depth peels as a therapeutic modality are from the West, a combination of Jessner's solution followed by the application of 35% TCA was found to be an effective and safe way of treating acne scars, even in patients of dark complexion, in an open study of 15 Iraqi patients.[10] In the opinion of Al-Waiz et al., this medium-depth peel is one of the most effective simple and safe combinations if performed carefully by an experienced dermatologist in only selected patients, even in India. The procedure is described as below.

Prepeel evaluation

The initial prepeel consultation is important for patient selection and to gauge the patient's expectations. A pertinent history is taken, and contraindications are ruled out. The procedure is explained realistically and in detail to the patient, including the postoperative erythema, swelling, and peeling that would keep the patient homebound for 7 to 10 days. Many patients are able to return to work in 7 days. The patient is also informed about potential complications. Strict sun avoidance is advised for at least 14 days. A written consent is obtained from the patient, and prepeel photographs are also taken.

Prepeel preparation

Preparing the skin for a chemical peel, or priming, is an important constituent in chemical peeling.[16] A single prepeeling agent or a combination of agents can be used for at least 2 to 6 weeks before chemical peeling, and they can be continued as a maintenance regime after the peels. Prepeel or adjunct topical agents reduce the seborrhea and thin the epidermis, allow a more rapid penetration of the peel, accelerate re-epithelization and wound healing, decrease the risk of postinflammatory hyperpigmentation because of the bleaching effect caused by the dispersion of melanin granules, and enforce the concept of maintenance regime.[13,16] Topical agents commonly used as prepeel agents in darker-skinned patients are hydroquinone 2% to 4%, broad-spectrum sunscreens, tretinoin 0.025% to 0.05%, and glycolic acid 8% to 12%. Salicylic acid, lactic acid, kojic acid, and azelaic acid can also be used. Nanda et al. assessed the efficacy of hydroquinone 2% versus tretinoin 0.025% as adjunct topical agents for chemical peeling in Indian patients with melasma. Two percent hydroquinone was found to be superior to 0.025% tretinoin as a priming agent and also in maintaining the results obtained with TCA peels by decreasing the incidence of postpeel reactive hyperpigmentation.[17] The author generally uses a combination of 2% hydroquinone, 0.025% tretinoin, and a broad-spectrum sunscreen as a combination for priming darker-skinned patients. Concentrations higher than 4% hydroquinone and 0.05% tretinoin are not well tolerated by these patients.

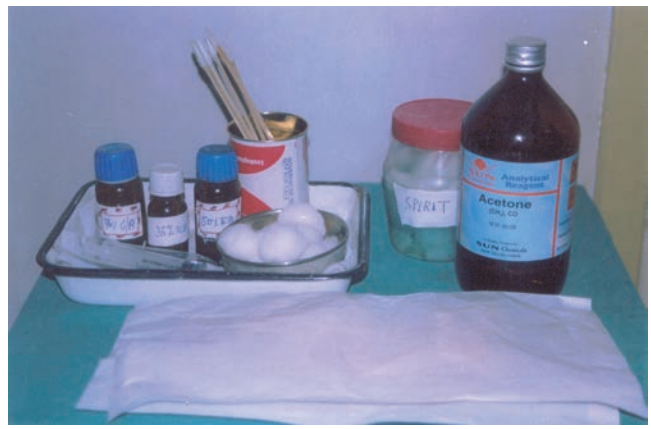

Figure 18-1 Materials for medium-depth chemical peeling.

Materials for medium-depth chemical peel

Materials for a medium-depth chemical peel would include clearly labeled bottles of freshly prepared peeling agents; cleansers such as alcohol, Septisol, and acetone; cold water; neutralizing solutions; a cap for the patient's head; disposable gloves; 2 × 2–inch cotton gauze pieces, and cotton-tipped applicators (Fig. 18-1).

Sedation and analgesia

Mild sedation may be offered preoperatively, although this is not always necessary. Preoperative sedation with short-acting sedatives (diazepam 5–10 mg orally) and mild analgesia with oral nonsteroidal anti-inflammatory agents or meperidine 50 mg, hydroxyzine HCl 25 mg intramuscularly may be offered to the patient.

Skin preparation

The patient is made to remove her makeup and repeatedly wash the face with soap and water. She is made to wear a surgical cap (or the hair is pulled back) and made to lie down on the back with the head elevated at an angle of 45 degrees. The eyes are kept closed or covered with gauge pieces. To obtain an even frost, vigorous cleansing is done with methyl alcohol using 2 × 2-inch gauze pieces fol-

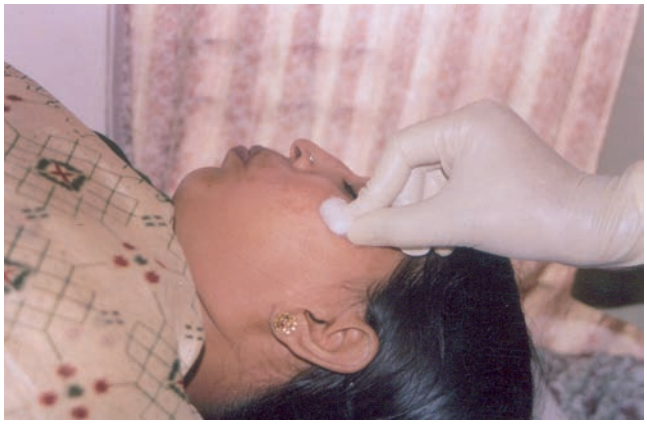

Figure 18-2 Vigorous cleaning and defatting the face with acetone before peeling. The patient has melasma.

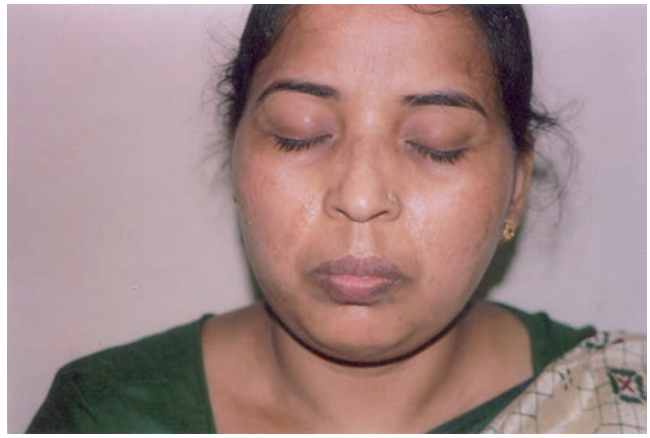

Figure 18-4 Erythema and edema 4 days postoperatively.

lowed by degreasing the skin with a cotton ball soaked with acetone (Fig. 18-2).

The medium-depth peel procedure

Jessner's solution is applied with cotton-tipped applicators or 2 × 2-inch gauze pads to the affected areas of the face. An erythematous response with a blotchy frosting is obtained within 2 to 3 minutes. Another application can be repeated to obtain the desired response, but solid white frosting should be avoided. The peel is applied smoothly on the face from the less sensitive to the most sensitive area—i.e., from forehead to right cheek, chin, left cheek, glabella, nose, perioral area, periorbital area, finally feathering into the hairline, submandibular area, and all around the face. This avoids lines of demarcation in the postpeel period.

After the appearance of the Jessner's solution frost, 35% TCA is applied in the same manner and over the same areas with cotton-tipped applications. An even white frost appears in 2 to 4 minutes (Fig. 18-3) and is indicative of upper reticular dermis peel. Overcoating with TCA must be avoided. The patient feels a burning sensation immediately after the TCA application. The peel is terminated by applying cool saline compresses for 5 to 10 minutes or cold-water gauze sponge. Xylocaine ointment can also be applied over the treated area, providing instantaneous and complete pain relief.[10]

Postoperative period

Postoperatively, the patient is instructed to soak the area in acetic acid solution for the first 24 hours and apply bland emollients only. From the second day onward, the patient can wash the face and scalp with a mild soap and water. For the first week, an antibiotic ointment (2% mupirocin) can be used twice a day. Some dermatologists also use a topical steroid antibiotic ointment twice a day in darker-skinned patients.[10] From the second week onward, a bleaching agent (2% hydroquinone) can be used. Strict sun avoidance must be adhered to for at least 10 to 14 days, and the patient can use a broad-spectrum sunscreen. Erythema, edema, vesiculation, and desquamation occur in the first few days (Fig. 18-4). The erythema intensifies in 3 to 4 days and subsides by the end of the week (Fig. 18-5).

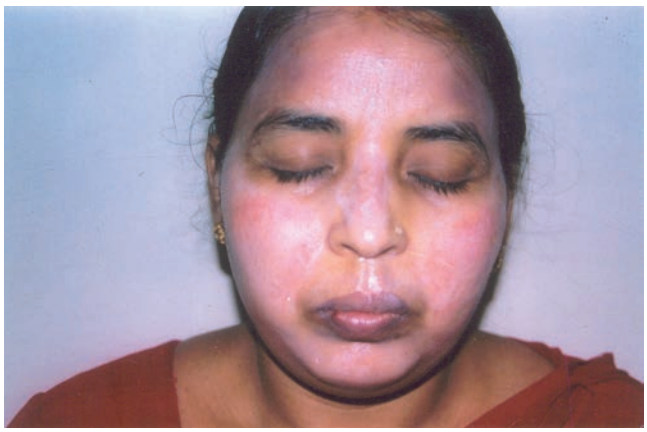

Figure 18-3 White frost after 35% TCA application.

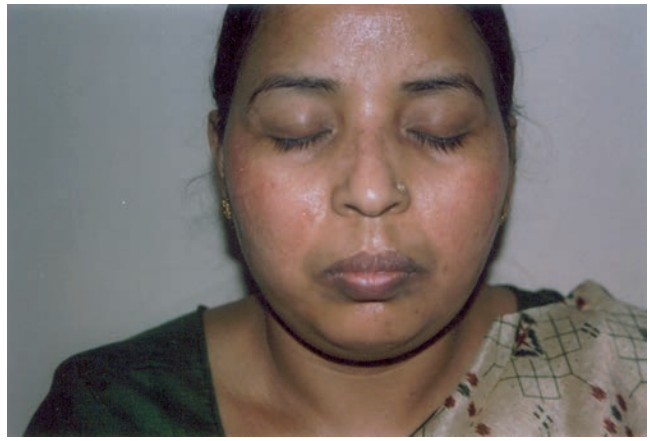

Figure 18-5 Postpeel appearance after 7 days.

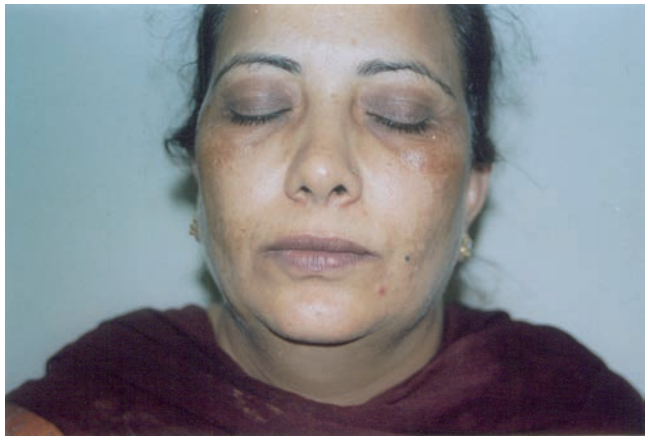

Figure 18-6 Severe melasma before application of 70% glycolic acid peel.

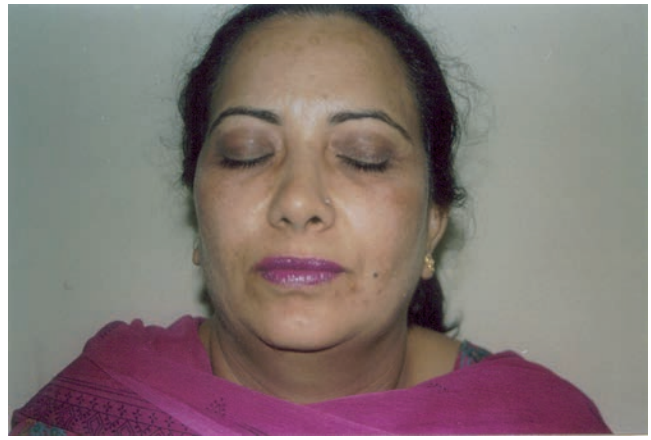

Figure 18-7 Clinical lightening after 70% glycolic acid peels.

70% glycolic acid

Glycolic acid, an alpha hydroxy acid derived from sugarcane, is commonly used as a superficial peeling agent. In 70% strength, it can be used as a medium-depth peel for a time varying from 3 to 30 minutes. It has to be stored in tightly capped bottles but is not light sensitive. It is available in various concentrations, but the higher the concentration used, the deeper the penetration and level of destruction. It is available as buffered, esterified, partially neutralized, and as free glycolic acid. Good results are obtained with lower pH of the acid and higher concentration of the free glycolic acid. In dark-complexioned patients, the free, nonneutralized glycolic acid (pH 0.6–1.7 in aqueous vehicle) used by experienced dermatologists works better than partially neutralized glycolic acid.[18]

Glycolic acid has a three-tier mechanism of action: In low concentration, it decreases corneocyte cohesion, stimulates epidermal growth, and causes thickening of the epidermis; in higher concentration, it causes epidermolysis and destruction of specific layers of the damaged skin, induction of inflammatory reaction, and production of new collagen and ground substance in the dermis. Unlike a TCA peel, this has a timed, nonvisible end point or erythema. The time of application varies according to the indication and the skin type. It must be neutralized with water or 10% to 15% sodium bicarbonate. In the author's experience, 70% glycolic acid peels used as solo medium-depth chemical peels are well tolerated by darker-skinned patients (Fig. 18-6 and Fig. 18-7). The postpeel erythema and burning is usually followed by peeling and exfoliation for 1 to 3 days. Overall, the complications of medium-depth peels, such as postinflammatory hyperpigmentation and hypopigmentation, are observed less frequently with 70% glycolic acid peels.

70% glycolic acid and 35% trichloroacetic acid

It was Coleman and Futrell who demonstrated the use of 70% glycolic acid before the application of 35% TCA as a combination medium-depth chemical peel.[19] In this combination, 70% glycolic acid is first applied with cotton-tipped applicators and then washed off with tap water. After 2 minutes, 35% TCA is applied with 2 × 2–inch gauze pads. The effect of this combination peel is similar to that of combined Jessner's and 35% TCA peel.[12,13]

88% phenol solution

Eighty-eight percent unoccluded phenol solution is rarely used as a medium-depth peel in darker-skinned patients because of the risk of hypopigmentation and cardiac and renal toxicity. It also takes a much longer time to perform. Because of these disadvantages, other alternatives are generally preferred over phenol as medium-strength chemical peels.

DEEP CHEMICAL PEELS

A deep chemical peel is a nonsurgical cosmetic procedure that can dramatically improve the aesthetic quality and appearance of the skin. It can cause necrosis of the skin down to the level of the midreticular dermis. Occluded or unoccluded Baker's phenol peel (phenol 88%: 3 mL; croton oil: 3 drops: liquid hexachlorophene or Septisol: 8 drops: tap or distilled water: 2 mL) is used for achieving deep chemical peels. However, Baker's phenol peel has been used frequently for the past several decades to achieve facial peeling.[20] It has been modified by combining it with a moist dressing technique, which minimizes the discomfort of taping.[8] Although phenol offers great cosmetic benefit, the most significant limiting factors in deep phenol–based chemical peeling are that they are melanotoxic, can cause porcelain white skin hypopigmentation and scarring, and have systemic side effects, such as cardiac arrhythmia and renal toxicity. Because of the risk of these complications and a longer time for recovery, deep chemical peels are rarely used.[9]

The deep phenol chemical peel does offer some advantages. It acts as an excellent tool in providing a striking improvement of advanced photoaging skin, wrinkles, and especially in the perioral area and acne scars (Table 18-2), despite the advent of resurfacing lasers in cosmetic surgery. A single deep chemical peel is required to achieve the desired results, and the effect is long lasting. The disadvantages are that the recovery time for a deep chemical peel is the longest and rather uncomfortable as the patient experiences discomfort, swelling, erythema, oozing, crusting, and peeling for more than a week at least. For about 2 to 3 months following a deep chemical peel, the skin will appear sunburned in appearance. The side effects are more pronounced in persons with darker and oily skin and those with freckles. Side effects include permanent pallor of the skin with inability to tan, scarring, and uneven skin pigmentation with lines of demarcation between peeled and nonpeeled skin. Cardiac arrhythmias, renal toxicity, and laryngeal edema are other limiting systemic side effects.[21–23] As the risks of deep chemical peels far outweigh the advantages, this procedure is usually not carried out in darker-skinned patients.[9]

Each ingredient of the Baker-Gordon phenol peel serves a specific function. Because of the sulfide bond disruption, phenol causes keratolysis and protein coagulation. Septisol is a surfactant, which offers a more uniform penetration through the skin by decreasing the skin surface tension. Croton oil also further enhances phenol absorption by causing epidermolysis.[12] All these ingredients are mixed in a clean glass cup just before the peel procedure. The other ways to increase the absorption of phenol peels, besides croton oil and Septisol, are by diluting the phenol concentration from 88% to 55% and by occlusion or taping. Recently, Hetter changed the concentration of croton oil in his version, the phenol croton oil peel, to make a less destructive and safer version of the Baker-Gordon phenol peel.[24,25] This provided a more natural-appearing skin color and texture. The method of performing a deep peel follows.

Prepeel evaluation and preparation

The prepeel evaluation and priming of the skin is essentially the same as for a medium peel. Perioperative antibiotics and antiviral agents may be started a night before the procedure and may be continued for 10 days thereafter. A full-face deep chemical peel takes 1 to 2 hours to perform, and a more limited procedure (treatment of wrinkling above the lip) may take less than half an hour. The presence of cardiac and hepatorenal disease should be ruled out. It is advisable to perform an electrocardiogram (ECG), a complete blood cell count, hepatorenal profile, serum electrolytes, and chest x-ray examination before the procedure.

Sedation and anaesthesia

The deep chemical peel is carried out by a trained cosmetic surgery professional in a doctor's office, hospital, or surgery center. Heavy sedation or general anaesthesia must administered for the procedure.

The deep chemical peel procedure

It is advisable to carry out the deep peel procedure in a medically supervised environment, where emergency cardiopulmonary resuscitation equipment is available and the patient can be monitored for blood pressure, pulse, and cardiac activity to avoid the arrhythmic complications of phenol toxicity.[21–23] Before the procedure, an ECG is performed. To decrease phenol absorption and lower serum phenol levels, two procedures are carried out. First, the face is divided into five to eight cosmetic units, and each segment is peeled sequentially at 15-minute intervals, allowing the procedure to be spread out over 60 to 120 minutes. Second, the patient is hydrated with a liter of lactated Ringer's solution before the procedure and another liter of the fluid during and after the peel. The peel solution is applied to the area to be treated (avoiding the eyes, brows, and lips). There can be a slight burning sensation, but it is usually minimal as the solution also acts as an anesthetic. After leaving the peel solution on for the desired effect, it is neutralized with copious amounts of water. Thymol can also be used to stop the phenol peel. In case a deeper peel is desired, occlusion in the form of either taping or a nonpermeable membrane or thick petroleum jelly is used. About 1 hour after the procedure, a thick coating of petroleum jelly is layered over the patient's face, covering the protective crust that develops rapidly over the area. Alternatively, the patient's face can be covered by a "mask" composed of strips of adhesive tape with opening for the eyes and mouth. The patient is released from the hospital after the procedure and allowed to recover at home.

Postpeel period

The patient can experience discomfort, swelling, erythema, oozing, crusting, flaking, and peeling. A few days after the peel, new skin with bright pink color will emerge and then fade within a few days. After about 2 weeks, this coloration can be covered with makeup. Postoperative swelling and difficulty in opening the eyes also subsides in a few days, but the skin remains sensitive. Analgesics can be given in the postpeel period to decrease the discomfort and swelling. Sun protection and use of broad-spectrum sunscreens are extremely important after a deep chemical peel and should be continued for 6 months after the peel along with a good bleaching maintenance regime. The patient can resume normal work schedule and other activities after 2 weeks. For about 2 to 3 months following a deep chemical peel, the skin has a sunburned appearance as re-epithelialization takes place. At the end of this period, the skin appears extremely pale. After re-epithelialization occurs, maintenance therapy with bleaching agents can be started. Follow-up visits should be done every 2 to 3 days after re-epithelialization is complete,

then every week for the next 2 to 3 months. Steroids must be avoided in the postpeel period as they interfere with the thickening process of the new skin. Deep chemical peels should not be performed before 1 year after the prior peel.

Combination procedures

For facial rejuvenation procedures, to obtain a natural appearance of the skin, the cosmetic units of the face are blended together. Deep chemical peels or laser resurfacing are usually applied to the perioral and periorbital areas. The forehead, cheeks, and chin are treated with a medium-depth peel and the neck is treated with a superficial chemical peel. The blending of these cosmetic units avoids demarcation lines and shortens the postoperative healing period.

Combined chemical peels with dermabrasion, laser, and dermasanding

Chemabrasion—or applying 50% TCA to the entire face followed by dermabrasion with topical cryoanesthesia, which was used for acne pitting and scarring—has been discarded because of postoperative scarring and pigmentary alterations that resulted from 50% TCA.[12] Pulsed CO_2 laser resurfacing system, as opposed to medium-depth and deep chemical peels, can eradicate the deeper wrinkles in the perioral and periorbital regions more effectively. A combined procedure is used for photoaging skin to obtain improved results: CO_2 laser for perioral and periorbital units, Jessner's plus 35% TCA for the remaining facial skin, and only Jessner's solution for the neck. The peel is performed first, followed by the laser. If one drop of diluted peel solution accidentally falls into a laser area, it may produce a scar.

Harris and Noodleman have demonstrated that combining dermasanding (silicone carbide sandpaper) with medium-depth chemical peeling is an effective method for treating fine to moderate rhytides.[26] TCA is applied first, and this is followed by abrading the skin in a circular motion with two 2 × 2–inch gauze pads rolled up into a cylinder over which autoclaved silicone carbide sandpaper is folded and moistened with normal saline. Once fine bleeding points are visualized, the dermasanding is stopped. Hemostasis is obtained by using 1:10,000 epinephrine droplets to coat the affected area. Acetic acid soaks and a moisturizer are used in the postoperative period. Scarring and hypopigmentation are the complications of this procedure.

COMPLICATIONS OF MEDIUM-DEPTH AND DEEP CHEMICAL PEELING

Proper patient selection, performance of the procedure by an experienced dermatologist or cosmetic surgeon, proper knowledge of the peeling agent, good prepeel preparation, and postpeel care are important factors in preventing complications with peeling agents.[8] However, the dermatologist must be aware of the complications that can occur and how they can be tackled in darker-skinned patients. The common complications of medium-depth and deep chemical peeling are pigmentary alterations: postinflammatory hyperpigmentation and hypopigmentation, persistent erythema, scarring, infections, pruritus, atrophy, textural changes, accentuation of telangiectasias, enlargement of pilosebaceous pores, and increased sensitivity to wind, sunlight, and changes in temperature.[8,10–13,27] In addition, phenol peels also have systemic complications, such as arrhythmias, renal toxicity, and laryngeal edema.

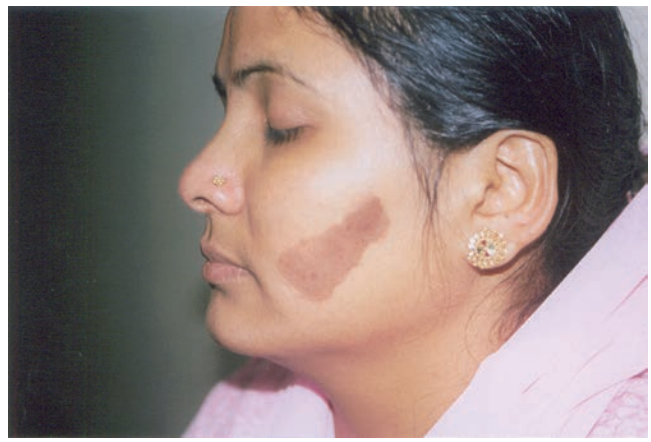

Figure 18-8 Postinflammatory hyperpigmentation after spot medium-depth peel.

Postinflammatory hyperpigmentation is seen commonly in darker-skinned patients and is one of the limiting factors in conducting chemical peels in darker races.[10,12] It is seen commonly with medium-depth chemical peels and may take months to years to return to normal (Fig. 18-8). In a study of medium-depth peels to treat acne scars in Iraqi patients, although 73.4% of the patients developed postinflammatory hyperpigmentation, none of them had permanent sequelae.[10] The pigmentation faded away in all after a maximum of 3 months. In patients with a family background of dark skin, hyperpigmentation can occur despite reasonable avoidance of sun exposure. This is due to melanocytic sensitivity caused by the irritating effect of the chemical peel.[10] Therefore, in susceptible individuals, treatment of this possible hyperpigmentation must be considered before its appearance.[28] A pretreatment as well as a maintenance regime of 2% to 4% hydroquinone, retinoic acid 0.025%, and 2% hydrocortisone cream (a modification of Kligman's regime) can be used to prevent and treat postinflammatory hyperpigmentation in dark-skinned patients.[29] This combination appears to be well tolerated by darker-skinned patients. Moreover, factors that exacerbate hyperpigmentation—including oral contraception, sunlight, pregnancy, and photosensitizing drugs—should be avoided for 6 months. Postpeel hypopigmentation is an

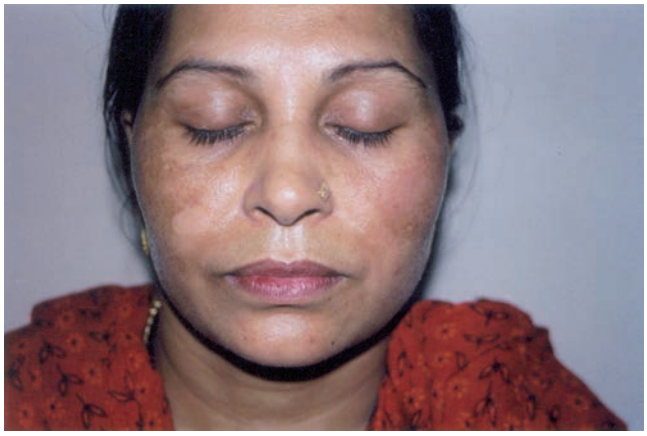

Figure 18-9 Postpeel hypopigmentation.

undesirable side effect with phenol peel.[13,26] and seen less commonly with medium-depth peels (Fig. 18-9). This is dependent on the amount of peel applied, occlusion, and depth of injury. Other pigmentary alterations with deep chemical peels are visible lines of demarcation between the treated and untreated areas, inability of the skin to tan, and uneven skin pigmentation. Careful application of camouflage makeup and foundation as well as sun protection may be required for aesthetic reasons.

Persistent erythema, a complication of medium-depth chemical peels, is almost always a transient phenomenon and may require no treatment in its mild form (Fig. 18-10). It usually lasts for 2 to 3 weeks after medium-depth peeling and 3 months after deep chemical peeling. Risk factors for this complication are genetic background, excess alcohol consumption, and a recent use of isotretinoin or topical tretinoin. In the author's practice, only 0.025% tretinoin is used in the prepeel and maintenance regime in darker-skinned patients. Higher concentrations of tretinoin are associated more frequently with this complication. Prolonged erythema may also be an early sign of potential scarring and pigmentation. It should be treated early with mild topical steroids, oral antihistamines, systemic corticosteroids, or camouflage makeup.[10,12] In a study of medium-depth TCA peels for treatment of acne scars in dark-skinned patients, persistent erythema occurred only in two patients but resolved spontaneously.[10]

Scarring is a common complication of medium-depth or deep chemical peels. Chemical peels using 50% TCA can cause increased scarring.[14] This can be avoided by using combination medium-depth chemical peels or using 50% TCA only at the edges of depressed acne scars. Hypertrophic scars usually occur on the skin of the neck, dorsal aspects of the hands and arms, and other areas not rich in cutaneous adnexa. On the face, it may occur on the upper lip and near the mandible.[8] Prior dermabrasion or chemical peeling, peeling over undermined skin, and isotretinoin use within the previous 6 months predispose a patient to scarring. A test spot may be helpful to prevent this complication. Scarring could be treated with gentle massage, topical or intralesional steroids, silicone gels, or pulsed dye laser.[12]

Streptococcal and staphylococcal folliculitis can occur as a result of use of occlusion in deep chemical peels and should be prevented with 0.25% acetic acid soaks in the postpeel period. If bacterial infection occurs, appropriate antibiotics should be given. For pseudomonas infection, oral ciprofloxacin should be given. Because latent herpes simplex infection can be reactivated by chemical peels, patients with a history of herpes simplex should be given prophylaxis with valacyclovir 500 mg three times daily, 1 day before and for 7 to 10 days after peeling. In case herpes infection occurs during the postpeel period, a higher dose will have to be used. Atrophy and textural changes are other postpeel complications with medium-depth or deep chemical peeling. These complications can be prevented by avoiding the application of deep peels in the periorbital area and repeeling with superficial peeling agents.

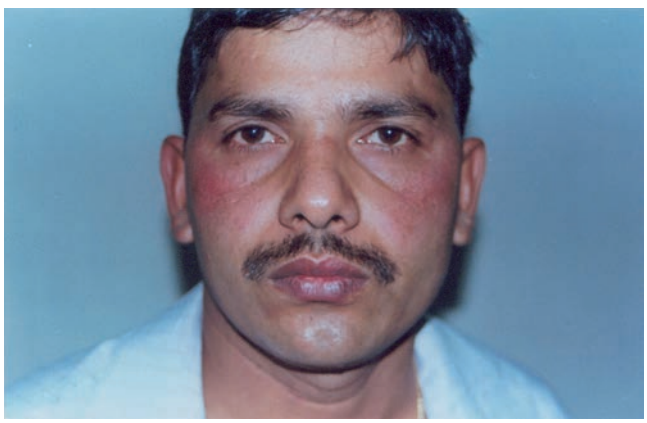

Figure 18-10 Postpeel persistent erythema after medium-depth peels.

CONCLUSIONS

Medium-depth chemical peels and deep chemical peels have changed the face of cosmetic surgery and dramatically improved the aesthetic quality and appearance of the skin, especially in cases of acne scars, photoaging skin, wrinkles, and recalcitrant pigmentary dyschromias. However, their complications, like pigmentary alterations and scarring, are more pronounced in darker-skinned patients, making them unsuitable candidates for such peels. Thus peels should be mainly reserved for fair-skinned patients. Medium-depth peels may still be performed by experienced dermatologists and cosmetic surgeons who have a good knowledge of the peeling agents as well as expertise in their technique in select, highly motivated, darker-skinned patients, using a good prepeel and postpeel topical

maintenance regimen to minimize the postpeel complications; but deep peels are hardly ever performed in this group of patients because of the undesirable side effects. Overall, the risks far outweigh the advantages in the case of medium-depth or deep chemical peels in darker-skinned patients, and the patient must be counseled realistically about the outcome of these procedures.

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19

Ablative and Nonablative Resurfacing in Darker Skin

Henry H. L. Chan

Skin rejuvenation in dark-skinned patients differs in several important respects from that in Caucasians. In dark-skinned patients, photoaging is associated with more pigmentary problems but less wrinkling. As a result, laser resurfacing is less warranted.

Furthermore, dark-skinned patients have higher epidermal melanin content and are more likely to develop postinflammatory hyperpigmentation (PIH) following laser resurfacing. Nonablative skin rejuvenation is therefore more suitable for dark-skinned patients. More recently, fractional resurfacing—a new technique that is considered to be halfway between ablative and nonablative skin resurfacing—has been introduced. With the appropriate parameters, fractional resurfacing can be used effectively and safely in skin rejuvenation among darker-skinned patients.

INDICATION AND CONTRAINDICATION FOR ABLATIVE AND NONABLATIVE SKIN RESURFACING IN DARKER SKIN

Darker-skinned patients have photodamage that presents with pigmentary problems but have less wrinkling than Caucasians. Chung et al. performed photographic assessment of 407 Koreans between the ages of 30 and 92 and assessed the manifestation of cutaneous damage.[1] Their findings indicated that pigmentary changes are common features of photoaging in Asians, with seborrhoeic keratosis being the major pigmentary lesion in men and lentigine the prominent feature in women. Furthermore, laser resurfacing in dark-skinned patients is associated with more adverse effects, especially PIH.[2] As a result, nonablative skin resurfacing is often the preferred option for most dark-skinned patients with photoaging. Ablative skin resurfacing is now used for those who fail to improve to their degree of satisfaction after nonablative procedure. Although acne scarring can also improve after nonablative skin resurfacing, the degree of improvement is often suboptimal, and ablative resurfacing remains the preferred treatment. More recently, fractional resurfacing has become a feasible alternative to ablative resurfacing for the treatment of acne scarring.

In terms of contraindications, patients who have been on systemic isotretinoin treatment should not receive laser resurfacing or fractional resurfacing for at least 6 months after the discontinuation of therapy. Topical retinoid should be stopped for 2 weeks before ablative and fractional resurfacing. In my experience, stopping systemic isotretinoin for a month is adequate for the nonablative procedure. A history of gold therapy and photodermatoses are other contraindications. Pregnancy should be considered as a relative contraindication. As PIH is the most common complication of laser surgery among darker-skinned patients, particular attention should be paid to factors that can increase it, such as sun exposure within 2 weeks of the surgery or the use of phototoxic agents, such as tetracycline.

THE USE OF LASER AND INTENSE PULSED LIGHT SOURCE FOR TREATMENT OF PIGMENTARY PROBLEMS IN DARKER SKIN

For many years, Q-switched (QS) lasers have been used to treat lentigines (Fig. 19-1), and although the approach is mostly effective, PIH occurs in 10% to 20% of darker-skinned patients. Several years ago, our group compared the efficacy and complication rates in Chinese patients treated with QS 532-nm neodymium:yttrium-aluminum-garnet (Nd:YAG) laser with those treated with long-pulsed 532-nm Nd:YAG laser and found that although the two groups had similar degrees of clearing, treatment with the QS device was associated with a greater risk of PIH.[3] We created controversy when we proposed that QS lasers are not suitable for the removal of lentigines in Asians because of the photomechanical effect of these systems leading to a greater risk of PIH (the rapid change of

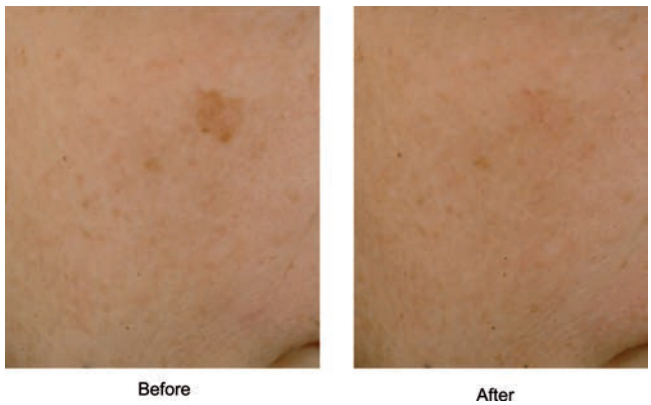

Figure 19-1 Lentigines after one treatment with QS532 nm Nd:YAG laser 2-mm spot size 0.6 J/cm^2.

thermal gradient that is associated with the use of QS laser leads to the generation of localized shock waves within the target). Since then, others looking at the use of intense pulsed light source (IPL) and long-pulsed 532-nm Nd:YAG laser in the treatment of lentigines in dark-skinned patients have confirmed our hypothesis.[4,5] By choosing a pulse width (minisecond domain) that matches the thermal relaxation time of the epidermis (10 miniseconds), the risk of thermal injury to the dermis is minimized (Fig. 19-2).

Most pigment laser/light source is also absorbed to a lesser degree by hemoglobin. Therefore, besides the use of long-pulsed rather than QS laser, another means to further reduce the risk of PIH is to compress and empty the dermal vessels and, in doing so, reduce the risk of dermal vascular damage.[6] A recent study compared the efficacy and complication of QS ruby laser against long-pulsed 595-nm pulsed dye laser with a compression window attached for

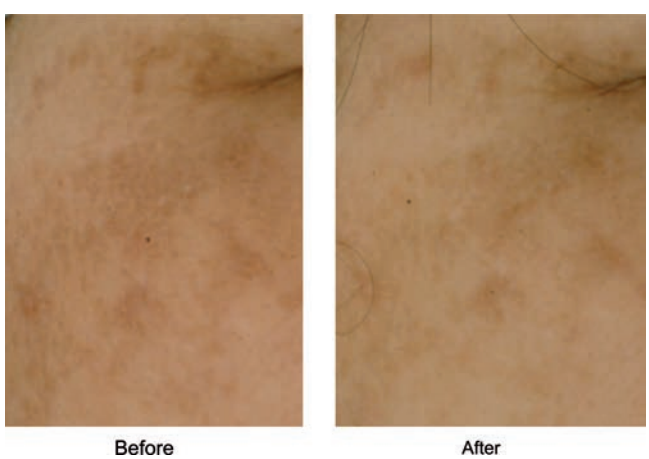

Figure 19-2 Lentigines after one treatment with long-pulse 532-nm Nd:YAG laser 2-mm spot size, 12 J/cm^2 with contact cooling.

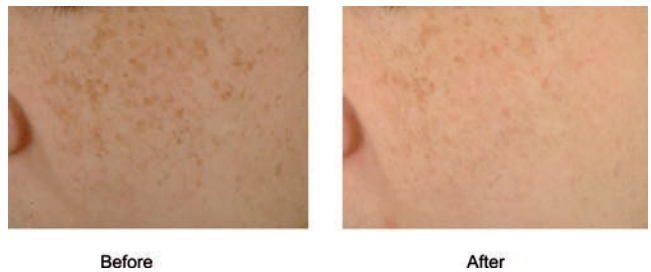

Figure 19-3 Lentigines after two treatments by intense pulsed light source (V-handpiece, Starlux, Palomar, 15 J/cm^2, 40 milliseconds).

the removal of lentigines among Japanese patients. The group treated with the compression technique was associated with a lower risk of PIH than the group treated with QS laser, but the degree of efficacy was the same in both groups.[7]

My current treatment approach is to use a long-pulsed laser (532 nm Nd:YAG) with an ashen-grey appearance as the clinical end point. A large spot-size second harmonic (532-nm) neodymium:yttrium-aluminum-garnet laser (Nd:YAG Gemini, Laserscope, San Jose, CA, USA) is one such device that can be used effectively to treat lentigines in darker-skinned patients (10-mm spot size, 20-millisecond pulse width, and 7 J/cm^2 for one pass over the entire anatomic area, then 2-mm spot size, 2-millisecond pulse width, and 12 J/cm^2 to individual lesions).[8] Patients are warned that there will be mild postoperative crusting for 5 to 7 days. About three treatment sessions are necessary to obtain desirable clinical effects.

For clinicians with QS laser, the intention is to use the lowest possible fluence and the smallest spot size (and therefore spare the surrounding normal epidermis) to obtain immediate whitening. For QS laser, a test area is best performed to assess the risk of PIH. A test area also helps patients to understand the procedure and the degree of postoperative downtime. With patients for whom downtime is an issue, IPL can be used instead (Fig. 19-3). Depending on the type of IPL, four to six treatment sessions are usually necessary, and if the removal of lentigines is the main aim, IPL is less cost-effective. IPL has the advantage of improving other skin qualities, such as skin texture and telangiectasia. Although cooling is essential when dermal chromophobes, such as water or vessels, are targeted, for the removal of epidermal pigment, excessive cooling can reduce IPL-induced photothermal effects.

In all cases, a moderate-potency steroid mixed with antibiotic (mometasone furoate) is applied to the skin immediately after surgery to reduce the risk of PIH. Sun protection, sun avoidance, and the use of bleaching agents 2 weeks before and after any laser/IPL procedure also lower the risk of PIH.

ABLATIVE, NONABLATIVE SKIN REJUVENATION AND FRACTIONAL RESURFACING: TECHNIQUE, DEGREE OF IMPROVEMENT, AND COMPLICATION

Nonablative skin rejuvenation involves the use of a laser/light source together with a cooling device, and in doing so improves the features of photoaging, including lentigines, telangiectasia, pore size, skin texture, wrinkles, and skin laxity with minimal downtime. Patients typically experience a mild degree of erythema that usually lasts less than 24 hours and darkening of the lentigines immediately after surgery. Repeat monthly treatment, usually for 6 months, is necessary to obtain the desired effect. A wide range of lasers or light sources can be used for nonablative skin rejuvenation, including visible green-yellow (532-nm Nd:YAG, 585-nm or 595-nm pulsed dye laser), near infrared and infrared lasers (1,064-nm Nd:YAG, 1,320-nm Nd:YAG, 1,450-nm diode, 1,540-nm erbium glass), and IPL sources.

Green and yellow lasers/light sources target the epidermal pigment and papillary dermal vessels. Injury to the papillary dermal vessels not only allows effective treatment of facial telangiectasia, but also leads to the subsequent healing process and new collagen formation. Affecting the microvascular supply of the sebaceous gland can reduce sebum production and improve pore size. Because of the higher epidermal melanin content of darker-skinned patients, epidermal melanin acts as a competing target chromophore for hemoglobin, which means that skin cooling is essential when vascular lasers are used for skin rejuvenation. In my experience, long-pulse pulsed dye laser with dynamic cooling can be used safely in skin rejuvenation among dark-skinned patients (V-beam, 595 nm, 10-mm spot size, 7.5 J/cm^2, 10 millisecond, Candela Corp., Wayland, MA, USA). Alternatively, large spot–size 532-nm Nd:YAG laser can be used, but swelling is more likely to occur, leading to longer downtime.

Near infrared and infrared lasers/light sources, together with skin cooling, target water content in the dermis, and their photothermal effect, produced as a result of the laser-tissue interaction, causes a rise in the dermal temperature. The consequences are collagen tightening, increased fibroblastic activity, and increased collagen production.

Near infrared and infrared lasers (1,064–1,540 nm) are particularly suitable for nonablative skin rejuvenation in dark-skinned patients as the longer wavelength is associated with less epidermal melanin interference. QS 1,064-nm Nd:YAG was one of the first lasers in the near infrared spectrum to be used for nonablative skin rejuvenation. Goldberg and Silapunt used pinpoint bleeding as the clinical end point for nonablative skin rejuvenation in lighter-skinned patients (type I to III) and found clinical and histological data to support the use of QS 1,064-nm Nd:YAG for the treatment of rhytids.[9] In my experience, QS 1,064-nm Nd:YAG laser can be effective in skin rejuvenation among dark-skinned patients. Mild erythema rather than pinpoint bleeding should be used as the clinical end point (QS 1,064-nm Nd:YAG laser, 6-mm spot size, 1.6 J/cm^2). A 1,064-nm Nd:YAG laser in the minisecond domain together with long-pulsed 532-nm potassium titanyl phosphate (KTP) laser has been used successfully for nonablative skin rejuvenation in Asians. Lee treated 150 patients (skin type I to V) with the long-pulsed KTP 532-nm (Aura; Laserscope, San Jose, CA) and long-pulsed Nd:YAG 1,064-nm (Lyra; Laserscope) lasers, both separately and combined.[10] The fluences that were used varied between 7 and 15 J/cm^2 at 7- to 20-millisecond pulse duration with a 2-mm handpiece, and 6 to 15 J/cm^2 and 30- to 50-millisecond pulse duration with a 4-mm handpiece for KTP. The Nd:YAG fluences were set at 24 to 30 J/cm^2 for a 10-mm handpiece and 30 J/cm^2 for a SmartScan Plus scanner (Laserscope, San Jose, CA). These energies were delivered at 30- to 65-millisecond pulse durations. All of the patients were treated monthly three to six times and observed for up to 18 months after the last treatment. All 150 patients were found to have a mild to moderate degree of improvement in wrinkling, a moderate degree of improvement in skin toning and texture, and significant degree of improvement in redness and pigmentation. The KTP and Nd:YAG laser combination was superior to either laser used alone.[10] In my experience, this combination is most effective, and using the large spot–size (10-mm) Nd:YAG laser, nonablative skin rejuvenation can be successfully performed in darker-skinned patients (10-mm spot size, 532-nm Nd:YAG 20 milliseconds, 7 J/cm^2 for one pass, then 2-mm spot size, 12 J/cm^2 to individual lentigines and telangiectasia and 1,064-nm Nd:YAG 45 milliseconds, 40 J/cm^2 for two passes) (Gemini, Laserscope, San Jose, CA, USA).

Among all of the long wavelength lasers that are used for nonablative skin rejuvenation, 1,320-nm Nd:YAG has been extensively investigated. Trelles et al. studied the use of a 1,320-nm Nd:YAG laser among Spanish patients and found histological improvement and fair to significant clinical improvement 4 to 6 months after twice-weekly treatment for 4 weeks in total (1,320-nm Nd-YAG, 30–35 J/cm^2, 30-millisecond dynamic cooling, 40-millisecond delay, 5-mm spot size, CoolTouch, Laser Aesthetics, Auburn, CA).[11] Another study was performed to look at the use of 1,320-nm Nd:YAG laser for the treatment of acne scarring and wrinkle improvement in Chinese women. Of the 27 patients, seven were treated for acne scarring and the others for wrinkle reduction. Besides treatment of the face, all patients also received treatment in the postauricular areas so that a postoperative skin biopsy could be obtained. A spot size of 10 mm was used, and three passes were performed (two precooling and one postcooling). The overall degree of patient satisfaction was 4.9 (range 0–9.8) for wrinkle reduction and 4 (range

0–10) for acne scarring. In terms of objective assessment by independent observers, the degree of improvement was mild in most cases. The independent pathologist who assessed the degree of improvement in terms of increased collagen production detected no change in eight patients, mild improvement in nine, and moderate improvement in ten. Blistering occurred in five cases, all in the central facial areas, and PIH occurred in three cases. This study indicated that although 1,320-nm Nd:YAG laser can be effective in wrinkle reduction and the treatment of acne scarring, other modalities such as subcision are necessary to enhance the outcome.[12]

The 1,450-nm diode laser is another nonablative laser with a wavelength that lies in the infrared spectrum. A control study that compared 1,450-nm diode laser treatment with dynamic cooling to treatment with dynamic cooling alone for facial rhytides showed that 13 out of 20 patients had clinical improvement on the laser/cryogen treated side but none on the cryogen only side.[13] Although this laser can theoretically be of particular advantage for dark-skinned patients given its long wavelength, PIH is surprisingly common and has been reported to range from 7% to 39%.[13–15] As most cases tend to develop after the second treatment and the total duration of cryogen spray was 60 milliseconds, it has been postulated that excessive cooling, which is due to the use of sequential cryogen spurts that prolong the overall "cooling time," is the main factor in the high risk of PIH in Asian patients. Our group is currently examining the optimal cooling parameters for this laser to minimize the risk of PIH.

The 1,540-nm erbium glass laser is another long wavelength infrared system that has been used for nonablative skin rejuvenation. Ross et al. investigated the use of a 1,540-nm erbium glass laser with contact cooling by a sapphire cooling handpiece in nine patients who were treated in postauricular sites.[16] The findings indicated that although selective dermal heating can be achieved, the range of fibroplasia and lack of clinically substantial cosmetic enhancement suggested that the dermal thermal damage obtained might have been too deep. However, others have not made similar observations, possibly because of differences in laser parameters. Using photographic evaluation, a dose-response study indicated the optimal parameter for a 1,540-nm erbium glass laser is 24 J/cm^2 delivered in three pulses (8 J/cm^2 per pulse) for the periorbital area and five pulses (40 J/cm^2) for the perioral area.[17] The same group of investigators then performed further clinical studies using assessment methods that included clinical ultrasound imaging and profilometric evaluation. Their results confirmed the effectiveness of this laser even after 14 months of follow up.[18] The advantage of 1,540-nm erbium glass over other lasers in the infrared spectrum is that it is painless. The lack of a clinical end point, however, is a disadvantage.

IPL is a polychromatic nonlaser light that is emitted in the spectrum of 400 to 1,200 nm. By emitting a fixed spectrum of wavelengths rather than a fixed wavelength, IPL has several advantages and disadvantages. A fixed spectrum of wavelengths allows penetration of different depths and the targeting of multiple chromophobes. This can be of particular advantage given the fact that nonablative skin rejuvenation often involves the treatment of several skin elements, including pigmentation, telangiectasia, and collagen remodeling. The use of a cutoff filter system to confine the emitted radiation to a certain spectrum of wavelengths allows some degree of selectivity, although not to the extent of laser therapy. Another advantage of IPL is that different pulse widths can be set, and one can choose the appropriate parameters that match the thermal relaxation time of the targets. The multiple purposes of IPL systems can be of particular advantage for clinicians with limited resources.

Negishi et al. were among the first to investigate the use of IPL in Asians. Using an IPL Vasculight, they studied its use for skin rejuvenation in 97 Japanese patients and found that 90% experienced a reduction in pigmentation, 83% experienced an improvement in telangiectasia, and 65% experienced an improvement in texture after three treatment sessions.[19] A cutoff filter of a shorter wavelength (550 nm, 28–32 J/cm^2 with a double pulse mode of 2.5–4.0/4.0–5.0 millisecond and a delay time of 20.0/40.0 millisecond between pulses) was used, and the epidermal melanin was affected, which led to a greater degree of reduction in pigmentation. The group observed no cases of PIH. Huang et al. used the same device and similar parameters (cutoff filter 550–590 nm, fluence 25–35 J/cm^2, with a single- or double-pulse illumination and a pulse width of 4.0 milliseconds) and treated 36 Chinese patients with freckles. Their findings indicated good to excellent results after a mean of 1.4 treatment sessions.[20] The mean number of treatment sessions to achieve good results differed significantly from Negishi's work, as well as that of others, despite the use of similar parameters.

IPL Quantum has also been extensively studied. Kawada et al. examined 60 patients with solar lentigines or freckles and found a significant degree of improvement (50% or more reduction in pigment) in 68% after IPL treatment (560-nm filter, 20–24 J/cm^2, 2.6–5.0 millisecond pulse duration in double or triple pulses with pulse delays of 20 milliseconds).[21] Negishi et al. used the same device to treat 73 Japanese with photoaging.[22]

After the fifth treatment, a combined rating of greater than 60% improvement was given to more than 80% of patients for pigmentation, telangiectasia reduction or removal, smoother skin texture, and overall improvement. Furthermore, histological evaluations showed strong staining of type I and type III collagen.

Newer-generation IPL systems (IPL2, Ellipse Flex system, Danish Dermatologic Development, Hoersholm, Denmark and Starlux, Palomar, Burlington, MA, USA) offer enhanced selectivity through user-specified fluence density with wavelength and pulse width, in addition to improved filtering technology and better cooling.[23,24]

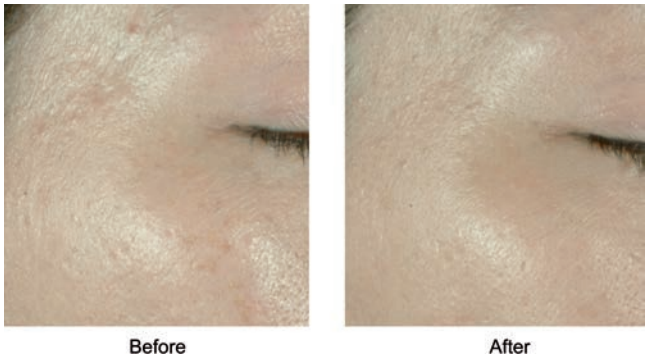

Figure 19-4 Parallel polarized view of nonablative skin rejuvenation 1 month after five monthly treatments using different lasers and IPL devices.

These newer IPL devices have a greater safety margin and improved therapeutic efficacy, and have gained much popularity because of their multipurpose design and limited postoperative downtime. It is important to point out that different IPL systems can have different clinical end points. IPL systems with longer pulse widths have the theoretical advantage of more gradual epidermal temperature elevation and better safety profiles (Medilux, Starlux, Palomar, Burlington, MA, USA). However, the clinical end points that are associated with these systems tend to be more subtle and delayed than those with a shorter pulse width. The subjective feedback of patients is therefore another important determinant for IPL with longer pulse widths. Regardless of the type of IPL, to improve safety, it is important to lower the fluence by 10% when treating an area that is known to be associated with more complications, such as the forehead.

Bipolar radiofrequency in combination with IPL/laser has been used for skin rejuvenation.[25,26] The hypothesis is that the combination of electric energy and light source can enhance the effects of both and achieve greater degree of improvement. Limited data on the efficacy of this device for dark-skinned patients is currently available.

In recent years, a combination approach that uses several devices (lasers and IPL) in the same treatment session has been advocated.[27] The intention is to use several devices to target different skin chromophores leading to the enhanced formation of new dermal collagen, which appears to optimize therapeutic outcome. However, to avoid an increased risk of adverse effects that are due to cumulative heat generation, a lower fluence should be used for each individual device when a combination approach is used. By using different lasers/light sources during treatment sessions, different wavelengths and therefore different depths will be affected. This combination method is our approach to nonablative skin rejuvenation in Asian patients. For example, during the first treatment, a large spot–size 532- and 1,064-nm Nd:YAG laser is used, and 4 weeks later, a combination of long-pulse pulsed dye laser, QS 1,064-nm Nd:YAG, IPL or 1540-nm Nd:YAG laser is used (Fig. 19-4 and Fig. 19-5).

For ablative skin resurfacing, in my experience, most of the cases are for acne scarring. Patients are warned before the procedure that even with ablative resurfacing, the degree of improvement is only about 40% to 70%. In terms of complications, all patients are warned to expect erythema that can last for several weeks and increase in pigmentation that can last from 2 to 6 months. To further optimize the result, a punch biopsy and subcision 2 weeks before surgery is recommended. For laser resurfacing, patients are prescribed a systemic antiviral (Famciclovir 250 mg three times daily) and a systemic antibiotic (cefuroxime 250 three times daily) 48 hours before laser surgery and until complete re-epithelization. Patients receive diazepam 10 mg and two tablets of Dologesic 1 hour before the laser procedure, which is performed under regional nerve block and local anesthetic tumescent injection. Three passes of CO_2 laser are performed, followed by one pass of erbium YAG. A closed dressing is applied for 48 hours, followed by an open dressing thereafter. Daily follow-up is necessary to ensure that wound infection does not occur. More recently, single-pass laser resurfacing has been recommended by some investigators with the aim of reducing the downtime and potential complications associated with this procedure.[28]

The prevention and treatment of PIH is important, especially in patients who undergo ablative skin resurfacing. Sun protection and avoidance is therefore necessary for at least 2 weeks before any laser/IPL procedure. We use sunblock that contains Tinosorb, titanium dioxide, or zinc oxide. The use of pre- and postoperative topical bleaching agents is also important. Many combinations—which can contain tretinoin, hydroquinone, topical steroid, alpha hydroxy acid, kojic acid, and azelaic acid—have been advocated. In our practice, all patients are given a combination of azelaic acid cream mixed with 4% hydroquinone and moderate potency steroid twice daily, preferably for 2 weeks before surgery, and then for another 4 weeks after

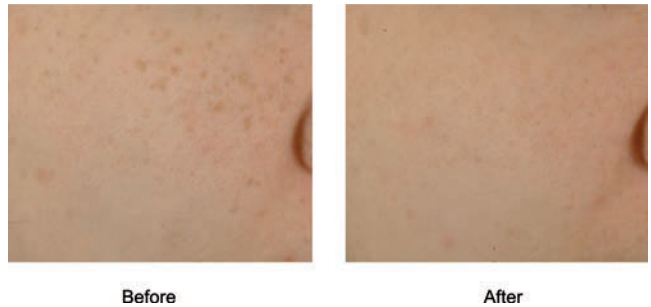

Figure 19-5 Cross polarized view of nonablative skin rejuvenation 1 month after five monthly treatments using different lasers and IPL devices.

surgery. We have reduced the use of retinoic acid because it causes irritation and is phototoxic.

Fractional skin resurfacing (Fraxel SR, Reliant Lasers, Palo Alto, CA, USA) is a new development that involves the use of a 1,540-nm laser to create microscopic spots of thermal injury that are surrounded by healthy skin tissue.[29] As the area of thermal injury is very small, the lateral migration of keratinocytes occurs rapidly, which leads to the complete re-epithelialization of the epidermis within 24 hours. Hence, this technique takes into consideration the mismatch between epidermal and dermal healing processes. The epidermis heals within 24 hours, but dermal collagen remodeling takes about 4 to 6 weeks to complete. This procedure has several unique features. First, unless very high energy (20 mJ or more) is used, the stratum corneum, with a much lower water content than the epidermis, remains intact, and the risk of adverse effects associated with ablative skin resurfacing, such as open wounds, infection, and scarring is kept to the minimum. The depth of collagen remodeling that is associated with the use of fractional resurfacing is much deeper than even the most aggressive laser resurfacing procedure (700 µm as compared with 300 µm), and although there is no data to compare the efficacy of repeat fractional resurfacing with that of laser resurfacing, such a depth of thermal collagen injury implies that fractional resurfacing can achieve a degree of improvement that is as good as, if not even better than, laser resurfacing for the treatment of acne scarring and wrinkles (Fig. 19-6). Finally, the downtime that is associated with fractional resurfacing and the risk of PIH is much lower if the appropriate parameters are used for dark-skinned patients.

To assess the prevalence and risk of PIH in dark-skinned patients treated with fractional resurfacing, our group performed a retrospective study of 34 Chinese patients who were treated with fractional resurfacing for acne scarring, skin rejuvenation, and pigmentation.[30] Skin cooling was not used. Two independent observers assessed pre- and posttreatment photographs taken by a standardized system that produced standard and cross-polarized views (Canfield CR system). A prospective study using nine different densities and energy treatments of the forearms of 18 volunteers was also performed to assess the optimal parameters for fractional resurfacing in Asians. Clinical photographs and spectrophotometer readings were performed before and after treatment. For the retrospective study, 117 treatment sessions were performed. Patients who were treated with high energy but low density (16 mJ, 1,000 Microscopic Treatment Zone (MTZ) had a lower prevalence of PIH (7% vs. 11%) than those treated with a low energy but high density (8 mJ, 2,000 MTZ). The prospective forearm study confirmed the importance of low density in the determination of PIH in Chinese. This allows us to conclude that lower density is important in reducing the risk of PIH in dark-skinned patients when fractional resurfacing is used. Cooling is another important factor that can reduce the risk of PIH. Repeat passes in the same anatomical area lead to bulk tissue heating, and in severe cases, blister formation can occur. This is particularly applicable in smaller anatomical areas, such as the lip. Effective cooling with an air-cooling device (Zimmer) can be most effective in reducing the risk of bulk tissue heating that can create excessive inflammation and subsequent PIH.

In my experience, the best means of reducing the risk of PIH for patients who are undergoing fractional resurfacing is to perform a mini-Fraxel. The mini-Fraxel involves Fraxel treatment using half of the density for that recommended for light-skinned patients. For example, in the treatment of epidermal melasma, 6 to 7 mJ, 1,000 to 1,500 MTZ is used. For acne scarring, 16 to 20 mJ, 500 to 750 MTZ is used. The treatment interval is also lengthened to 2 to 4 weeks for epidermal lesions and 4 to 6 weeks for dermal lesions, with the intention of further reducing the degree of inflammation. The use of air cooling during the treatment session is important, and the cooling parameters should be documented to ensure consistency in future treatment. Other means of further reducing the risk of PIH that is due to fractional resurfacing are documented in Table 19-1.

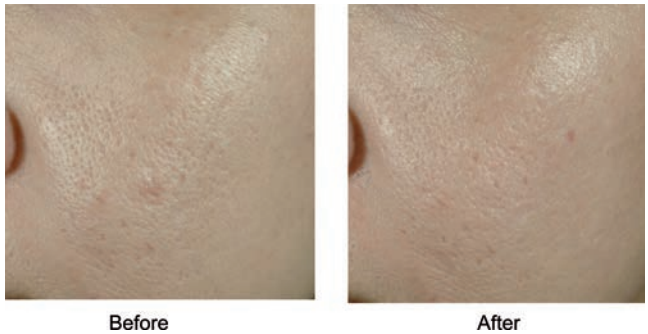

Figure 19-6 Acne scarring 6 weeks after five treatments of fractional resurfacing (15–20 mJ, 1,000 MTZ).

PHOTOMODULATION WITH LIGHT-EMITTING DIODE

Photomodulation using a light-emitting diode (LED) laser is a recent development for the treatment of photoaging. Data suggest that for the yellow light device (590-nm GentleWaves, LightBioScience, LLC, Virginia Beach, VA), photomodulation works by sending signals to the cells, and in doing so leads to alternation in cellular function, including increased collagen production and the reduction of collagenase activities.[31] A recent multicenter clinical trial looked at 90 Caucasians who were treated with this device

Table 19-1

Measures to reduce the risk of postinflammatory hyperpigmentation postfractional resurfacing in Asians

To avoid localized postinflammatory hyperpigmentation:

1. Use air cooling.
2. Ensure a constant hand movement.
3. Stop completely at the end of each pass.
4. Ensure good contact between the handpiece and skin surface, especially in areas such as the forehead.
5. Reduce the number of passes in small anatomical areas, such as the upper lip, to avoid bulk tissue heating.
6. Treat the whole anatomical area.

To avoid generalized pigmentation:

1. Reduce the energy (start at 6 mJ for epidermal lesions and 15 mJ for dermal lesions), and use the average duration of edema after treatment as a guide to increase or decrease the energy (swelling should be less than 2 days).
2. Lower the density: 1,000–1,500 MTZ/cm^2 for epidermal lesions and 500–750 MTZ/cm^2 for dermal lesions.
3. Lengthen the treatment interval: 2–4 weeks for epidermal lesions and 4–6 weeks for dermal lesions.

for photoaging.[32] All patients were treated twice weekly for 4 weeks, and the degree of wrinkling, pigmentation, redness, pore size, and roughness were assessed subjectively and objectively. Skin biopsies were taken before and up to 16 weeks after treatment. The study indicated that the best result was 4 months after treatment with more than 90% of patients showing improvement. To examine the use of this device for the treatment of photoaging in Asians, our group performed a prospective study.[33] Twenty Chinese women were included, and each received weekly treatment for 8 weeks. The patients were asked to complete a structured questionnaire after the procedure, and blinded observers assessed clinical photographs taken by the use of a Canfield system. Finally, a Cutometer was used to assess the degree of elasticity to determine the degree of improvement. Although more than 50% of the patients reported at least mild degree of improvement 4 months afterward, no improvement was detected by the blinded observers, and only some but not all of the parameters assessed by Cutometer showed improvement. Interestingly, like those in previous studies, our patients tended to subjectively notice further improvement 4 months after treatment. Our findings differ from previous studies for two possible reasons. First, with a higher epidermal context, 590 nm is less well absorbed by Asians, and either more treatment sessions are needed or the laser parameters (energy or exposure time) should be changed. Another possible explanation is that Asians age with more pigmentary problems and less wrinkling, and subtle improvement in wrinkling is not well detected by photographic imaging.

Yellow light and blue, red, and infrared light–emitted diodes have been proposed to be effective in the treatment of photoaging by different mechanisms, including the reduction of inflammation and the enhancement of blood and lymphatic flow through the release of nitric oxide.[34,35] Recent studies looking at the use of these light sources indicated their role in reducing the erythema that is associated with postlaser resurfacing, improving pore size, and smoothing fine wrinkles. Both the combination of blue and infrared, and the combination of red and infrared, have been reported to be effective. Further studies are necessary to examine their use in dark-skinned patients.

CONCLUSION

Dark-skinned patients present with photoaging in a different manner than Caucasians, with pigmentary problems being most commonly encountered. By choosing the appropriate parameters, ablative and nonablative procedures can be used effectively and safely in the management of photoaging in darker-skinned patients.

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PART

5

Facial Tightening Procedures

20

Surgical Tightening Procedures

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AGING

Facial aging is a gradual process that typically begins in the fourth decade of life. The process, however, can be accelerated by excessive sun exposure, cigarette smoking, radiation therapy, or certain genetic disorders (e.g., progeria, pseudoxanthoma elasticum). Histologically, aging is characterized by multiple changes that occur primarily in the dermis and at the dermal/epidermal junction. There is loss of the dermoepidermal papillae and a gradual reduction in the melanocyte population. The thickness of the reticular dermis is substantially reduced as overall dermal organization is degraded. A decrease in total collagen content results in thinning of the skin with age; the normal ratio of type I to type III collagen is also altered. Total dermal thickness decreases with age by an average 6% per decade of life in both men and women.[1]

There are alterations in both the facial skeleton and soft tissues that contribute to age-related changes in the face. With age, there is a remodeling of the facial skeleton that involves a rotation of the facial structures downward and inward with respect to the cranial base. Wrinkles, gravitational descent, and atrophy constitute the significant soft-tissue changes that occur over time. There are three causes of wrinkles in the human face: repetitive mimetic muscle action, disruption of the elastic structural network, and sun damage. Although sun damage is preventable to a certain degree and is often more limited in individuals with darker skin color, the other two noted factors contribute to the aging process in virtually all human populations. The increased melanin present in darker-skinned individuals limits actinic damage and slows the development of age-related stigmata. Darker-skinned ethnicities often do not exhibit the same degree of facial wrinkling and furrowing as their lighter-complected counterparts. If they do, it is usually at a much later age.

HISTORY

Early facelift procedures involved a limited elevation of the skin and subcutaneous tissues, placing the burden of tension on the skin. Innovative surgeons were eager to reduce the skin slough and scarring that was believed to be at least partly due to tension on the skin flaps and incisions. There was also a desire to improve the longevity and aesthetic results of the procedures. To improve outcomes, other methods were developed, especially following the description of the superficial musculoaponeurotic system (SMAS) in 1976 by Mitz and Peyronie.[2] Skoog and others developed techniques that involved dissection and suspension of the SMAS, thereby transferring tension from the skin closure to deeper tissues.[3–7] The literature was soon replete with various descriptions of SMAS procedures (plication, imbrication, strip SMASectomy) aimed at achieving the most aesthetically pleasing results.[8–10] The deep-plane facelift and composite rhytidectomy pioneered by Hamra were both extensions of the SMAS procedures, involving extensive sub-SMAS dissections and suspension.[11,12] The next landmark in the evolution of rhytidectomy surgery was the description of the subperiosteal facelift, in which the soft tissues of the face are elevated off the facial skeleton.[13,14] Over time, techniques were popularized that involved progressively deeper planes of dissection. The increased complexity of these procedures was believed to be warranted by improved and longer-lasting results.

Interestingly, in the new millennium, there has been a change of focus to minimally invasive procedures. The application of the endoscope to facial surgery has inspired facelifting procedures that limit incisions and minimize recovery times. Through exposure by the mass media and a wider acceptance of plastic surgery by the public in general, these procedures have become some of the most sought after, especially in the younger age groups. It is imperative for practitioners to describe to their patients the benefits as well as the limitations of these less invasive techniques; they certainly cannot achieve the results of a more traditional facelift and may only have applications for a specific subset of patients with more limited degrees of facial aging.

The wider acceptance of plastic surgery in the United States has led to an increased demand for facelift procedures in almost every ethnic group. Whereas surgeons previously

focused almost exclusively on issues related to Caucasian skin types, they now have to be intimately familiar with issues related to wound healing, scarring, and skin care in darker-skinned individuals. Surgeons must understand these issues for surgical planning to achieve optimal results in these patient populations.

PATIENT SELECTION AND EVALUATION

Ethnic patients presenting for facial rejuvenation require a thorough evaluation before a surgical plan can be established. In addition to taking a full history that includes documentation of comorbidities, prior surgery, medications, family history of aging, sun exposure, and tobacco history, there must be an inquiry as to how the patient heals wounds (i.e., a history of keloids or hypertrophic scars) and whether the patient has problems related to nonuniform skin pigmentation or other medical skin conditions. Furthermore, it is necessary to ask the patient targeted questions regarding hairstyle and care, such as how they style their hair, whether they wear wigs, and if they frequently receive hair-conditioning treatments. Contraindications to surgery that could be elicited in the history include cardiovascular disease, autoimmune diseases (e.g., lupus, sarcoid, sickle cell anemia), and prior radiation therapy to the face or neck.

As with any plastic surgery patient, there must be a clear and realistic expectation of goals. It is important to allow the patient to express in their own words exactly what result he or she hopes to obtain with facial rejuvenation surgery. An invaluable part of the initial exam is providing the patient with a mirror and asking him or her to point out areas for which he or she is seeking specific improvement. This should be followed by a complete physical examination, including skin color and thickness, assessment of actinic damage, amount/location of skin laxity, assessment of facial bony skeleton, cranial nerve exam, assessment of hairline, and inspection of previous surgical or traumatic scars.

Medical photodocumentation is an integral part of the initial consultation that allows the surgeon to reanalyze the patient before surgery. It also provides a basis for postoperative comparison. The standard preoperative photographic views for facelift surgery include the full-face frontal view, full-face left and right oblique views, and left and right profiles.

The physician must process all of this information to recommend a procedure that can be performed safely and provide the results that will most closely match the expectations of the patient. For example, patients who are obese and/or have extremely thick skin must be informed that the results of rhytidectomy may be less than satisfactory. Ultimately, the best outcomes can be expected in those patients who have moderately thick skin, minimal sun damage, and some preservation of skin elasticity. In addition, patients with strong facial bony structures and a well-defined, acute cervicomental angle will exhibit more dramatic postoperative enhancements than those without such pre-existing features.

OPERATIVE TECHNIQUES

Subcutaneous facelift

The original surgical tightening procedure involves a preauricular incision extending posteriorly around the lobule of the ear into the postauricular sulcus. The incision is often carried into the postauricular hair-bearing region of the scalp or, alternatively, it may follow the hairline inferoposteriorly toward the neck. The skin is elevated, preserving some subcutaneous fat on the flap so as not to compromise its vascularity. Although the pioneers of this procedure would perform limited undermining before skin excision and closure, it was soon realized that unless the flap was elevated for some distance medially and inferiorly, the excessive skin tension would result in skin slough and widened scars.

Although there are now few indications for a purely subcutaneous lift given the development of other safe and effective techniques, there are certain patients in whom this indeed may be the appropriate procedure. In patients who have previously had facelifting procedures and are presenting years later for revision surgery, the subcutaneous lift may provide a safe, effective way of refining the recurring effects of aging. It is believed that in these patients, the skin flaps have improved vascularity from previous elevation that minimizes ischemic complications and that a SMAS or sub-SMAS dissection would be difficult and perhaps treacherous if planes of dissection are scarred and obscured because of previous surgery. Furthermore, the thicker skin often present in darker-complected individuals would provide an additional margin of comfort when elevating and retracting facial skin flaps. However, the procedure is generally not an ideal option in patients with a history of cigarette smoking because of the compromised vascularity in the skin.

Subcutaneous facelift with superficial musculoaponeurotic system manipulation

Facelifting procedures based on SMAS manipulation begin with the dissection of a skin flap as described for the subcutaneous lift. (The original Skoog procedure was described as elevation of the skin and SMAS as a single unit). Once the SMAS is identified, it should be followed into the neck, where it becomes continuous with the platysma. Elevation of the SMAS-platysma in unison permits a rejuvenation of the midface, jowls, and neck that produces an effective surgical enhancement. Once dissected, methods of lifting and tightening the SMAS include plication (suture infolding), imbrication (incision,

advancement, and overlapping), or strip SMASectomy (excising a strip of SMAS). Regardless of the specific method, adequate suspension of the SMAS using multiple points of suture fixation must be performed to produce the desired tightening.

Once the fascial lift has been completed, the skin flaps can be redraped and modified as necessary. As the excess skin is trimmed, the surgeon should place great importance on stable skin fixation in both the preauricular temporal region and along the postauricular incision. An effort should be made to minimize skin tension to avoid alterations to the final position of the hairline, the tragus, and the lobule of the ear.

The various methods of subcutaneous dissection with SMAS manipulation undoubtedly account for the most commonly performed facelifting procedures. Critics argue that separation of the SMAS from the skin limits perfusion of the skin flap by the underlying fascia system and that ultimately the dermis still bears the burden of tension during skin closure. Furthermore, a lengthy subcutaneous flap dissection may still result in unacceptably high rates of wound-healing complications when performed in smokers. However, in trained hands and with appropriate patient selection, there is abundant evidence that these techniques yield exceptional, long-lasting results.

Deep-plane/composite facelift

The deep-plane and composite techniques for facelifting consist of a limited subcutaneous dissection from the initial incision (2–3 cm), followed by an extensive sub-SMAS elevation extending anteromedially above the zygomaticus major muscle to include the lower orbicularis oculi muscle. The platysma undergoes a more thorough dissection to permit its suspension to the preauricular fascia near the lobule of the ear. Essentially, the skin, subcutaneous tissue, SMAS, and platysma are elevated as one thick flap extending from the site of SMAS incision laterally to a point medial to the nasolabial folds. Imbrication is then performed at the level of the SMAS to achieve suspension, allowing the skin to be redraped, trimmed, and inset as in other facelifting procedures.

The aesthetic results that can be achieved with these procedures are attributed, at least in part, to the widespread SMAS undermining, as well as extension of the dissection across the nasolabial folds. Whereas in other procedures the nasolabial folds are often not sufficiently tightened, the deep-plane/composite procedures emphasize elevation and suspension in this area of the face. Extensive undermining in the sub-SMAS plane permits suspension of a thick musculofasciocutaneous flap and is believed to produce longer-lasting results and be safer in smokers. On the contrary, the procedure may have a higher rate of nerve injury that is due to the deeper plane of dissection, with longer operative times and a somewhat prolonged recovery compared with procedures that are characterized by more limited dissection.

Subperiosteal facelift

Extensive dissection in the subperiosteal plane of the temporal and malar regions is the basis for the subperiosteal facelift. The soft tissues are mobilized with suture suspension, and the results can be enhanced with deep periosteal tacking sutures. In the temporal region, the dissection is carried deep to both layers of temporalis fascia, thereby reducing the risk of injury to the frontal branch of the facial nerve. The procedure is beneficial for redraping of the forehead and malar areas but may be insufficient for rejuvenation of the perioral areas and neck unless direct skin suspension is included. In fact, patients with significant redundancy in the lower third of the face are probably not candidates for a subperiosteal facelift. The critics of this procedure argue that an extensive subperiosteal dissection may disinsert mimetic muscles and thereby actually accentuate cheek ptosis.

Although the subperiosteal facelift has not been accepted as widely as the aforementioned procedures, it has been the foundation for some of the newer, minimally invasive procedures designed to rejuvenate the midface.

MINIMALLY INVASIVE TECHNIQUES

In the last 15 years, there have been numerous descriptions of procedures designed to surgically tighten the face. These are characterized by smaller incisions and quicker recovery times compared with traditional facelifts. Many of these are based on the techniques of the subperiosteal facelift but incorporate the use of the endoscope to minimize incision length. One of the popular techniques for endoscopic midface rejuvenation was popularized by Hester, who described the transblepharoplasty subperiosteal cheek lift.[15,16] The procedure consists of a lower blepharoplasty incision to access the subperiosteal plane over the maxilla, followed by an endoscopically assisted dissection of the midface and suture suspension of the malar soft tissues in a superior vector of elevation. Other authors have described a similar procedure using a temporal incision to achieve a more superolateral vector of soft tissue suspension.[17–19] The most appropriate candidate for endoscopic-assisted composite rhytidectomy would be a patient with minimal skin redundancy, as the limited incisions would prohibit aggressive skin resection and redraping.[20]

Recently, there has been great interest in surgical tightening procedures that use transcutaneous needles and barbed sutures to elevate the midface and neck, thereby obviating the need for skin incisions altogether. These products have been marketed under several different brand names, and there has been widespread interest from patients looking for a minimally invasive method of facial rejuvenation. These procedures generally do not involve any soft-tissue undermining; the suspension sutures must therefore counteract the soft-tissue attachments of the face. Short durations and quick recovery

Figure 20-1 Pre- **(A)** and **(B)** postoperative photos of a patient undergoing endoscopic browlift and midfacelift.

times render these procedures quite attractive to patients, but there is still no consensus as to the longevity of the results. Furthermore, the patients who may indeed be candidates for these techniques are not necessarily the same patients who would benefit from more traditional facelifts.

Although it is desirable for surgeons to incorporate minimally invasive techniques into their practices to provide patients with a greater number of options, they must do so carefully during this time of ongoing evolution of these types of procedures.

ISSUES SPECIFIC TO ETHNIC FACELIFTING

Between 1999 and 2001, the number of African Americans who had cosmetic surgery quadrupled, along with other darker-complected ethnic groups.[21] The increased demand for surgical tightening procedures in these populations has encouraged physicians to analyze how best to achieve surgical success and patient satisfaction. Whereas a successful facelift in a Caucasian patient may involve one set of criteria, it does not necessarily apply to other ethnic groups. For example, African American patients seeking facial rejuvenation may not want to eliminate the natural characteristics of their ethnicity, seeking instead a natural-appearing restoration of more youthful African American features (Figs. 20-1, 20-2, and 20-3). Therefore, any surgeon caring for ethnic patients must understand what are considered to be attractive features in each group.

The skin characteristics of darker-complexioned ethnicities must be considered in the preoperative evaluation of a cosmetic surgery patient. Obviously, there is a concern for scarring that often may be more of a risk than in Caucasian patients. A thorough history and examination of previous surgical or traumatic scars will sometimes elicit whether the patient is likely to develop postoperative hypertrophic scars and/or keloids. There are, however, some patients who will develop keloids and hypertrophic scars despite a negative history (Fig. 20-4). This is especially relevant in the traditional rhytidectomy incision. People of color must be counseled about the prominence of the incision in the pre- and postauricular region, and those patients who wear their hair short or back may not be the ideal candidates for a traditional facelift incision. Surgical planning may have to be modified based on the severity of the risk, and patients must receive a detailed explanation of the risk of scarring and possible remedies if it occurs.

African American patients and other dark-skinned ethnicities often present for facial rejuvenation procedures at a later age than their Caucasian counterparts. The effects of aging may present later in life, and there may be fewer signs of facial aging present at younger ages. The

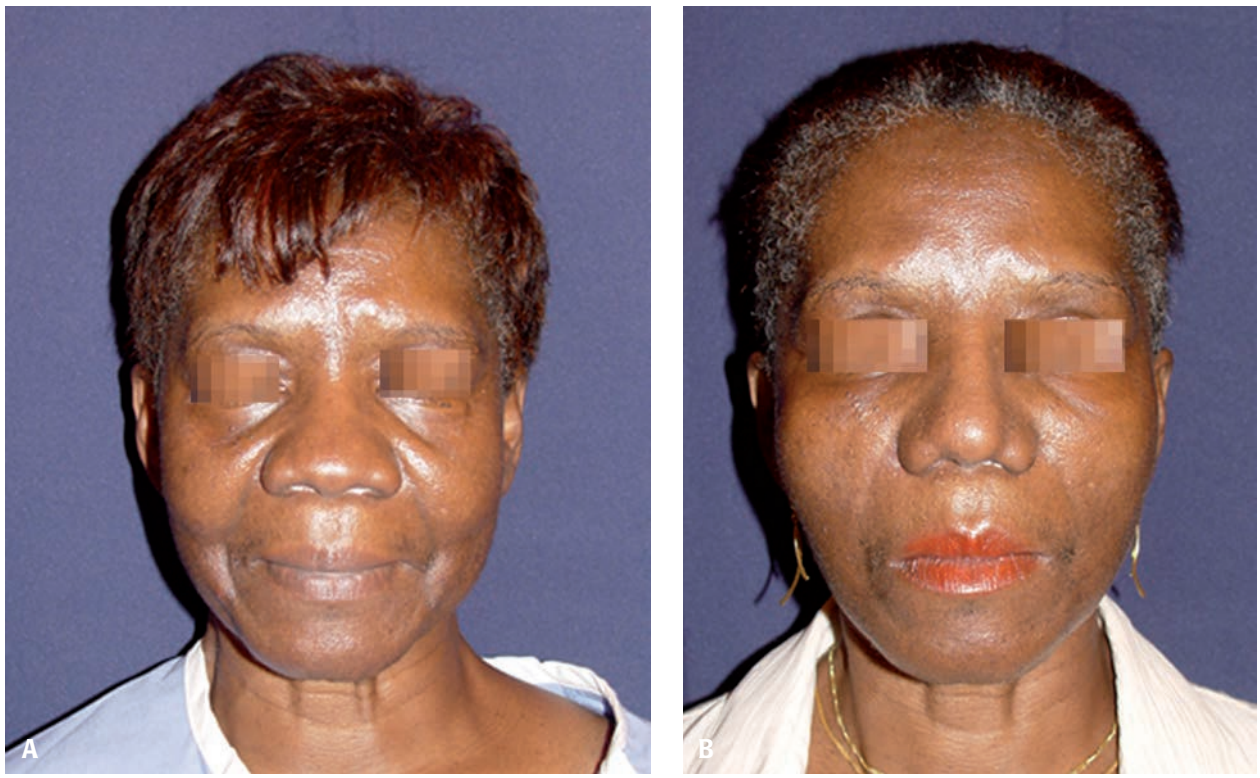

Figure 20-2 Pre- **(A)** and **(B)** postoperative photos of patient undergoing endoscopic midfacelift and rhinoplasty.

characteristics of skin in these ethnic groups include protective features that limit many of the age-related changes that are common to lighter-skinned patients. Therefore, the goal of facial rejuvenation surgery may not be removal of redundant skin and an elimination of wrinkles and creases, but rather simply a repositioning of soft tissues over the facial bony skeleton to restore natural ethnic features.

The development of minimally invasive techniques has been timely, given the increased demand for facial rejuvenation surgery amongst ethnic populations. First, it is our opinion that traditional facelift scars in darker-skinned patients almost never heal as well as in their lighter-skinned counterparts. As practitioners gain confidence and expertise in facelifting procedures that can be performed with minimal incisions, perhaps it should be these procedures that receive initial consideration for darker-skinned patient populations. Second, because these patients often can be significantly improved with simply a repositioning—rather than removal—of soft tissues, the minimally invasive procedures are often effective methods of achieving surgical success and patient satisfaction.

Aside from scarring, there are certain skin-related concerns that are more prevalent in darker-complected individuals. For example, many African American patients are concerned about a lack of uniformity in skin pigmentation and are looking for topical treatments that will correct areas of hyper- or hypopigmentation. The treating physician must have an understanding of both the degree of patient concern as well as the available treatments for this condition. Oftentimes, the surgical rejuvenation procedures will be enhanced by effective treatments of these skin conditions to achieve the most optimal aesthetic results.

COMPLICATIONS

Although facelifting procedures are generally considered to be safe, there are certain complications that must be made known to the patient. A complete description of all facelifting complications is beyond the scope of this chapter, but it is important to discuss the three most common: hematoma, nerve injury, and skin-flap necrosis.

Hematoma

Hematoma formation is the most common complication, occurring in 2% to 15% of patients. It is twice as common in male patients.[22,23] A large hematoma will usually present within the first 12 hours after surgery and requires re-exploration. There are certain factors that have been established as correlating with hematoma formation, including poor blood pressure control, ingestion of aspirin-containing products or nonsteroidal anti-inflammatory drugs (NSAIDs), and high doses of vitamin E. Preventing this undesirable event includes strict peri- and intraoperative

Figure 20-3 **A:** A 64-year-old woman, baseline frontal view. **B:** After lower facelift. **C:** Baseline oblique view. **D:** After lower facelift. (Courtesy of Arthur Jensen, MD.)

blood pressure control, especially on emergence from anesthesia, and a detailed medication history elicited from the patient regarding use of aspirin, NSAIDs, and vitamins.

Apart from the major hematomas that require immediate evacuation to prevent skin slough and airway compromise, minor hematomas that present gradually in the first week after surgery can often be managed conservatively with needle aspiration or a small opening in the incision and compression. An extended course of antibiotics should be prescribed to minimize the risk of infection.

Figure 20-4 This patient underwent traditional facelift procedure and has a hypertrophic scar in the **(A)** pre- and **(B)** postauricular areas.

Nerve injury

Although the buccal branch of the facial nerve is the most commonly injured facial nerve branch during facelifting, it is unusual for there to be clinical sequelae given the overlapping territories supplied by adjacent branches. Alternatively, injury to the marginal mandibular branch or frontal branch of the facial nerve will indeed result in facial weakness in the lower or upper portions of the face, respectively. Deeper planes of dissection are associated with higher rates of nerve injury. Medial extension of the sub-SMAS dissection requires particular care; the surgeon will encounter the distal branches of the facial nerve as they approach their respective mimetic muscles. Although there is more concern for the facial nerve and the potential for injury during facelifting procedures, the most commonly injured nerve is actually to a cervical sensory branch: the great auricular nerve.

Skin-flap necrosis

There are certain predisposing factors to skin-flap necrosis following a facelift, which is ultimately caused by compromise of the random blood supply to portions of the skin. It is believed that excessive undermining of a subcutaneous skin flap or elevation of a flap that is excessively thin places the skin blood supply in jeopardy and may result in flap ischemia. In addition, excessive tension on the flaps, especially in the postauricular area of fixation, may compromise viability and lead to necrosis.

There is a significantly elevated rate of skin-flap necrosis in smokers when compared with nonsmokers. This is attributed, at least in part, to the deleterious effects of nicotine on skin circulation.[24,25] It is important to counsel smokers preoperatively so that they may embark on a smoking cessation program and at the very least refrain from smoking both 3 weeks before and after the surgery.

SUMMARY

There has been a tremendous increase in the demand for surgical facial rejuvenation amongst ethnic populations. Darker-complexioned individuals often present for treatment at a later age and often with less severe aging stigma than their lighter-skinned counterparts. Although traditional facelifting procedures may be appropriate in certain patients, the potential for unsightly scars in certain individuals may preclude a successful outcome. The development of effective minimally invasive techniques may allow plastic surgeons to effectively treat these patients and avoid the placement of facial incisions.

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21

Nonsurgical Tightening Procedures

Sorin Eremia

IMPORTANT DIFFERENCES BETWEEN LIGHTER AND DARKER SKIN TYPES

The detailed histologic and physiologic characteristics of darker skin types are beyond the scope of this chapter.[1–4] Chapter 2 provides an overview of the structural and physiologic features of darker skin types. It is, however, important to understand three key differences between lighter and darker skin types that are relevant to the aging process and to methods of skin tightening discussed in this chapter.

Presence of increasing amounts of melanin

The amount of melanin is the very basis of the skin type I to VI classification. More melanin translates, on one hand, into better photoprotection and delays the appearance of the photoaging changes seen earlier in lighter-skinned individuals. On the other hand, melanocyte response to epidermal and superficial dermal tissue injuries is more severe, with potential permanent or at least long-lasting and difficult-to-treat pigmentary changes. Therefore, when aging changes begin to appear in darker-skinned individuals and these patients seek treatment, much greater care must be taken when using the concept of tissue injury to trigger rejuvenating changes, such as new collagen and elastic tissue formation and collagen tightening and remodeling in general.

Treatment methods that involve significant epidermal tissue injury, methods that are defined as ablative skin resurfacing—be they the more modern laser or broadband light-based methods or the older chemical and mechanical abrasive methods—are not well suited for darker skin types. Such treatment techniques are in fact considered largely contraindicated for anyone with skin darker than what is defined as a relatively light type IV. The increased presence of skin pigment also generally limits the wavelengths that can be used for photorejuvenation treatments to longer wavelengths outside the melanin absorption spectrum. Epidermal cooling to protect superficial skin injury that may trigger melanocytes to respond also becomes of greater importance the darker the skin type that is being targeted for treatment.

Increased thickness of skin associated with dark skin types

The increased thickness of skin associated with darker skin types appears to be primarily due to increased dermal thickness and amounts of collagen present. Combined with better melanin photoprotection, it delays the appearance of fine wrinkles associated with actinic damage, typically seen in lighter skin type individuals. It contributes to differences in skin appearance at a given age, according to skin type characteristics, and makes larger wrinkles a greater concern for non-Caucasian patients, especially those with types V and VI skin. In the author's experience, thicker, non-Caucasian type skin tends to experience better tightening following the use of nonablative rejuvenating devices that heat the dermis.

Risk of hypertrophic and keloid scar formation and generally greater visibility of incisional scars

These risks make incisional-based, especially traditional long incision, tissue-resection–based skin tightening less desirable for non-Caucasian skin patients. It raises some concerns even for minimal incision lifts, although in the author's experience, relatively small incisions placed inside the hairline and closed without tension do not present a significant problem. Increased tendency to scar formation also increases the risk of serious complications secondary to heat-generating energy–based nonablative rejuvenating devices, from what would have been only a minor superficial burn in lighter skin type patients. Therefore, greater caution must be exercised with such devices for darker, non-Caucasian patients. Many of the published and conference presented reports of good skin tightening results achieved with such devices also include, in the complications section, a certain number of minor burns that healed without or with minimal scarring. Unless otherwise specifically mentioned in the reports, most likely those injured were lighter skin type patients, and far more serious consequences could have developed in comparably burned darker skin type patients.

As of August 2006, there are two categories of relatively nonsurgical, minimally invasive treatment methods and devices that are available for skin tightening in darker-skinned, non-Caucasian patients: (a) the use of energy-delivering devices to achieve tissue tightening, and (b) the use of minimal incision suspension sutures, including the newer small barbed or larger multianchor type suture. These sutures elevate the tissues into position and rely either on natural postinsertion skin contraction or on inducement of subcutaneous fibrous tracts or fibrosis in a plane above or below the elevated tissues to hold up the lift long term. To improve long-term results, increased tissue fibrosis and contraction is induced through various methods, including the combined use of energy-delivering devices with suspending sutures.

ENERGY-DELIVERING DEVICES USED FOR NONABLATIVE OR MINIMALLY ABLATIVE SKIN TIGHTENING

The concept behind these devices is to deliver sufficient energy to the superficial and middermal tissue without creating any—or at least very little—injury to the epidermis, hence the terms *nonablative* and *minimally ablative*. The energy is transformed into heat as it is absorbed by the target tissue. The desired thermal injury occurs in the area of maximum energy absorption. The injury triggers formation of new collagen and elastic tissue; it is hoped, in sufficient amounts, to achieve a clinically significant improvement. Sufficient heating of the collagen fibers can also trigger some dermal "remodeling" through instant shrinkage of these protein fibers. The trick is to limit the thermal injury to the targeted dermal tissues and to avoid significant injury to the epidermis, either from direct epidermal absorption of the energy beam as it traverses the epidermis to reach the dermis or from diffusion of the heat superficially. Selection of suitable energy parameters and delivery methods, such as wavelengths and pulse widths, can minimize or virtually eliminate the absorption of energy by the epidermal tissue and determine the depth of maximal dermal absorption. The use of epidermal cooling technologies can protect the epidermis from injury resulting from a certain degree of unavoidable energy absorption by epidermal tissue and from heat diffusing up from the dermis.[5]

From a wavelength point of view, properly delivered far infrared and radiofrequency energy can pass through the epidermis with very little absorption by epidermal tissue, including melanocytes. Wavelength selection also takes into consideration its scatter characteristics as it passes through tissue. Some wavelengths in the infrared spectrum, such as 1,319 nm and 1,450 nm, also have more scattering characteristics as they penetrate through the dermis than 1,064 nm, so most if not all the energy is delivered to the desired dermal target area. On the other hand, when the target area is deeper—such as with hair follicles, which are deeper in the subcutaneous fat—a wavelength with low scatter characteristics is better suited. The delivery of energy in pulses can also vary the target tissue. Various components of the skin have different thermal relaxation times. Larger targets, related to the surface-to-volume ratio of the target, dissipate absorbed heat more slowly than smaller targets. Therefore, when energy is delivered more slowly over time (longer pulse width), smaller targets with short thermal relaxation times have the time to dissipate the heat before the next pulse of energy hits the target, and the heat does not accumulate. Larger targets, with longer thermal relaxation times, accumulate heat, eventually reaching the critical temperature that triggers thermal injury. Skin-cooling strategies also need to take into account the source of heat reaching the epidermis. When some of the energy is absorbed by the epidermis as it passes through, precooling as well as contemporaneous cooling of the epidermis is very important to prevent epidermal injury. When the heat is not the result of direct absorption by the epidermis but instead rises up from the dermis, postcooling or continuous cooling may be more effective at preventing epidermal injury. Continuous cooling is obviously effective at protecting the epidermis, but on one hand can carry the risk of excessive cooling and freeze injury to the epidermis and on the other hand can diffuse into the dermis and negate the desired thermal injury there.

Although device manufacturers obviously take all such factors into consideration when building their machines, patent restrictions and technical and cost considerations sometimes limit their ability to provide the most effective energy delivery and cooling system. In the author's opinion, it is important for physicians using such devices to have a thorough understanding of the science behind them to be better able to judge and choose the most appropriate device for the physician's patient population needs.

First-generation nonablative devices

The first-generation devices specifically designed for nonablative skin tightening were lasers delivering light energy in the far infrared spectrum. CoolTouch (NewStar Lasers, Rosemont, CA) using a 1,320-nm Nd:YAG–generated wavelength and a fixed 50-millisecond pulse width was introduced in 1997. The availability of cryogen spray pre- and postcooling, the addition of a temperature sensor, and a relatively large 10-mm treatment spot set CoolTouch apart from the SmoothBeam (Candela Lasers, Boston, MA), a smaller, less sophisticated, but less expensive, 1,450-nm diode–generated wavelength laser and the European-developed Aramis Erbium:Glass 1,540-nm laser, which never quite caught on in the United States. As is too often the case with new devices, the laser manufacturers and some physicians promoting these lasers made unrealistic claims that as few as four treatments could produce significant skin tightening and improvement in acne scars and even improve acne. In time, it was determined

that many treatments (for example, in the author's experience, 10 to 14 monthly treatments with the CoolTouch laser) were needed to achieve modest long-term skin tightening or acne-scarring improvement. Overaggressive treatments also resulted in rare but annoying scarring thermal injuries. Both the CoolTouch and SmoothBeam lasers are still available and have proven to be generally reliable, low-operating-cost lasers. Very similar to the CoolTouch, but technologically more advanced, is a Sciton 1,319-nm Nd:YAG laser that presents several advantages. It has a variable pulse width, which allows great flexibility as to how the energy is delivered; a fast, large treatment area with a scanned 6-mm spot; and excellent adjustable contact window cooling. One of the chief complaints about the CoolTouch, and the SmoothBeam lasers is significant patient discomfort. Use of longer pulse widths decreases treatment pain, and, when compared with the 10-mm CoolTouch spot size, so does the randomly scanned smaller 6-mm Sciton spot. The unit can operate on a platform that can support multiple lasers (such as 1,064-nm Nd:YAG and an Er:YAG, and pulsed broadband light units). The wavelength used by all these lasers has virtually no melanin absorption.

Other lasers and early broadband light devices

The concept of nonablative thermal skin injury to induce formation of new collagen and elastic tissue led to attempts to use other existing lasers, such as the 595-nm pulse dye laser, the 1,064-nm Nd:YAG with long pulse width, alone or in combination with the 532 Nd:YAG to induce skin tightening. In general, these results have been very modest. The use of the 532-nm and the 595-nm wavelengths in darker skin is contraindicated. The use of selectively filtered pulsed broadband light was also attempted for purposes of skin tightening. The earliest version was the "photofacial" treatment with the Lumenis intense pulsed light units. Skin tightening results were very disappointing. Newer units are discussed below.

Radiofrequency devices

In 1999, the ThermaCool device (Thermage Inc., Hayward, CA) was introduced. Volumetric dermal heating is accomplished using a skin-cooling tip with capacitative coupling monopolar radiofrequency (RF) technology. The device converts electrical energy to RF spectrum wavelength energy. These waves of energy are delivered in monopolar fashion to the skin through a square tip that is also equipped with surface chilling to help cool and protect the epidermis. A coupling gel is used to decrease epidermal impedence and allow the energy to get through to the dermis with minimal absorption. Dermal tissue resistance/impedence converts the RF spectrum energy waves to heat, which has been shown to produce various degrees of tissue-tightening results. FDA approval for periorbital skin tightening use was obtained in 2002 amid much fanfare and claims of impressive documented skin tightening and lateral brow elevation. This was followed with claims on national television shows of impressive tissue tightening and appearance improvement in the jowls area of the face. Unfortunately, these results seemed largely exaggerated, or at best unpredictable, and limited to a small percentage of treated patients. Claims were also made of significant acne scarring improvement as well as long-term improvements in acne as well. Misguided attempts to produce such results through use of high-power settings led to some highly publicized burns with permanent scars.[6] The treatment tips initially developed by Thermage were small (1 cm) and delivered the energy slowly and quite painfully. Newer generations of tips and improved treatment protocols that involve multiple passes at lower energy settings[7] have decreased risks, improved treatment speed, and, with the most recent 3-mm tips, significantly decreased patient discomfort and operator fatigue. These large tips have also rendered more practical the use of the Thermage unit for nonfacial areas, such as the abdomen and arms, with studies ongoing.

The newest Thermage tip is specially designed for treatment of the eyelids, which was previously contraindicated with the older tips. This tip is much smaller, delivers much less energy, and is designed specifically for the thin upper-lid skin. The use of a plastic (not metal) eye shield is essential. The eyelid tip was introduced in April 2006, and preliminary results appear to be better and more predictable than results on the face. Because RF waves are not absorbed by melanin, non-Caucasian skin is well suited to it (Fig. 21-1A,B). Also, the thicker dermis of certain ethnicities appears to respond better to this device than thinner skin. The cost of the ThermaCool unit is much lower than most other tissue-tightening devices. It is relatively small and portable as well as reliable and less expensive to maintain than laser and light units. However, the cost of the tips, which are single-use disposable devices, is quite high—$500 to $600 or more per treatment (about $175 for the eyelids tip)—and has been one of the obstacles for greater use. Thermage was once promoted its product as an independent, one-time, effective treatment. More likely, several treatments at 1- to 3-month intervals are needed for best results. Although not as much a concern with types V to VI skin, the RF-induced skin-tightening effects do little if anything for fine facial wrinkles nor does it improve any pre-existing dyschromia. The author is using Thermage both as an independent procedure and in combination with the knotted multianchor suspension suture lift (AnchorLift) discussed later in this chapter.

In 2005, Aluma (Luminis, Santa Clara, CA) introduced a bipolar RF unit using vacuum to press the tissues to the treatment head. This keeps the skin in contact with the parallel electrodes, decreasing the risk of arcing and accidental skin burns. It is claimed this vacuum-negative pressure, which pulls the tissues tight onto the RF current–generating electrodes, reduces the fluences needed to heat the desired

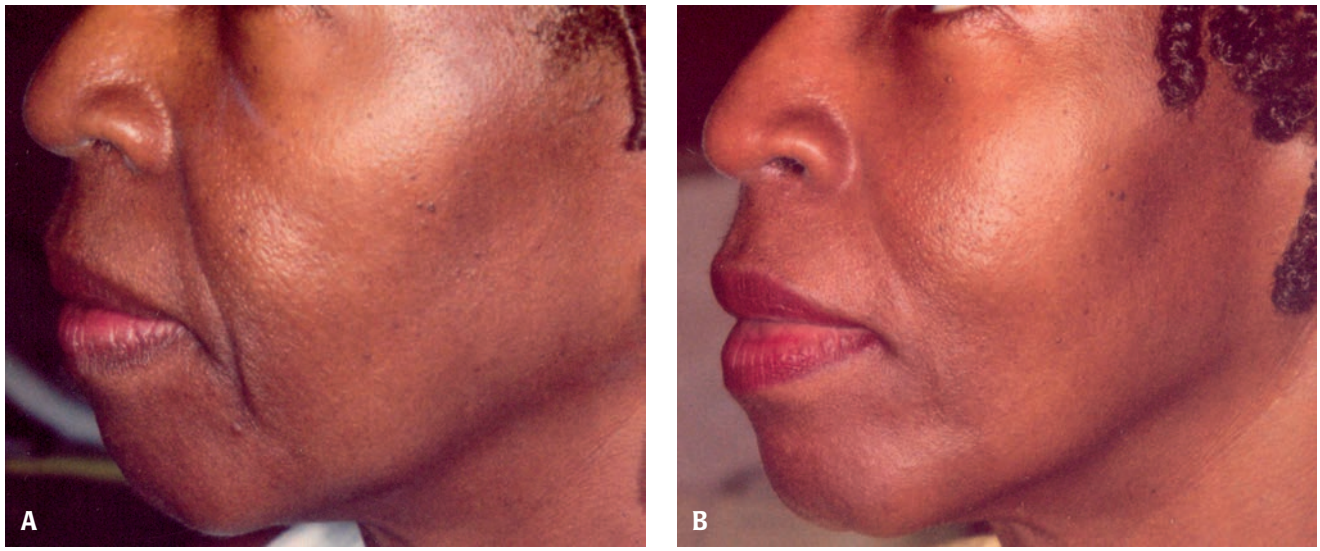

Figure 21-1 **A:** Pretreatment of lower face rhytides, type VI skin, African American patient. **B:** Six months posttreatment of the lower face with a Monopolar RF device. (Courtesy of Dr. Mark Nestor and Thermage Inc.)

volume of dermis, reducing patient discomfort. As with other RF units, a coupling gel is also used.

The tip is disposable and works for only 300 pulses, rendering treatment costs relatively high. The initial manufacturer-supported studies claim impressive results, but, as with most of these units, early results have yet to be independently confirmed as truly clinically significant.

Accent (Alma Lasers, Caesarea, Israel), still awaiting FDA approval, has two separate handpieces—one for monopolar and one for bipolar RF technology—to provide variable penetration depths and heating. The monopolar handpiece heats the dermis up to 2 mm in depth and appears to be designed for tissue tightening. The bipolar handpieces heats deeper, between 2 and 4 mm, and may be able to cause adipocyte lipolysis. The released fatty components are absorbed and eliminated. The bipolar component is more designed for treatment of cellulite. Treatment pain has been reported to be a significant factor, and results are variable. The unit is thus a dual-purpose one, designed to induce facial skin tightening and for treatment of cellulite on the rest of the body. Care must be taken not to use the bipolar component on the face where it could lead to subcutaneous fat loss. Alma also makes a fractional delivery device (Pixel) using an Er:YAG laser (not to be confused with the Er:Glass lasers used by Fraxel and Palomar) and a pure pulsed broadband light device.

Combined radiofrequency and broadband light devices

Shortly after Thermage introduced pure volumetric monopolar RF dermal heating as a skin-tightening modality, Polaris (Syneron Medical Ltd., Yokeam, Israel) was introduced as a nonablative tissue-tightening device that combines the use of 780- to 980-nm light energy with RF energy, delivered with a contact cooling tip. Claims have been made of a synergistic effect,[8] but whether such synergy has been demonstrated remains subject to debate. Lower levels of RF energy are delivered by this unit, resulting in smaller volumes of dermal heating per pulse. At the very least, the 780- to 980-nm light treatment portion has some effect on the epidermis and very superficial dermis, primarily because of melanin absorption, and can generate minor, probably temporary improvements in fine wrinkles and dyschromia. There are published reports claiming skin-tightening results, and many users are happy with the patient response. Given the use of melanin-absorbed optical energy with this device, its use for darker skin types is probably contraindicated. A newer device is ReFirme, combining the use of bipolar RF with broadband (700–2,000 nm) light energy. It is more powerful than Polaris, delivering up to 120 J/cm^3 of RF energy and 20 J/cm^2 of light energy. It is too early to judge how much more effective this newer unit will be. Early reports from manufacturer-supported studies are, as with most new devices, optimistic. Presence of melanin-absorbed wavelengths suggests caution for darker skin types.

Pure broadband light devices

Titan (Cutera, Brisbane, CA) is the flagship of this technology. It emits infrared light energy in the 1,100- to 1,800-nm range. It uses a 1.5 × 1 cm tip with a cooled sapphire skin contact window to help protect the epidermis.

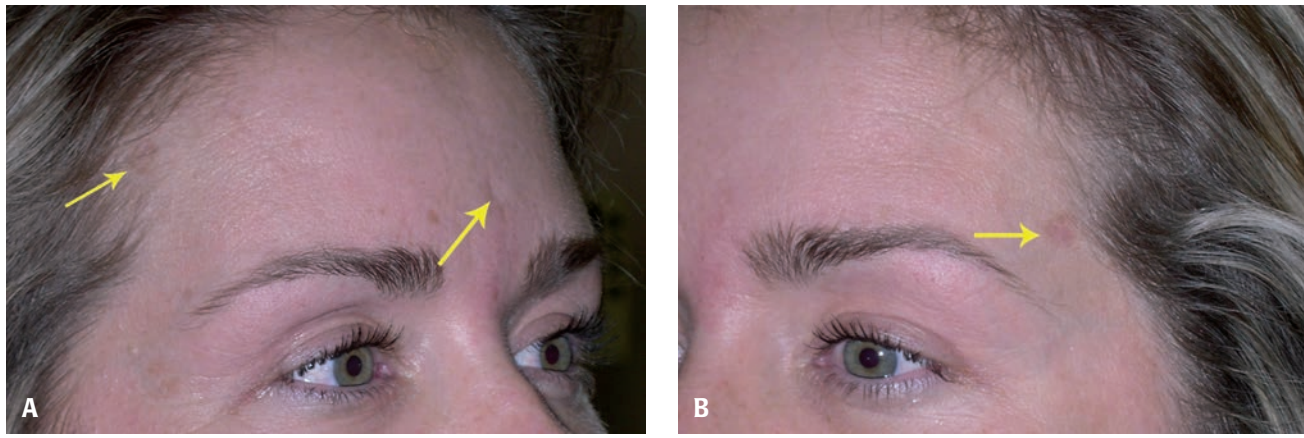

Figure 21-2 Complication following aggressive use of Cutera-Titan broadband light device. Note the permanent depressions on the forehead. **(A,B)** The patient was told by the treating physician he would try to be aggressive to give her "better results." These types of complications have been reported with other dermal heating devices, such as the 1,320 Nd:YAG laser and RF devices. Excessive heating of the dermis literally melts the collagen.

The unit automatically calculates the duration of the light exposure based on the fluence selection. It is important not to overheat the dermis, as collagen can melt, resulting in permanent depressed scars (Fig. 21-2A,B), which are occasionally actual footprints of the treatment tip. Fluences should be varied according to the skin type and location, and decreased over thin skin areas and bony prominences. Although Titan can generate fluences of up to 65 J/cm^2, most treatments should be carried out below 35 J/cm^2, in the 25 to 35 J/cm^2 range. Reports from ordinary users, as well as a few studies, indicate that several treatment sessions are needed to produce a certain level of skin tightening. Two small side-by-side studies indicated that three Titan treatments achieved about the same result as one Thermage treatment.[9] (*Note:* The 1.5-cm fast tips were used with Thermage; these have now been replaced by the new 3-cm fast tips.) When compared with the older Thermage tips, Titan treatments were less painful. When compared with the new larger Thermage tips, treatment discomfort seems more comparable when manufacturer-recommended fluences are used. When analyzing costs per treatment, Titan does not have a disposable tip like Thermage or the Luminis Aluma, but the flashlamp wears out, and its replacement cost is quite high. In the author's opinion, if considering the 3:1 treatments ratio for equivalent results, the much higher cost of the Titan unit, and the higher service-contract costs, there is not much cost difference between the two. These are expensive treatment methods for limited results, but with realistic expectations, patient satisfaction can be quite high.

The LuxarIR (Palomar, Burlington, MA) is an infrared light device (850–1,350 nm) that delivers its energy in fractional fashion from a 12 × 28 mm treatment tip with contact cooling. Unlike the true fractional Er:Glass 1,540-nm lasers (see below), which create very small columns of thermal necrosis zones through the epidermis and dermis, this broadband light unit heats 2-mm circular areas to peak temperature of about 55°C and leaves an area of tissue around these peak temperature zones at lower temperatures. Because most of the light delivered is not well absorbed by melanin, the unit can probably be used safely in darker skin types, but maybe not at its maximum power. Independent studies demonstrating long-term results are not yet available. Palomar recommends combining the light unit with its true fractional Er:Glass laser for best results. Both can be installed on the same platform. Like with all broadband light units, the operating costs are related to replacing the flash lamp.

Minimally ablative fractional energy-delivery treatment area devices

Fraxel (Reliant, Palo Alto, CA) was the first device to use fractional tissue destruction, in the form of many tiny columns of so-called microthermal zones of tissue necrosis, surrounded by sufficient intact tissue to allow for very rapid healing with virtually no downtime. Multiple treatments are needed—at least four to ultimately treat most of the skin surface for a desired area. Calculating the surface areas of tissue injury versus intact tissue, only 20% to 25% of an area is treated per session. These tiny plugs of necrotic tissue are very quickly expelled, and rapid healing occurs. However, if the injury is sufficiently deep inside the dermis, the usual tissue-healing cascade is triggered, resulting in formation of new collagen and elastic tissue. The results are particularly impressive for acne scars, although in the author's experience, it takes more like 5 to 6 monthly treatments for optimal results. Mild improvement for superficial facial rhytides can be seen with multiple

treatments. With delivery of the energy beams at lower fluence and higher density, more superficial epidermal/dermal columns of destruction are achieved, with good results for melasma. The most practical use of this device is on the neck, chest, hands, and arms. It appears to be far more effective for these areas than broadband light devices and infinitely safer and with less downtime than erbium lasers or comparable strength chemical peels. On these nonfacial areas, the author (and others) have noticed a combination of improvement in both dyschromia and what is best described as apparent thickening of the skin. However, the application of this device to darker skin types is probably more for acne scarring and possibly melasma, as fine wrinkles and thin actinic damaged skin of the sun-exposed nonfacial areas is not a common presenting problem.

From a practical point of view, the Fraxel unit is both expensive to purchase, maintain, and operate because of consumable tips that have to be replaced every few patients, depending on the surface area treated and fluences used. The unit does not have built-in cooling, and the manufacturer recommends use of a cold-air device. Discomfort, even with use of the chilled air and topical anesthesia, can be a problem, though less so on the trunk and extremities than face and neck.

Lux 1540 Fractional (Palomar, Burlington, MA) uses virtually the same 1,540 Er:Glass laser–derived microbeams of energy concept as the Fraxel. They are delivered through a contact cooling sapphire window. The tips are either 10- or 15-mm square and are applied with 50% overlap.

The unit is priced about 20% lower than the Fraxel, and the operating costs per treatment are lower. Although the tip does not need to be replaced, the laser-generating source needs to be replaced after a certain number of pulses. It is estimated the cost will be around 15 to 20 cents per cm^2 of surface area treated. Side-by-side studies are needed to determine how the Palomar device compares with Fraxel with respect to superficial crusting, pain, and wrinkle reduction.

Affirm/Afirm1440 (Cyanosure, Westford, MA), introduced in August 2006, combines a 1,440-nm Nd:YAG laser with a 560- to 950-nm broadband light source, using fractional energy–delivery technology. The laser tip is 10 mm, and the pulsed light tip 11 × 55 mm. The system uses the same cold-air blowing device for skin cooling as the Fraxel.

The concept of combined light and laser fractional energy delivery is similar to that advocated by Palomar. The light spectrum, however, could make it unsuitable for darker skin types. As with most new devices, efficacy is difficult to evaluate absent well-designed, independent studies.

CHOOSING A DEVICE

In addition to the obvious factor of efficacy and relative safety, device selection should also take into account cost, duration, and frequency of treatments, ease of use, size, and space requirements. Cost includes not only initial purchase price, but also use of consumables, which are not necessarily limited to single-use consumables but also to expensive parts that wear out and translate into a cost-per-use factor. Last but not least are maintenance, reliability, and after-sale service. Most devices come with a 12-month warranty. Service contracts after the first year can be very expensive—often 7% to 10% of the cost of the unit—and sometimes they do not cover everything. Service calls not covered by warranty can be exorbitant. Many laser companies charge $200+/hour with a 4- to 8-hour minimum for any noncovered service call. Replacement parts can also be very expensive. Some laser companies charge 8 to 10 times the cost of a simple GE flash lamp in addition to the service charge to install it. It is prudent that all laser buyers carefully research the company and laser options before purchase.

Serious and unbiased side-by-side comparisons of laser, light, and RF devices are sorely needed to provide prospective buyers with fair and accurate information.

SUSPENSION SUTURES

Suture suspension methods using ordinary sutures weaved in and out of tissues or looped around tissue have been around for some time but have never been proven very practical or effective. Problems with the tissue puckering and the sutures eventually cutting through the tissue that was pulled up and suspended seem to doom this type of approach. The introduction of cogged sutures, originally with small barbs, to distribute tension and induce tissue fibrosis seemed like a revolutionary concept that might lead to better results.

The initial attempts to achieve facelifting using only sutures with multiple barbs, cogs, or anchors that distribute tension over a greater surface started with the use of bidirectional polypropylene barbed sutures, introduced a few years ago in Russia by Dr. Marlen Sulamanidze as APTOS threads and introduced in the United States in 2000. A U.S. patent for similarly barbed sutures by Dr. Gregory Ruff apparently preceded the APTOS thread concept and was the basis for the development of contour threads. The original 2-0 polypropylene self-anchoring APTOS threads[10] have bidirectional small barbs and float freely in the subdermis[11] (Fig. 21-3A). Subsequently, Wu has described a method of looping a longer APTOS type thread, suspending and tying it to temporal fascia.[12] Although initially widely used and now largely abandoned, the APTOS threads have never received FDA clearance. The FDA has approved a unidirectional helical barbed polypropylene suture with a long straight inserting needle attached at one end and curved needle at the other based on the Ruff patent. The suture has an increased number of short barbs over 25 helical twists. It is placed subdermally and secured to fascia through small incisions.

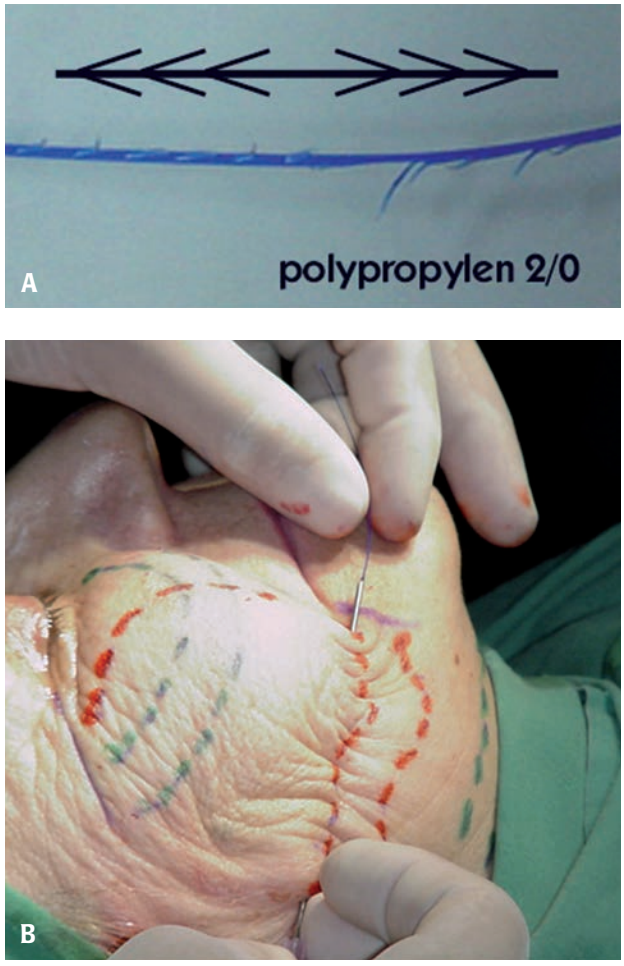

Figure 21-3 **A:** APTOS-type bidirectional barbed threads. **B:** Insertion of barbed suture under the skin through a large-gauge spinal-type needle. The skin is puckered up on the barbs.

It became commercially available in August 2004. Instead of relying on tiny directional barbs, in January 2004, the author designed a multianchor suspension suture by placing 7- to 9-mm bits of suture through each of five to nine simple square knots spaced 1 cm apart on a 2-0 absorbable monofilament suture. The bits of suture, stiff because of their short length, act like multiple anchors that open up at a right angle to the main body of the suture, like multiple molly bolts that withstand significant tension. The author also devised a novel reusable instrument that allows simple, fast, atraumatic placement of the multianchor suture through a single entry point. Preliminary results were presented at an American Society for Dermatologic Surgery meeting in September 2004.[13–16] In early 2006, Dr. Nicandor Isse who had previously used barbed suture for midface elevation,[17] introduced a suture—still in the early experimental stages and awaiting FDA approval—with 2-mm cones secured over simple knots, which conceptually is much closer to the author's knotted multianchor sutures than barbed threads.

Applications of small barbed and larger anchor sutures to minimally invasive lifts

Minimally invasive face–neck lifts can be separated into no skin excision pure suspension lifts and conservative, less invasive versions of more traditional lifts. The most minimally invasive lift was the APTOS barbed suture, a 2-0 polypropylene (nonabsorbable) suture with bidirectional tiny barbs. It is inserted under the skin through a large-gauge spinal-type needle, and the skin is puckered up on the barbs (Fig. 21-3B). The idea was that fibrosis would occur, and the skin would shrink. Twelve-month results have been disappointing, and a lot of problems with breakage and extrusion of the sutures has occurred. Often marketed as the feather lift in the United States, these sutures, subject to a patent dispute as well, are no longer used. One problem was that both ends of the suture floated free in the tissues. A number of variations of the original APTOS suture concept have evolved, where either a loop is made and both ends tied together, or one end of the suture is tied to fascia, usually in the temporal scalp, and the other end floats free. The skin is pulled up, and the dermis hooks on and is attached to the barbs.

Ruff modified his original concept to develop a thread with helical unidirectional barbs.[10,11] The distal ends of two sutures are looped around temporal fascia and are tied together. Four to eight such sutures are used on each side of the face. Although the incisions are small and heal fast, there is swelling and puckering of the skin, and it takes a few days before the patient looks really close to normal. The procedure is fast—1 to 1.5 hours—and can be done with local anesthesia, although some patients require sedation. The procedure is far from perfected, and much experimentation is happening as to how best to use the helical barbed threads. Because of problems with extrusion of knots, a new double-armed suture has been introduced. Also, in spite of initial optimistic projections by many of ContourThreads' early proponents that barbed sutures induced sufficient fibrosis along the suture tract to cause pure barbed suture lifts to last several years, results seemed disappointing. Because of this, ContourThread protocols were modified by adding blind undermining to the technique.

There is very little scientific data to support the longevity of results up to and beyond 12 months. The cost to the physician of helical barbed threads is about $130 each, and 12 to 14 threads are required to do an entire face.

There has been no significant change in the original Anchor suture design. From a small incision behind the hairline, the suture, loaded inside the suture passer, is placed much deeper than barbed sutures, just above the superficial musculoaponeurotic system (SMAS) (Fig. 21-4A). As the suture passer is removed (Fig. 21-4B), the "anchors," bits of knotted sutures, open up and deploy like anchors and grab on to the deep subcutaneous fat (Fig. 21-4C). This allows for marked elevation of the tissues, which are then suspended up to fascia (Fig. 21-4D).

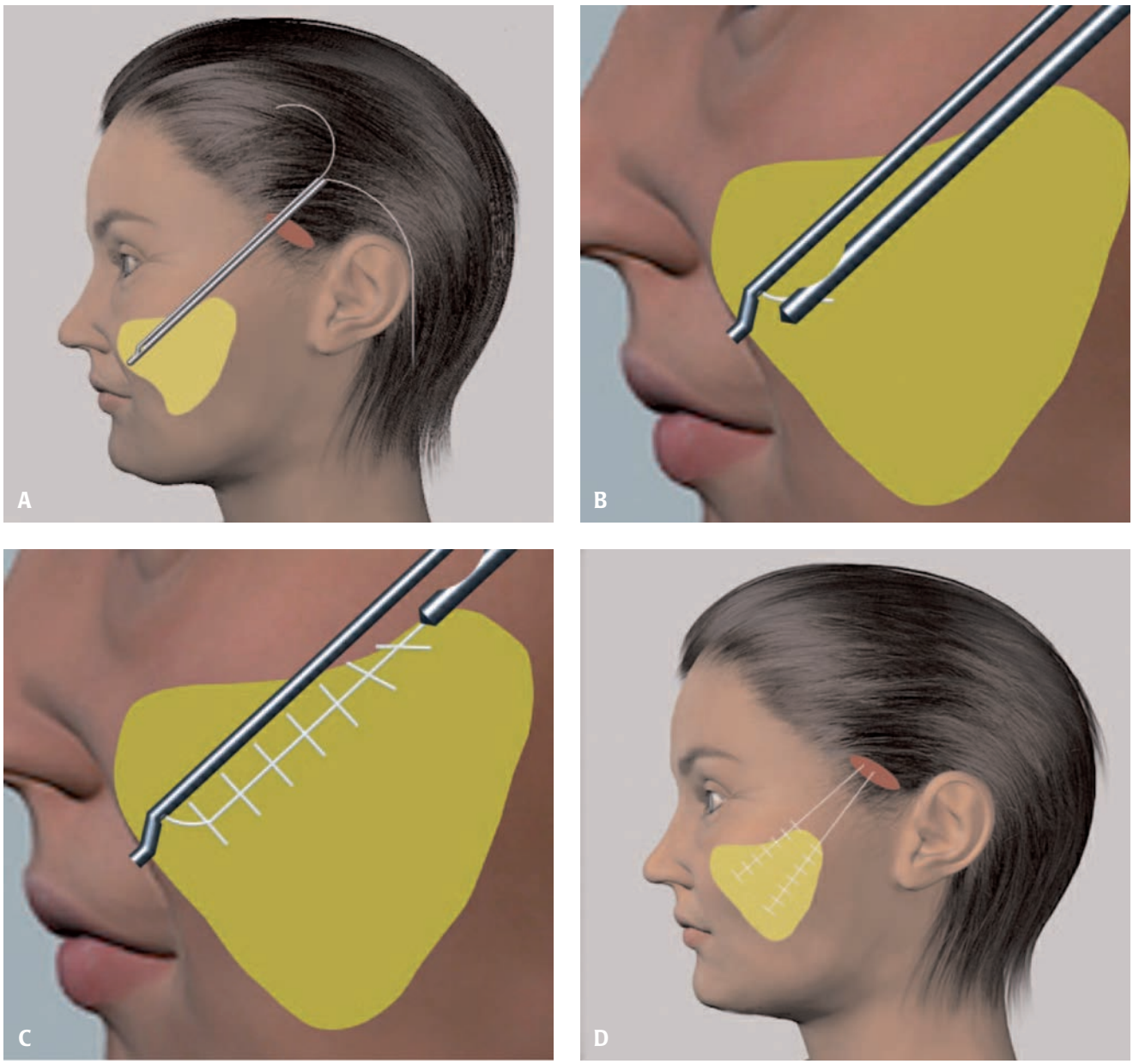

Figure 21-4 AnchorSutures. **A:** The loaded suture passer is introduced in the deep subcutaneous (just supra-SMAS) plane, through a posttemporal hairline incision. The incision is typically 2.5 to 3 cm. **B:** The smaller tube component of the suture passer is disengaged from the larger tube to expose the suture. The first suspension suture typically runs through the upper malar fat pad to the upper third of the nasolabial fold. **C:** The tissue to be lifted is pulled back over the instruments so the anchors will be in the proper position. The larger tube is removed, exposing the anchors, while the smaller tube holds the suspension suture in place. After anchors are engaged in the tissue, the smaller tube is removed. **D:** Tissue to be suspended is pulled up, and the needle end of the suture is secured to the appropriate temporal fascia. The free end of the suture is clipped as far back as possible and floats freely without purpose. Two to three sutures will reposition the malar fat pad and elevate the corner of the mouth as well. One additional suture can be used for the jowls and one for the neck.

Figure 21-5 Results of "no skin excision, minimal incision" AnchorLift (knotted multianchor suspension lift) in an African American patient. **A:** Preoperative. **B:** Six months postoperative. **C:** Fifteen months postoperative. Notice the remarkable initial improvement followed by eventual loss of correction.

The multianchor suture is, in the opinion of some of its users, better suited to lift the tissues than the small barbed sutures. Some use the two combined, with the anchor sutures deeper and the barbed threads more superficially. Because the anchor suture is eventually absorbed, it presents less potential risk for problems. Long-term results, however, are still questionable, and its inventor believes that simple tissue elevation with small barbed or larger anchor sutures cannot hold up and yield very good long-term results (Fig. 21-5A,B,C). For this reason, the author now combines the use of suspension sutures with other non- or minimally invasive skin-tightening procedures. Results of studies using the simultaneous combination of anchor sutures with either ablative CO_2 laser resurfacing or with nonablative Thermage RF treatment are promising (Fig. 21-6A,B).[16] In addition, the author

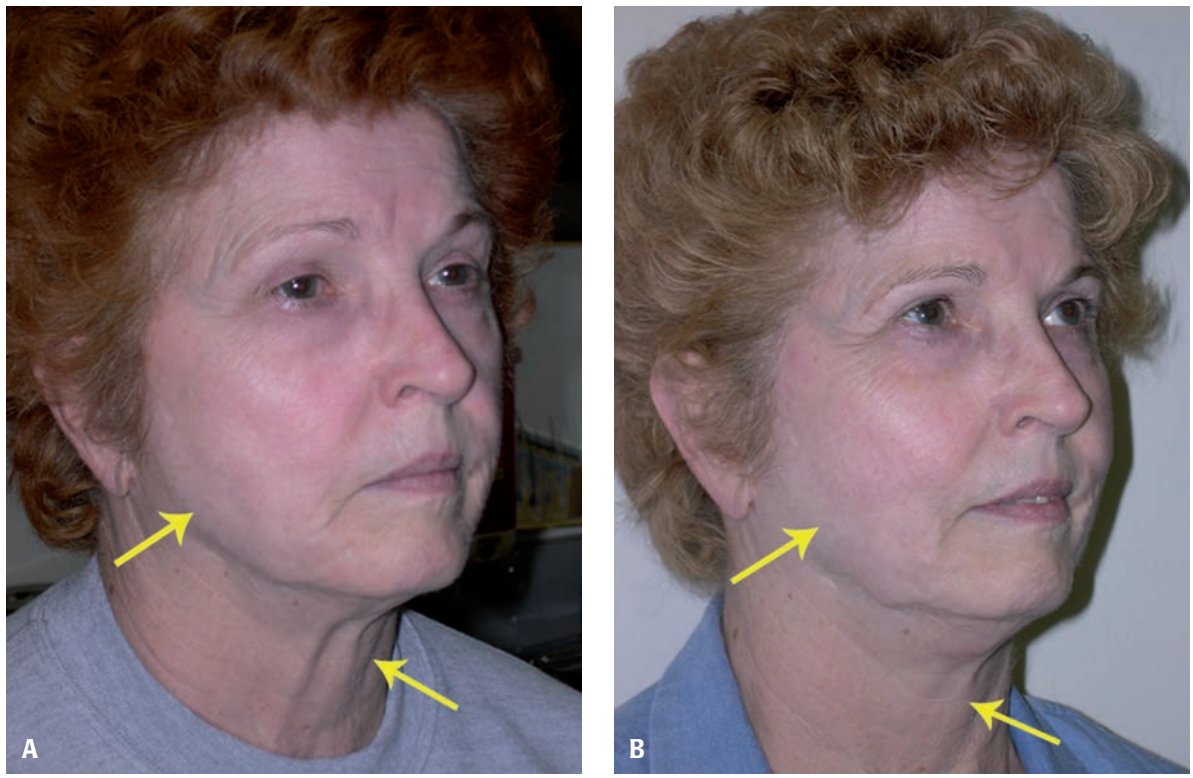

Figure 21-6 Results of the same type of AnchorLift procedure as Figure 21-5 plus the addition of Thermage RF treatment immediately before the AnchorLift procedure. **A:** Preoperative. **B:** Twelve months postoperative. Notice improvement in the neck area as well as improved volume, contour, and skin elasticity of the mid- and lower face.

presented results demonstrating marked benefits of the use of Anchor-Sutures in combination with open facelifts.[19] Most notable were impressive results achieved with more conservative facelift procedures by adding a few anchor suspension sutures. Of interest for darker-skinned patients is the ability of slowly absorbable multianchor sutures to redistribute tension from the incision line to the entire skin flap. This helps prevent stretching of the scar and can reduce the incidence of hypertrophic scarring along the anterior periauricular facelift incision line, a feared complication in type IV to VI skin patients.

The developers of the Silhouette Suture theorize that the resorbable 2-mm cones will trigger more fibrosis than other suture designs and enough to hold up a simple suspension lift long term. There is little data to substantiate this concept. Such sutures may ultimately be used with open facelifts as in the case of my AnchorSutures. They may also be used in combination with other techniques to trigger tissue tightening.

All the techniques described, including combined ablative and nonablative resurfacing, and even anchor suture assisted conservative facelifts, can be performed with local anesthesia. Placement of APTOS threads use a guiding needle to pass along a previously outlined contour (Fig. 21-3B). The lifted and grouped tissues remain fixed by the bidirectional barbs that point toward the middle of the suture from both ends. The suture ends are cut and pushed into the subcutaneous tissue. The AnchorSuture was originally hand assembled from 2-0 commercial PDS sutures with five to nine equally spaced knots. Each knot secures a 7- to 9-mm bit of suture cut from the same 0 thickness suture material. The suture needle remains attached but is straight, so the inserting instrument can be withdrawn back over the needle end. The author prefers PDS-like slowly absorbable monofilament sutures, but permanent sutures can also be used. The suspension sutures are placed through a small temporal scalp or postauricular incision, in the deep subcutaneous tissues, just above the SMAS, by use of a simple blunt-tip instrument that does not require a second distal exit point (Fig. 21-4A). After insertion, the instruments are disengaged (Fig. 21-4B), the tissues are pulled up into position over the inserting instruments, and the inserter is withdrawn. The "anchors" open up and engage the tissues as they exit the inserter (Fig. 21-4C). The distal end of the suspension suture floats freely in the deep subcutaneous tissues. The proximal needle end of the suture is secured to temporal or mastoid fascia, and the knot is buried in the deep tissue

(Fig. 21-4D). Contour Threads use separate deployment and fixation needles. The long straight deployment needle is inserted through a small scalp incision in the opposite direction of the lift until exiting the skin. The long needle is cut off, and the curved needle is used to secure the proximal end to the fascia. Tension is placed on the distal free end of the suture while elevating the tissues. The distal free end is cut and pushed into the subcutaneous tissue.

Suspension suture results

APTOS threads have shown mild correction for the short term, but documented long-term results are lacking, and there are reports of extrusion of the barbed permanent polypropylene sutures.[20] First-generation helical barbed threads were designed to be self-anchoring, much like the APTOS threads. However, the ones being sold in the United States and variations of APTOS threads sold elsewhere in the world are now being used more like the anchor sutures by securing the proximal end of the threaded suture to fascia and using the barbs to hold the tissues into their new position. Theoretically, this should offer better support for elevation of the tissues. Convincing evidence of long-term results are lacking, and the use of secured unidirectional permanent barbed threads present the same potential risks as the unsecured APTOS bidirectional threads, although helical barbed threads are placed slightly deeper than APTOS threads. There are ongoing studies with the new helical threads, but mostly short-term results have been presented so far. Anchor sutures are designed for deeper placement at the level of the SMAS or platysma. Initial studies, using slowly absorbing monofilament sutures, showed dramatic initial results but almost complete loss of correction by 12 months. Much better results are obtained combining the anchor sutures with CO_2 laser resurfacing and, to a lesser extent, with nonablative RF treatments. The anchor sutures have also been used with open facelifts to elevate the midface and to provide additional support tissues following customary tightening of the SMAS-platysma complex (flap or plication). The use of the anchor sutures to supplement a short skin-flap, conservative-type lift offers the advantage of achieving vastly superior results, especially for the midface. There is significant persistence of the initial correction, but the longest follow-ups are only 2 to 2.5 years.

Complications

Improper placement can lead to asymmetry, usually easily corrected or resolving spontaneously over time. Superficial placement can lead to palpable sutures, especially with the larger anchor sutures. Extrusions, foreign body reactions, and occasional infections have been anecdotally reported with the permanent polypropylene barbed sutures, although none so far with the deeper-placed, single-entry-point absorbable Anchor sutures. Injury to nerves and vessels, especially with the use of sharp inserting needles, are a theoretical concern. For darker-skinned patients, devices that require entry and exit holes in visible facial areas and hyperpigmentation at the site of the puncture wound can be a problem. Late extrusion of permanent sutures could also lead to potentially more scarring and hyperpigmentation in such patients.

CONCLUSION

In conclusion, it is possible to provide excellent tissue-tightening alternative procedures for darker-skinned patients who are otherwise not good candidates for more invasive ablative resurfacing or surgical-tightening techniques. Significant advances have been made in nonablative tissue-tightening techniques. However, when choosing a nonablative skin tightening device, the physician must always understand the type of energy it uses and how this energy interacts with tissue. The treating clinician must be careful to avoid those devices that use light energy that can be absorbed by melanin. One must always remember that what might be a minor burn on fair skin can end up a disastrous scar on darker skin.

The recent availability of suspension sutures that can be placed through minimal, inconspicuous incisions in areas unlikely to keloid, such as behind the temporal hairline, offers excellent additional opportunities to help these patients. Currently only one of those sutures has an inserting device that avoids secondary puncture exit wounds that could hyperpigment. The combination of suspension sutures and nonablative skin tightening may be the best option for many patients.

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PART

6

Noninvasive Wrinkle Correction

22

Botulinum Toxin

Doris M. Hexsel, Camile L. Hexsel, and Leticia T. Brunetto

The value of facial and corporal aesthetic image plays an important role in society and has grown with the development of numerous minimally invasive procedures. Patients are looking for safe, new, and less invasive techniques for facial rejuvenation as they search for quick results with low incidence of side effects. Certain minimally invasive procedures are also practical, as patients can immediately return to their activities.

Repeated facial movements, caused by contraction of the muscles of facial expression, are one of the most important etiologic factors of facial expression lines and rhytides. Such repeated movements also play a role in the development of redundant skin around these lines and rhytides. Botulinum toxin (BT) injections represent one of the latest and most revolutionary treatments in facial rejuvenation, targeting hyperkinetic muscles of facial expression. They are currently considered the best alternative for the treatment of dynamic wrinkles.[1] BT can be used alone or in combination with other minimally invasive or invasive techniques.[2–4]

In the last decade, the results of the therapeutic and cosmetic use of BT types A and B have been published in many articles and chapters. The cosmetic use of BT has permitted better understanding of the physiopathology of the aging process, specifically of the role of muscular contraction in aging.

HISTORY OF CLINICAL USE

In 1817, Justinus Kerner described botulism, a new disease characterized by muscle paralysis caused by the intake of poisoned food, probably spoiled sausage (from the Latin *botulus,* sausage).[5,6]

In 1897, Emile Pierre Van Ermengen isolated an anaerobic bacteria from contaminated food and injected the toxin of this bacteria, promoting disease in laboratory animals.[6,7] He identified this anaerobic Gram-positive bacillus as the etiological agent of botulism and called it *Bacillus botulinus*.[5,7] As bacillus identified aerobic organisms, in 1922, *Bacillus botulinus* received a new denomination of *Clostridium botulinum,* indicating its anaerobic nature.[5,8] *Clostridium botulinum* produces botulinum toxin, the most potent neurotoxin known in nature.[9] There are seven different serotypes of botulinum neurotoxins. Botulism in humans is most commonly caused by BT types A, B, and E.[5]

In 1949, it was demonstrated that BT inhibits the release of acetylcholine (Ach) from nerve endings.[10]

In 1973, Scott reported the use of BT in monkeys, demonstrating reversible ocular muscle paralysis during 3 months. In 1980, the toxin was introduced as a therapeutic agent when the same author published a study demonstrating BT injections as a successful adjunctive or alternative treatment to the surgical treatment of strabismus.[8,11] After that, the clinical use of BT advanced to the treatment of other muscular disorders, characterized by excessive or inappropriate contraction, such as focal dystonia, blepharospasm, achalasia, anal spasm, vaginismus, and nystagmus.[12,13]

The cosmetic use of BT type A began in the late 1980s, when Carruthers and Carruthers noted an improvement in the glabellar lines after injections of BT for the treatment of patients with blepharospasm.[14,15] At the beginning, only the upper third of the face was treated.[16,17] Later, the cosmetic use advanced to applications in the mid- and lower face and neck.[4,16,18–21] Other important uses in dermatology, such as hyperhidrosis[22,23] and gingival smile,[16] among others, have been developed in recent years.

The therapeutic use of BT for migraine and tension-type headache has also been described,[16] and they include the treatment of some muscles of facial expression.

AVAILABLE BOTULINUM TOXINS

Seven neurotoxin serotypes were purified and identified. They are denominated as A to G. The serotype A has been shown to be the most potent. Currently not only the serotype A but also the serotype B are commercially available and authorized for therapeutic use.[24] Only the serotype A is currently used for cosmetic purposes. Other serotypes are under investigation, as well as other toxins,[17,25–28] and perhaps new toxins will be available in the near future. The serotype B has shown to be an option for the treatment of patients resistant to serotype A.[24,29]

Botulinum toxin type A is available in three commercial preparations that are authorized for cosmetic use in some

Table 22-1
Characteristics of Botox and Reloxin

	Reloxin	Botox cosmetic
Composition	*Clostridium botulinum* toxin type A hemagglutinin complex 125 μg (0.125 mg) human serum albumin 2.5 mg lactose	*Clostridium botulinum* toxin type A hemagglutinin complex 500 μg (0.5 mg) human serum albumin 0.9 mg sodium chloride
Molecular Weight (neurotoxin)	150 kDa	150 kDa
Bulk Active Substance (total protein content)	~5 ng	~5 ng
Vial Size	500 Units	100 Units
Recommended Storage (postreconstitution)	2°–8°C (2°–8°C/use within 8 hours)	–5°C (2°–8°C/use within 4 hours)

countries, including Brazil: Botox (Allergan Inc., Irvine, California, USA), Dysport (Ipsen Limited, Paris, France), and Prosigne (Lanzhou Institute of Biological Products, China). Dysport is currently under investigation in the United States by the Food and Drug Administration (FDA), and its approval is expected for the next year. The commercialization of Dysport in the United States may go by the name of Reloxin. All these products produce similar and comparable effects in muscles and sweat glands, although they have distinct characteristics.[2,16] Other BT type As are currently under investigation, such as Xeomin (Merz Pharmaceuticals, Frankfurt, Germany)[30,31] and Neuronox (Meditox/Comedix, Seoul, South Korea).

Botulinum toxin type B is commercially available as Myobloc/NeuroBloc (Élan Pharmaceuticals Inc., South San Francisco, California, USA). Its use was approved by the FDA for the treatment of cervical dystonia in 2000[24,32] and was investigated in patients who have developed antibodies to type A.[29,33] Studies have shown the safety and efficacy of BT type B for the treatment of axillary hyperhidrosis,[34,35] although it is not currently approved for cosmetic use.[32] The data in the literature evaluating the safety and efficacy of BT type B for the treatment of facial wrinkles is sparse.[32]

MECHANISM OF ACTION

Botulinum A exotoxin prevents the release of Ach from the presynaptic neuron of the neuromuscular junction of striated muscles, producing chemical denervation and consequently reversible paralysis of the muscles.[16,25,26,36,37]

There are three steps involved in the inhibition of the release of neurotransmitter Ach from the presynaptic nerve terminal at the neuromuscular junction:[37,38]

1. *Binding:* The toxin binds to a receptor at the surface of the cell membrane of the presynaptic neuron.
2. *Internalization:* The toxin is internalized within the neuron.
3. *Blockage:* The release of Ach-containing vesicles is blocked by the interaction of the toxin with intracellular proteins that are responsible for vesicle release.

Weakness of affected muscles begins 6 to 36 hours after injections of BT, depending on the dose,[26] and is clinically evident 3 to 7 days after treatment, rarely later. This action lasts for 3 to 6 months, when the formation of new neuromuscular junctions (neurogenesis) occurs, permitting muscular function.[5,16,25,37,39–41]

The chemical denervation is also effective for excessive sweating, as it can affect the eccrine sweat glands leading to transient anhidrosis.[22,23,42]

PHARMACOLOGY, CONSERVATION, DILUTION, AND STORAGE

Botox, Reloxin, and Prosigne are marketed in a vacuum-dried lyophilized form, but only Botox and Prosigne are vacuum sealed.[43,44] Any vial of Botox or Prosigne[45] without vacuum seal should be discarded.[43] The expiration date indicated on the package of all these toxins should be respected.[43–46]

Myobloc is provided as a clear and colorless to light yellow sterile injectable solution in 3.5 mL glass vials.[46]

The particular characteristics of Botox and Reloxin are shown in Table 22-1.

Prosigne is made with *Clostridium botulinum* toxin type A hemagglutinin complex, 5 mg gelatin, 25 mg dextran, and 25 mg sacarose.[45]

Myobloc is made with *Clostridium botulinum* toxin type B in 0.05% human serum albumin, 0.01 M sodium succinate, and 0.1 M sodium chloride at an approximately pH 5.6. The neurotoxin complex is recovered from the fermentation process and purified through a series of precipitation and chromatography steps.[46] Myobloc vials contain 5,000 units (U) of BT type B per milliliter.[46] It is available in three vial presentations of 2,500, 5,000, and 10,000 U.[47]

The vials of Botox and Prosigne contain 100 units of BT type A.[43,45] The vials of Reloxin contains 500 units of BT type A.[44]

The storage temperature recommended by the manufacturers are 2°C to 8°C (35°–45°F) for Reloxin,[44] Prosigne,[45] and Myobloc[46] and –5°C (25°F) for Botox.[43]

Myobloc has shown stability for months when stored appropriately at this temperature.[48] Its manufacturer recommends to avoid freezing or shaking the vial of Myobloc.[46]

The recommended therapeutic doses of Botox and Reloxin are different,[49] and there are divergences about their equivalence.[50] Some publications consider that 1 U of Botox is equivalent to 3 U to 5 U of Reloxin.[21,50–53] The equivalence ratio use is 1:2.5 U between Botox and Reloxin, and similar results can be achieved. A recent pilot study performed by two of the present authors (Hexsel and Hexsel) demonstrated similar action halos between Botox and Reloxin at a conversion ratio of 1:2.5 U when injections are performed using the same volume and at the same depth on frontal muscles.[54] It is important to emphasize that side effects are more frequent when higher conversion rates, such as 1:3 or 1:4 or more, between Botox and Reloxin are used.[53,55]

Botox and Prosigne have 100 units of BT type A per vial and seem to be equivalent, although there is currently no evidence of this equivalence in the literature.

Manufacturers of all BT type A recommend the reconstitution of their products, with 0.9% preservative-free saline solution.[43–45,56,57]

Myobloc does not require reconstitution.[47] However, it also can be diluted with normal saline if necessary. Once diluted, the product must be used within 4 hours, as the formulation does not contain a preservative.[46]

Some studies tested the effects of the use of preservatives in BT type A dilutions.[26,58–60] In 2002, a double-blind, randomized controlled trial demonstrated no difference in the efficacy of the treatment when comparing results of BT type A reconstituted using isotonic sodium chloride with and without preservative. This indicated that reconstitution with preserved saline solution does not impair the stability of the toxin.[60] The use of BT type A reconstituted with preserved saline would also have additional advantages, such as longer periods of storage after reconstitution, reduced risk of bacterial contamination,[26] and less painful when compared with preservative-free saline reconstitution.[26,59,60]

To date, only one fatal case of anaphylaxis was described in a patient who received Botox with lidocaine.[61] Mixtures of BT with local anesthetics should be avoided because it may change the tertiary structure of the toxin and interfere with its pharmacokinetics.[62]

The dilution of Botox, Prosigne, or Reloxin may be performed with 1 mL, 2 mL, 5 mL, or 10 mL of preservative-free saline, aiming a concentration of 10 U/0.1 mL; 5 U/0.1mL; 2 U/0.1 mL; or 1 U/0.1 mL, respectively, for Botox and Prosigne or 50 U/0.1 mL, 25 U/0.1 mL, 10 U/0.1 mL, or 5 U/0.1 mL for Reloxin. Dilution of the commercially available toxins depends on the physician's preference. For cosmetic purposes, dilution of the products with a smaller amount of volume is recommended because it results in higher concentration and allows the injection of smaller volumes. Additionally, it is safer and more precise, reducing the risk of complications and increasing the duration of the effects.[5,16,17,27,41,63,64] To achieve a 1:2.5 U equivalence dose between Botox (or Prosigne) and Reloxin, an easy and practical way to go is to dilute Reloxin in double the amount of volume of saline used for Botox, which allows physicians to inject same exact volumes of both product for the same indications by same technique, reducing the possibility of conversion mistakes. This equivalence ratio allows the achievement of similar results regarding potency and duration of effects.[54] However, proper to the high sensitivity of the muscles for BT, in some cases, especially at the lower face, the equivalence of Botox for Reloxin must be modified for 1:2 or lower.

The recommended doses of BT type A and B are different. The equivalence doses between BT type B (Myobloc) and BT type A (Botox) have been described as a conversion ratio of 50 U of Myobloc/1 U of Botox.[65]

BT type A may be inactivated by heat, freezing, shaking, excessive dilution, and surface tension generated from bubbles when the toxin is reconstituted.[37]

The reconstituted vial should be used within 4 hours according to the manufacturers' instruction for Botox[43] and Prosigne[45] and 8 hours for Reloxin.[44] They can be stored in the refrigerator at 2°C to 8°C. In 1996, a study demonstrated that reconstituted Botox refrigerated for up to 1 month had no substantial loss of potency.[58] More recently, Hexsel et al. demonstrated in a multicenter, double-blind study that reconstituted Botox stored in the recommended conditions may be applied up to 6 weeks without losing its effectiveness.[66] A similar study with Reloxin is being done, and the results will be available soon.

Any reconstituted BT type A should be clear, colorless, and free of particles.[43,45,67]

A comparative study using BT type A (Botox 5 U) and BT type B (Myobloc 500 U) for the treatment of forehead wrinkles described that BT type B produced a greater area of diffusion and a more rapid onset of action than type A.[68]

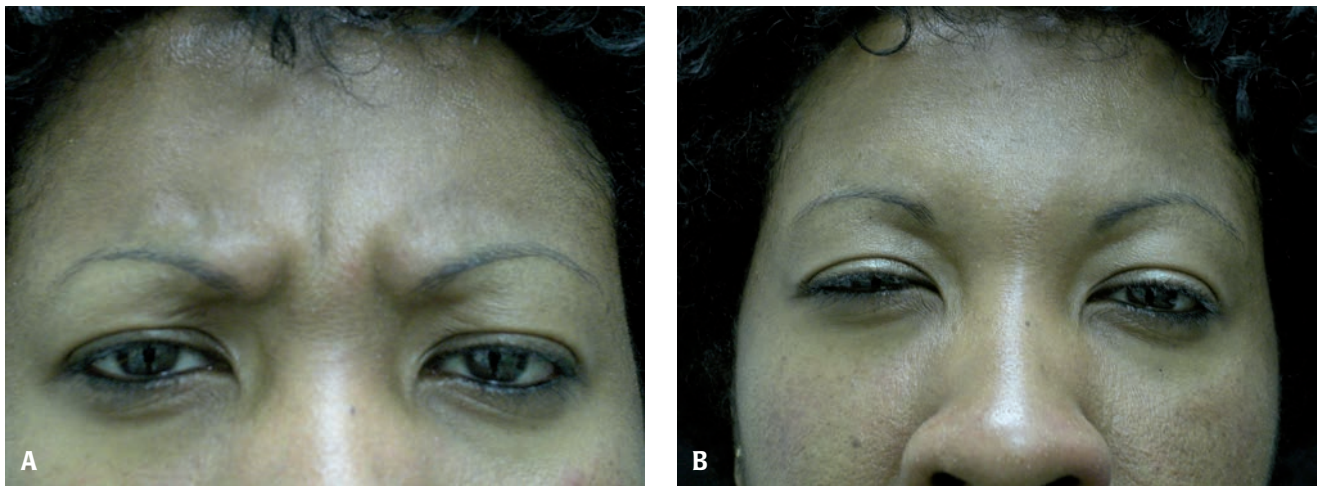

Figure 22-1 Before **(A)** and after **(B)** pictures of the glabellar area, showing the efficacy of the treatment with botulinum toxin.

INDICATIONS OF BOTULINUM TOXIN INJECTIONS IN DARK-SKINNED PATIENTS

The cosmetic use of BT is recognized as an effective and efficient treatment for dynamic wrinkles, independently of sex, age, or race.[18,69] Some characteristics that are unique to darker ethnic skin patients are relevant for BT injections in these individuals. They include the rounded facial phenotype, fuller upper and lower lips, and broader and flattened nostrils. Dark skin patients (DSPs) have fewer facial wrinkles than fair-skinned patients when comparing patients of similar age. Dynamic wrinkles in these individuals are also predominantly found in the upper face, especially in glabellar area (Fig. 22-1A).

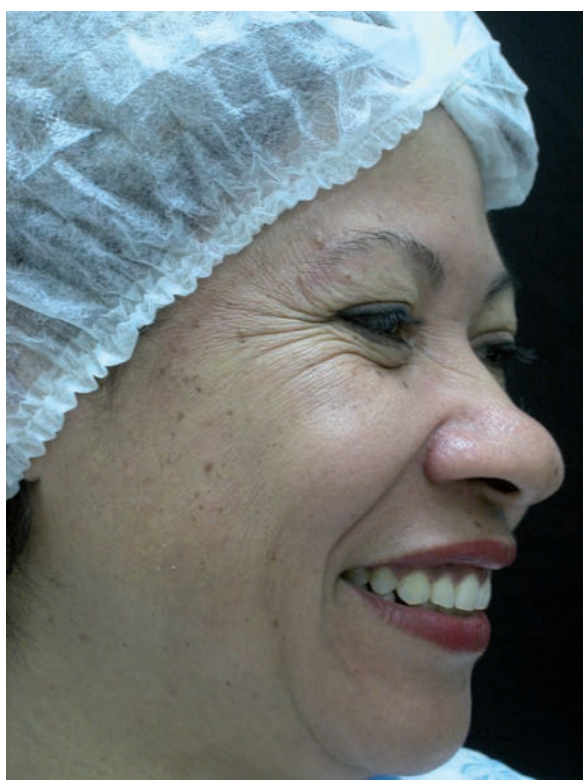

Figure 22-2 Periorbital (crow's feet) wrinkles in a 50-year-old patient. She also recruits her nasal muscles when smiling.

In the glabellar area, BT injections can erase or diminish lines[70] and promote better position[17,71,72] and shape of the brow (Fig. 22-1B).[16,56,73–75] Repeated injections of BT can also prevent the physiologic brow ptosis.

Periorbital wrinkles are one of the earliest signs of the normal aging process. They are mainly caused by a combination of photodamage and muscular hyperactivity. Periorbital wrinkles appear after the age of 40 in DSPs and can be treated by injections of BT type A (Fig. 22-2).[58,76,77] Nasal wrinkles can appear in these patients when smiling, but they are usually associated with excessive activity of glabellar muscles (Fig. 22-2).

Most DSPs present late physiologic blepharoptosis. However, eye bulging seems to be as frequent as in fair-skinned patients, because this condition is basically caused by anatomical configuration of the eyelid and subcutaneous fat.

Perioral injections of BT are rarely needed or performed in DSPs. BT can correct perioral wrinkles (Fig. 22-3), increase the fullness of the lips, and cause slight eversion of the upper lip.[78] These effects are usually undesirable. Perioral wrinkles appear late in life and are rare in DSPs.

As the mentalis muscles can be very expressive in some DSPs, this is often an indication for BT injections for these individuals. The mentalis muscles have synergistic movements with the depressor angulis oris (DAO) muscles, so mentalis muscles relaxation determines less action of the DAO muscle.

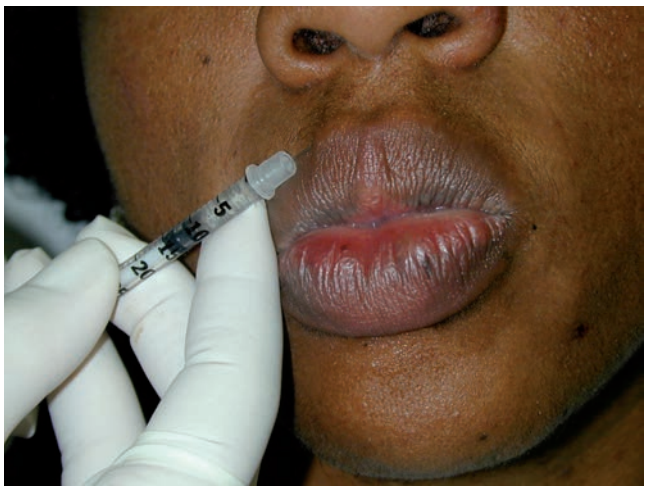

Figure 22-3 Small doses of BT injections can be used in the treatment of perioral wrinkles, such as 0.5 to 1 U of Botox or 1.25 to 2.5 U of Dysport/Reloxin.

Aging neck is characterized by signs of photodamage, including wrinkles, laxity, loose skin, and poikiloderma of Civatte. These findings are more frequent in Caucasians and can be treated adjunctively by other techniques, such as surgical lift of the neck and tightening. Other signs of aging neck are wrinkles caused by the action of the platysmal bands. Selected cases in whom the platysmal bands are expressive can be successfully treated by BT type A applications.[19,20,77,79] DSPs present fewer signs of photoaging, but the action of the platysmal bands seems to be similar to fair-skinned patients.

Independent of skin color, all patients develop the same response to BT injections. In the phase III BT type A clinical trials, 21 of the 405 enrolled were African American. An analysis was conducted looking at the overall efficacy and safety in the 21 African Americans compared with Caucasian subjects. There were no statistically significant differences in the efficacy or safety responses[80] (Fig. 22-4A–C).

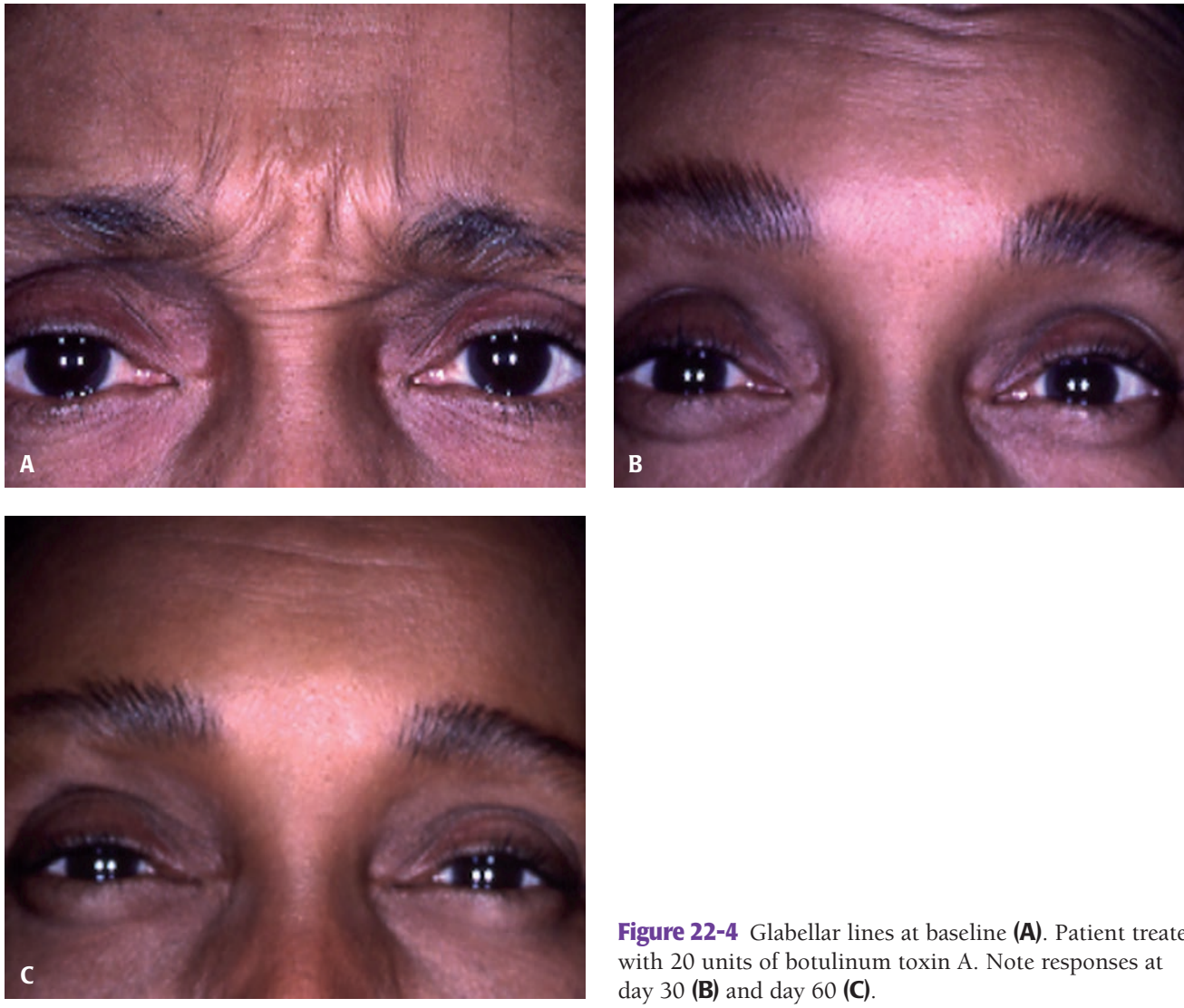

Figure 22-4 Glabellar lines at baseline **(A)**. Patient treated with 20 units of botulinum toxin A. Note responses at day 30 **(B)** and day 60 **(C)**.

Doses and treatment should be individualized for each patient, according to the muscles to be treated, their location and size, as well as their potency of contraction. Cultural and other particular aspects, such as patients' desires and needs, should also be taken into account.

CONTRAINDICATIONS

The complete medical history of the patient is required to identify any contraindications to BT injections. BT is not recommended in patients who are psychologically unstable, overly anxious, or have unrealistic expectations.[5,27,62] It should not be used in the presence of infection at the proposed injection sites.[17,43,45] Previous history of neuromuscular disease is a relative contraindication.[21,26,37,43] It is not known if BT type A affects the reproduction capacity or causes harm to the fetus when administered to a pregnant woman; therefore, it is classified as a category C drug in pregnancy.[27,28,41,45,81] It is also unknown if it is excreted in human milk.[43] Therefore, its use in pregnancy or breastfeeding women is not recommended.[21,26–28,37,41,56]

The administration of BT type A must be avoided in patients known to be allergic to any ingredient of the formulation, such as botulinum toxin, lactose, gelatin, saline, or human albumin.[5,26,45,56]

Simultaneous administration of BT type A and aminoglycosides or other agents interfering with neuromuscular transmission, such as quinine and calcium channel blockers, should only be performed with caution, as they can potentate the effects of the toxin.[21,26–28,41,45,82]

One case of death caused by anaphylaxis to Botox-lidocaine mixture has been described.[61] An important precaution of not reconstituting the toxin in any fluid different than 0.9% saline should be taken and the history of previous reaction to drugs, especially lidocaine, should be investigated before the injections.

PRE- AND POSTOPERATIVE CARE

Preoperative instructions should be given to all patients. Certain drugs that may cause prolonged bruising, such as anticoagulants, analgesics, steroidal and nonsteroidal anti-inflammatory agents, vitamin E or beta-blockers, if possible, should be stopped 7 to 10 days before the injections.[27,41,56,83,84]

Photographs should be taken before and after the procedure, preferably at rest and at maximum contraction of the facial muscles.

Special caution should follow the application of BT type A for any cosmetic purpose to minimize the risk of side effects and complications. The recommended advice includes to avoid pressing, massaging, or manipulating the treated area in the following 3 to 4 hours after injections,[5,64,85] to avoid physical extenuating activities during the rest of the day,[74,85] and to maintain vertical posture in the 4 hours following injections.[5,41,64,85] Some authors believe that the toxin works better in actively contracted muscles after injections, so they recommend patients contract the treated muscles repeatedly a few hours after the injections.[5,21,37,64,85,86]

TECHNIQUES OF INJECTIONS

Patients are positioned sitting upright on a chair with the upper part of the body elevated.[5]

After cleaning the skin, the points to be injected are marked using a marking pen while the facial musculature is examined. Antisepsis of the area to be treated must be performed carefully, usually with 70% alcohol or iodinated alcohol.[17]

Local anesthesia is usually not necessary. Pain upon injection is slight but may be further minimized by previously using topical anesthetics[28] or by cooling the area before and after the injections, if necessary.[5,21,41,67]

The use of an 1-mL or smaller syringe with a 30-gauge needle is preferable and minimizes patient's discomfort.[39,50] The BD Ultra-Fine II short-needle 0.3-cc syringe is considered the ideal syringe to deliver precise units of botulinum toxin to the underlying musculature for cosmetic treatment of the aging face.[87] BT type A should be injected slowly, followed by gentle massage at the injection site.

All toxins once active provoke the formation of an action halo around the injected points. Percutaneous injections of BT type A deposit the toxins into or adjacent to the overactive muscles, relaxing the target muscles and eliminating overlying rhytides of the skin. It is important to emphasize that Botox and Reloxin have similar action halos when the equivalent dose of 1:2.5 U between Botox and Reloxin in the same volume, depth, and technique are used. These action halos are sometimes misinterpreted as diffusion halos.[54]

ANATOMIC CONSIDERATIONS FOR BOTULINUM TOXIN INJECTIONS AND INDICATIONS

The knowledge of the facial muscular anatomy is extremely important for correct and successful treatments with BT. Facial lines and wrinkles are usually perpendicular to the direction of the fibers of the muscles.[5]

Upper face

Horizontal forehead wrinkles

The function of frontalis muscles is to raise the skin of the forehead, elevating the eyebrows.[5,74,88] The fibers of these muscles are oriented vertically, and their contraction leads

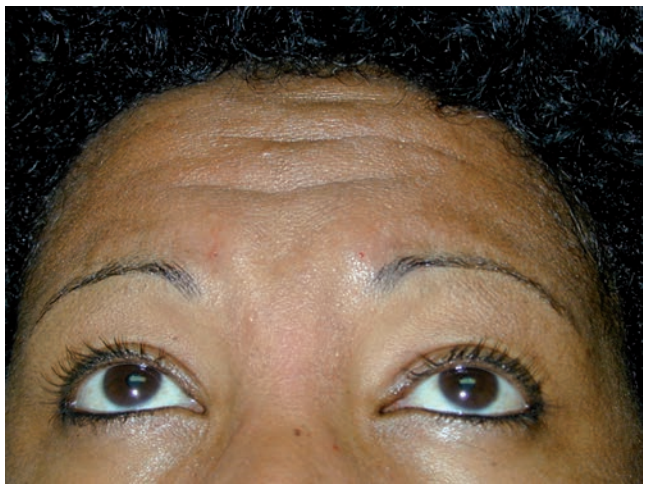

Figure 22-5 The horizontal forehead lines are due to the contraction of frontalis muscles.

to brow elevation and simultaneous appearance of horizontal forehead lines[5,88] (Fig. 22-5). The aging process lowers the brows, leading to subconscious use of frontalis in all individuals, promoting and aggravating horizontal forehead lines.[74] BT type A is effective for these lines. However, it is not recommended to treat the frontalis muscles alone, but always in conjunction with brow depressor muscles of the glabellar area to prevent brow ptosis.[77,83,89]

A recent study reports that effectiveness and side effects change according to the vertical length of the forehead (distance from the glabella to the hairline) and describes different techniques for the application of BT type A for the treatment of frontal lines according to the dimension of the patient's forehead. The authors of this study recommend that patients with narrow forehead (distance less than 60 mm) should receive BT injections in three horizontal lines, and those with wide forehead (distance exceeding 70 mm) should receive BT injections in three vertical lines.[90]

The total doses range from 10 to 20 U of Botox[17,91] or Prosigne and 20 to 50 U of Reloxin injected in multiple sites of the forehead,[92] depending on the area to be treated, the length of forehead, and the location of the undesired wrinkles (Fig. 22-6A–C). It is always recommended to inject 1 cm or more above and at the medial side of the eyebrows, finishing at the hairline,[5] according to the chosen technique.

Glabellar rhytides and eyebrow elevation

The repeated contraction of the corrugator supercilii, the medial orbital portion of the orbicularis oculi, and the vertical fibers of the depressor supercilii are responsible for formation of vertical glabellar lines.[5] The procerus muscle is responsible for development of the horizontal glabellar wrinkles.[5,74,93]

Eyebrows are depressed by the contraction of the corrugator supercilii, depressor supercilii, orbicularis oculi, and procerus[27,75] and elevated by the contraction of medial and lateral fibers of frontalis muscles.[75]

The first multicenter, double-blind, randomized, placebo-controlled study proving the efficacy and safety of BT type A injection for the treatment of glabellar lines was published in 2002. The study describes good results with the use of the five-point technique, injecting 4 U of BT type A (Botox) into the midline point of the procerus and two points at each side of corrugator supercilii,[94] using a total dose of 20 U of Botox. There are no published studies regarding doses of Prosigne for glabellar rhytides. A multicenter double-blind study conducted by Ascher et al. showed that 50 U of Reloxin is an efficacious dose to treat glabellar lines.[70] From the data shown in these two multicenter studies, it is possible to infer that the equivalent ratio of 1:2.5 U between Botox and Reloxin produces comparable good results.

Glabellar muscles are brow depressors, and their treatment leads to elevation of the brows, especially when the action of frontalis muscles is preserved.[5,41,77] To raise the brows, use doses ranging from 3 to 5 U for Botox[92] or Prosigne and 6 to 12.5 U for Reloxin injected at the point where the lateral brow meets the temporal fusion line[92] (Fig. 22-6 and Fig. 22-7).

Although not yet published, a first randomized, double-blind study of BT type A in DSPs evaluated the degree and duration of efficacy of 20 U compared with 30 U for the treatment of glabellar lines in black women with skin types V and VI. Evaluations were conducted at baseline and at 30, 60, 90, and 120 days. The percentage of responders at maximum frown did not differ significantly between the two groups. Although not statistically significant, the effect lasted somewhat longer in subjects receiving the 30 U dose. In addition, no differences were evident between groups at response through day 120. The drug was well tolerated with no side effects[95] (Fig. 22-8).

Crow's feet wrinkles and hypertrophy of orbicularis oculi muscles

The function of orbicularis oculi muscle is to close the eyes.[17,64,74] The contraction of its lateral fibers in association with photodamage creates the crow's feet in the lateral canthal area,[5,64,74,88,93] and consequent redundancies of the skin.

Injections of BT type A in the lateral fibers of orbicularis oculi produce weakening and result in satisfactory amelioration of wrinkling.[58,77] BT can be considered a safe and effective treatment for crow's feet wrinkles,[76] as these wrinkles are mainly due to muscular contraction.

The doses per side range from 5 to 15 U of Botox[64] or Prosigne, and 10 to 37.5 U of Reloxin. The first injection site is usually at the center of the crow's feet area, and the other one or two injections are approximately 1 to 1.5 cm

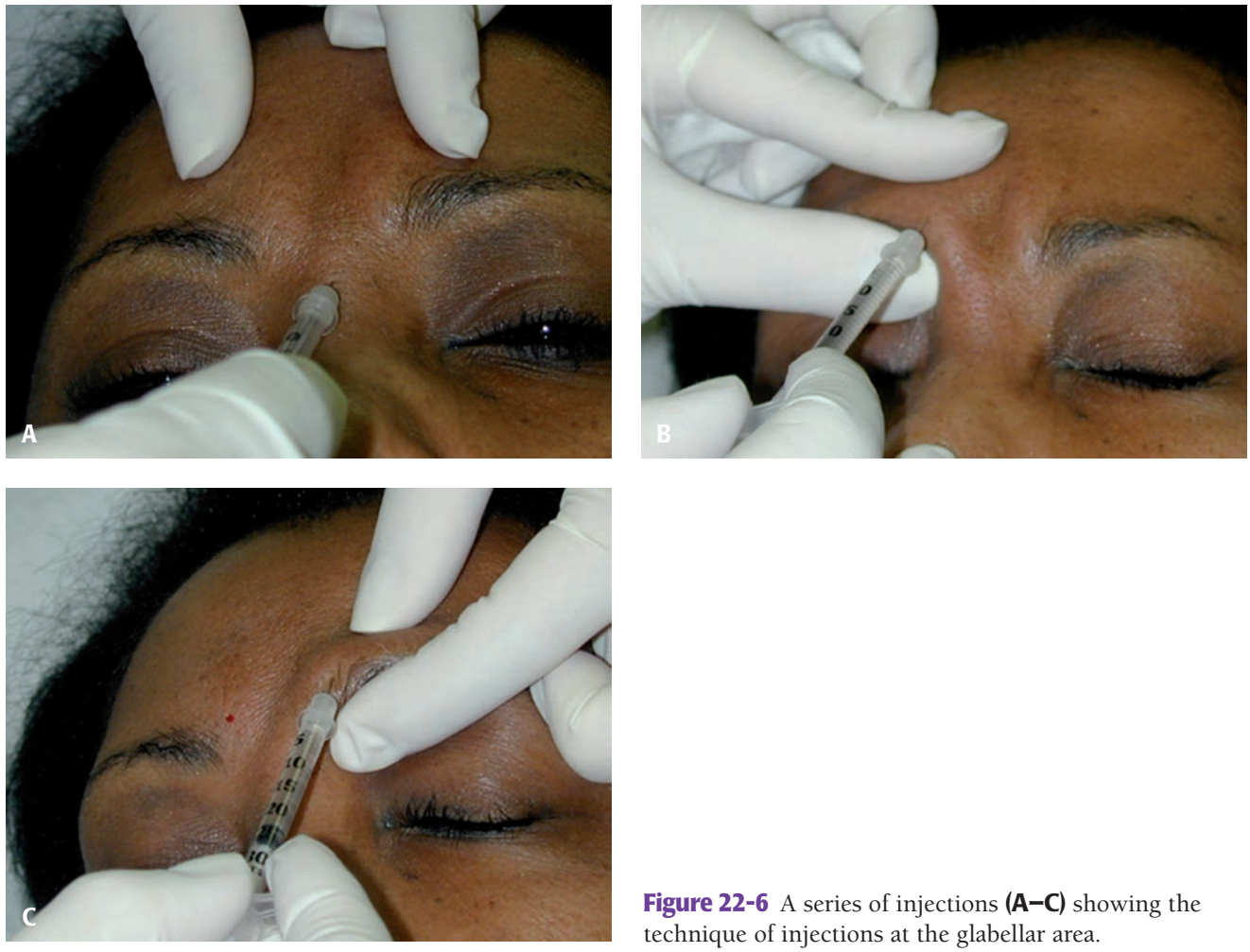

Figure 22-6 A series of injections **(A–C)** showing the technique of injections at the glabellar area.

Figure 22-7 Botulinum toxin type A injections in the dorsum of the nose for the treatment of the nasalis muscles **(A)** and lower part of the procerus **(B)**.

Figure 22-8 Patient with glabellar and horizontal lines at baseline **(A)**; after treatment with botulinum toxin A at 7 days **(B)** and 60 days **(C)**.

above and below the first site,[64] depending on the presence of wrinkles when smiling. They must be performed at least 1 cm to the lateral orbital rim.[5,27,41,64,77,92]

Hypertrophy of the lower pretarsal portion of the orbicularis oculi diminishes the palpebral aperture, especially when smiling,[18,21] and can cause early wrinkles. Injections of BT type A in this muscle provide an increase to palpebral aperture,[18] both when smiling and at rest.[21,96] This treatment is a good option for Asian patients desiring a wider-eye look,[18,21,96] and the results seem to be more dramatic on these patients.[96] The suggested dose is 2 U of Botox[21,96] or Prosigne, and 4 or 5 U of Reloxin injected into lower pretarsal orbicularis, in the midpupillary line, 3 mm below the ciliary margin.

Midface

Nasal ("bunny") wrinkles and flaring

Radial rhytides at the radix of the nose result from the contraction of the fibers of the upper nasalis muscle and can be softened by BT type A.[18,21,88] The doses range from 2 to 4 U of Botox[21] or Prosigne and 4 to 10 U of Reloxin to be injected into the belly of the upper nasalis muscle (Fig. 22-7).

Nasal flaring is caused by the persistent overaction of the lower nasalis muscle and can lead to repeatedly dilated nostrils, which can embarrass these individuals in social situations. Injections of BT type A into this muscle can produce a satisfactory and prolonged response by weakening this involuntary action.[18,21,77] The doses range from 5 to 10 U for Botox[21,77] or Prosigne and 10 to 25 U for Reloxin injected bilaterally into the lower nasalis fibers.[21,77]

Lower face

Vertical perioral rhytides

Radial perioral rhytides are caused by the repeated action of the orbicularis oris muscle (OOM) in association with aging, photodamage, and hereditary loss of hard and soft tissues.[18,21,78,97] Small doses of BT type A into the OOM can promote discrete relaxation of this muscle, improving the appearance of perioral rhytides, when these wrinkles are caused by the action of OOM[18,21,78] (Fig. 22-3). The treatment often results in only temporary improvement because low doses are indicated to prevent problems with the normal perioral function. Adjunctive treatment with injectable fillers is recommended for better results.[18]

The OOM is responsible for lip closure.[18,78,93] High doses of BT or equivalences higher than 1:3 between Botox and Reloxin can paralyze this muscle, compromising the sphincter function and making it difficult to speak, eat, or drink.[18,93]

The recommended doses range from 1 U[21,78,97] to 4 U[78] of Botox or Prosigne and 2 to 10 U of Reloxin per upper or lower lip, divided in 1 to 3 points at or above the vermilion border in the area of muscle contraction adjacent to the

creases.[21,78,97] Injections should be avoided on the corners of the lips and the midline.[21,97]

Gingival or gummy smile

In some patients, the overaction of lip levator muscles during smile causes retraction of the upper lip and overexposure of the gum,[18,21] a condition called gummy or gingival smile. This is not frequent in DSPs because of frequent bigger volume of the lips. A moderate drop in the upper lip can be achieved with the application of small doses of BT type A into the levator labii superioris, covering the gum line.[18,21]

The doses range from 2[21] to 5 U[98] of Botox or Prosigne and 4 to 12.5 U of Reloxin into the levator labii superioris muscle on each side of the bony nasal prominence.

Mouth frown and melomental folds

The contractions of the depressor anguli oris (DAO) muscle causes the downward angulation of the mouth (mouth frown) and aggravates the line that extends from the corner of the mouth to the lateral mentum (melomental folds), producing a sad expression.[18,21,77,88,97]

Treatment of DAO with BT type A injections shows satisfactory results, elevating the corner of the mouth and improving the aspect of melomental folds.[18,21,77] This can be combined with soft-tissue augmentation for better and longer results.[18,21,69,97]

The patients are asked to pull down the corners of their mouths to aid in the location of the muscle (DAO).[21] Inferior to a point 1 cm lateral to the oral commissure, DAO can be felt by pulling inferiorly.[77] Then, 2 to 3 U of Botox[21] or Prosigne and 4 to 7.5 U of Reloxin can be injected directly into these points on each side of the mouth. Caution must be used when injecting toxin close to the mouth because of the risk of complications.

For melomental folds, 2 to 5 U of Botox[21] or Prosigne and 4 to 12.5 U of Reloxin should be injected into each DAO above the angle of mandible and 1 cm lateral to the lateral oral commissure.[21] Injections too medial can cause ipsilateral weakness of the depressor labii with flattening of the lower-lip contour on the lips' movements, and injection too high can compromise the sphincter function of the orbicularis oris.[21]

Mental crease and *Peau d'Orange* chin

Mental crease is characterized by a semilunar fold between the prominence of the chin and the lower lip, resulting of the contraction of the mentalis muscles.[18,21,97]

In addition to the mental crease, the contraction of the depressor labii and orbicularis oris muscles, as well as the loss of dermal collagen and subcutaneous fat, cause the so-called *peau d'orange* chin.[18,21,97]

BT type A can safely relax the mentalis muscles and promote satisfactory results for both problems.[18,97] Subcision or filling agents can be used in combination to BT injections to soften the appearance of the *peau d'orange* chin,[18,21,97] but they seem to be ineffective for mental crease.[21,97]

For mental crease, doses of BT range from 3 to 5 U of Botox[21,97] or Prosigne and 6 to 12.5 U of Reloxin. They can be injected into each side of mentalis muscles under the point of the chin, just anterior to the bony mentum.[97] It creates a satisfactory aesthetic softening of the crease while avoiding complications from weakening of the orbicularis oris.[21]

For *peau d'orange* chin, doses of BT range from 5 to 10 U of Botox[21,27,28,64,97] or Prosigne and 5 to 12 U of Reloxin into the mentalis at the mandibular insertion of these muscles (Fig. 22-4).

Neck

Horizontal "necklace" lines occur as a result of loss of elasticity of the cervical skin and the subcutaneous musculoaponeurotic system (SMAS) attachments.[16,18,21] BT type A may be injected in the deep intradermal plane.[18,21]

Platysmal bands occur because of separation of the platysma muscle anteriorly into two diverging bands. Tightening of the anterior borders often occurs, making the bands more visible while speaking, exercising, or playing a musical instrument.[16,18,99] BT type A in platysmal bands can relax these lines.[16,18,20,77,79] Loose skin or flaccidity of the neck is usually treated by surgical lifting of the neck and lower face.[18,20]

For horizontal neck lines, doses of BT used range from 10 to 20 U of Botox[18] or Prosigne and 20 to 50 U of Reloxin per treatment session. Each site can be injected with 1 or 2 U of Botox[18] or Prosigne, or 2 to 5 U of Reloxin at the deep intradermal plan along the lines and bands, over multiple sites.[18,21]

Each platysmal band can be treated with doses ranging from 5 to 10 U of Botox[20] and Prosigne, and 10 to 25 U of Reloxin. Higher doses can promote side effects.

Facial asymmetry

Facial asymmetry can occur in the upper, mid-, and lower face. It can be caused by loss of bone and soft tissues, as well as by neuromuscular disorders and trauma. The identification of the cause of facial asymmetry is important, as BT type A can only address neuromuscular causes.

For hyperfunctional asymmetries, BT type A can be injected in the affected muscles. For example, in hemifacial spasm, the facial movements of zygomaticus, risorius, and masseter pull the facial midline over toward the hyperfunctional side. BT type A injections in these muscles can correct the asymmetry, centering the face at rest. For aesthetic improvement of hypofunctional asymmetries, BT type A injection should be applied at the normofunctional or opposite side of the same group of affected muscles.[17,18,21]

SIDE EFFECTS AND COMPLICATIONS

There is a low incidence of side effects or complications in the cosmetic use of BT.[27,28,41] They can or cannot be related to the action of the toxin.[64]

Most complications related to the toxin are caused by injections in incorrect sites. Other complications include excessive weakness of the injected muscles, usually caused by high-dose, high equivalences between the available toxins or diffusion of the toxin beyond the injection site (usually associated with manipulation of the treated area, leading to unwanted/undesired weakness of adjacent muscles). These can also be caused by inappropriate selection of patients.[21,28,37,62]

Only one case of fatal complication was related to BT type A injections diluted in lidocaine.[61]

Mild pain, bruising, and/or paresthesia at the injection site may occur during or immediately after the injections.[5,27,28,41,62,64,83] Bruising is more common when injecting at the lateral orbital (crow's feet) area because of the thinner skin and the presence of superficial blood vessels in that area.[64,74] Headache in the few hours after the application[27] and mild nausea may occur.[5,28,41,62,64,83]

Injection-related post inflammatory hyperpigmentation and hypopigmentation may occur in DSPs, but is unexpected after BT injections. A study of 26 African American patients who received repeated periocular BT type A injections described no evidence of periocular cutaneous depigmentation.[100]

Brow ptosis is described in many papers as the main side effect resulting from the treatment of the frontal and glabellar wrinkles.[5,27,28,41,64,77,89,93,101] It is rare and considered technique dependent.

Total paralysis of the frontalis presents as a loss of expressivity, called masklike appearance.[5,28,62]

Complications in the glabellar and periorbital areas also include blepharoptosis and diplopia. These are caused by weakness of the upper eyelid levator muscle and the action of BT in the extraocular muscles.[5,27,28,41,56,64,77]

The treatment of glabellar wrinkles without injecting the frontalis muscle can lead to excessive elevation of lateral eyebrow giving a characteristic unwanted appearance.[5]

Aggravation of the wrinkles along the side and at the dorsum of the nose can be observed in a large number of patients treated with BT type A for glabellar frown lines and periorbital lines.[102] They become evident when the patient smiles, are known as a sign of BT injections,[62,83] and are explained by increased recruitment of nasalis muscles.[102]

Drooping of the lower eyelid may occur when injecting the lateral orbital (crow's feet) area by the action of the toxin in this area, leading to corneal exposure, dry eye, and superficial punctuate keratitis.[5,93]

The most common complications in the mid- and lower face are undesired paralysis of the muscles related to the lips and mouth. Such paralysis is characterized by asymmetric smile and incompetence of the function of the mouth sphincter, which causes difficulty in swallowing, speaking, smoking, whistling, and/or playing wind instruments in addition to involuntary biting of the lips, loss of filter design, difficulty in moving the lips when applying lipstick, and involuntary loss of saliva when speaking.[21,27,28,41,77,93]

On the neck, excessive weakness of the platysmal bands can cause difficulty in swallowing and lifting the head as well as neck discomfort.[103]

CONCLUSION

Physicians must be aware of several important factors when performing BT injections. These include the characteristics of the available products, such as the appropriate storage, reconstitution, and conservation; and the appropriate dilution, doses, and volumes to be injected. These can be achieved by the use of a proper injection technique and the knowledge of the possible complications and their prevention and treatment. Careful exclusion of patients with any pre-existing contraindication, in addition to proper patient selection with information of pre- and post-procedure recommendations, can also minimize the risk of side effects. These are the keys to achieving good results, as well as taking into account the facial characteristics and skin color, the individual cultural acceptance, and the patient's expectations.

Darker racial ethnic groups age slower than fair-skinned counterparts. Dynamic wrinkles in these individuals, predominantly found in the glabellar area, can be successfully treated by botulinum toxin injections.

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23

Fillers in Ethnic Skin

Frederick Beddingfield III and Jenny Kim

There has been rapid growth in the number of surgical and nonsurgical cosmetic procedures in darker racial ethnic groups, which accounted for approximately 20% of all cosmetic procedures in 2005. This group is comprised of Hispanics 9%, African Americans 6%, Asians 4%, and all other non-Caucasians 1.3%.[1] Non-Caucasians are slightly less likely to obtain cosmetic procedures versus their Caucasian counterparts; nonetheless, ethnic minorities account for a significant population interested in cosmetic procedures and will likely account for a higher percentage of such cosmetic procedures in the future as this segment of the population is growing rapidly.

Dermal fillers are the third most common nonsurgical cosmetic procedure performed and are used to correct a range of skin defects, from fine lines to deeper nasolabial folds, lip augmentation, and volume correction of the cheeks. Collagen fillers were historically the most commonly used dermal fillers and have been used with great success for more than 20 years. However, hyaluronic acid fillers, because of their longer duration and excellent safety record, have become the most common filler injectables and the gold standard against which others are compared. In the United States in 2005, hyaluronic acid dermal filler injections were the third most common nonsurgical cosmetic procedure, behind botulinum toxin injections and laser hair removal.[1] The use of hyaluronic acid filler injections saw a 35% growth rate from 2004 despite a 4% decline in nonsurgical cosmetic procedures overall. In 2005, patients had 1.2 million hyaluronic acid injections versus 221,000 collagen injections, 91,000 autologous fat injections, 40,000 calcium hydroxylapatite filler injections, and 35,000 L-poly lactic acid filler injections.[1] This chapter will describe the characteristics of various fillers presently being used and discuss important factors to consider when fillers are used in patients with darker-skinned ethnic groups.

HYALURONIC ACID FILLERS

The development of hyaluronic acid (HA) fillers has been an important advance because they have significant advantages over many collagen fillers—particularly longer duration. HA is a glycosaminoglycan consisting of D-glucuronic acid and N-acetyl-D-glucosamine disaccharide units and is a component of the extracellular matrix of skin connective tissue found in the epidermis and dermis. Additionally, it is found in vitreous humor, umbilical cord, synovial fluid, and the capsule of certain microorganisms.

Various HA products are now available, and the most widely used HA fillers around the world are the Restylane, Hylaform, and Juvéderm families of products (Table 23-1). Restylane and Juvéderm products are all derived from streptococcal bacteria, and Hylaform products are derived from rooster combs. Unmodified nonanimal HA produced by bacterial fermentation process is identical to HA in humans and it is not a protein. It offers excellent biocompatibility and, there is no need for skin testing.[2] Hypersensitivity reactions are rare and not expected. However, hypersensitivity reactions are possible as a result of manufacturing-related non-HA components of fillers. Thus, Hylaform products are contraindicated in patients who are hypersensitive to avian proteins because they are derived from rooster combs. Additionally, unlike collagen, there is no need for overcorrection during the injection procedure. Thus, HA fillers are particularly useful for patients who may react to collagen fillers or who desire immediate and predictable clinical improvement without the need to wait several weeks for the results of skin tests (Fig. 23-1A,B).

Naturally occurring HA contributes to adhesion, elasticity, and viscosity of extracellular substances. Comparative studies suggest HA fillers may be more durable than collagen fillers.[3,4] Furthermore, HA is highly hydrophilic and is able to hold more water than any other natural substance. Once injected, it attracts water and has a hydrating effect on the skin. Although HA alone is degraded in the body within only a few hours, it can be stabilized by cross-linking so that its effects are far more prolonged. The longer duration of HA relative to collagen appears to be the primary reason why dermal filler use has increased so much in the United States since the approval of Restylane. Most HA fillers product lines are composed of two or three related formulations to enable a wide range of clinical

Table 23-1

Hyaluronic acid fillers

Injectable	Source	Skin test needed?	Main uses	Characteristics	Duration of effect	FDA approval status
Restylane Fine Lines	Nonanimal streptococci	No	Fine lines (e.g., perioral and periorbital lines)	20 mg/mL HA Gel bead size of 150 μm 200,000 U/mL Cross-linked using 1, 4 BDDE	Immediate effect Lasts several months	Not FDA approved but in use outside U.S.
Restylane	Nonanimal streptococci	No	Designed for mid- to deep dermal injection for correction of moderate to severe facial wrinkles and folds (e.g., nasolabial folds)	20 mg/mL HA Gel bead size of 250 μm 100,000 U/mL Cross-linked using BDDE	Immediate effect Lasts several months	FDA approved for filling moderate to severe wrinkles around the nose and mouth
Perlane	Nonanimal streptococci	No	Designed for deeper placement in the subdermis to treat larger and more significant soft-tissue defects	20 mg/mL HA Gel bead size of 1000 μm 10,000 U/mL Cross-linked using BDDE	Immediate effect Lasts several months	Not FDA approved but in use outside U.S.
Restylane SubQ	Nonanimal streptococci	No	For facial shaping and adding volume (e.g., to sunken cheeks)	20 mg/mL HA Largest gel bead size 1,000 U/mL Cross-linked using BDDE Alternative to fat transplantation	Immediate effect Lasts several months	Not FDA approved but in use outside U.S.

Captique	Nonanimal streptococci	No	For injection into the mid- to deep dermis for correction of moderate to severe facial wrinkles and folds (e.g., nasolabial folds)	Cross-linked using DVS Similar to Restylane but softer	Immediate effect May last up to 1 year	FDA approved for filling moderate to severe facial wrinkles and folds (e.g., nasolabial folds)
Hylaform Fineline/ Hylaform/ Hylaform Plus	Nonanimal Rooster combs	No	Hylaform Fineline for superficial papillary placement to treat fine lines (e.g., periorbital and perioral lines) Hylaform for midreticular placement to treat glabellar lines, oral commissures, moderate nasolabial folds, and acne scars Hylaform Plus for deep reticular placement above the subcutis to treat deeper folds (e.g., deep nasolabial folds), lip enhancement, facial contouring, and deeper scars	5.5 mg/mL HA Cross-linked using DVS Mean HA particle size larger in Hylaform Plus than Hylaform	Immediate effect Lasts several months	Hylaform and Hylaform Plus are FDA approved for moderate to severe facial wrinkles and folds (e.g., nasolabial folds) Hylaform Fineline is in use outside the U.S.
*Juvéderm 18/ 24/30/24HV/30HV Ultra (U.S.) Ultra Plus (U.S.)	Nonanimal streptococci	No		Cross-linked using BDDE Monophasic	Immediate effect Lasts several months	PMA for 24HV (Ultra), 30HV (Ultra Plus) and 30 formulations FDA approval in December 2006 Also, use outside U.S.

(*continued*)

Table 23-1

Hyaluronic acid fillers (*Continued*)

Injectable	Source	Skin test needed?	Main uses	Characteristics	Duration of effect	FDA approval status
Teosyal	Nonanimal streptococci	No	Meso formulation for preventing wrinkles and reducing deficits in elasticity and hydration in the face and neck 27G formulation for nasolabial folds, lip augmentation, and facial contouring 30G formulation for linear wrinkles and peribuccal contours	Meso is 15 mg/g HA 27G and 30G are 25 mg/g HA Cross-linked using BDDE Monophasic	Immediate effect Lasts several months	In use outside U.S.
Esthelis	Nonanimal streptococci	No	"Soft" formulation is for fine lines "Basic" formulation is for at least medium lines	HA is double cross-linked using BDDE "Soft" formulation contains 20 mg/g HA "Basic" formulation contains 25 mg/g HA	Immediate effect Lasts several months	Not FDA approved but in use outside U.S.
Puragen/ Puragen Plus	Nonanimal bacterial	No	For adding volume, smoothing wrinkles, and restoring fullness in the glabellar lines, nasolabial folds, and lips Also suitable for wrinkles, lines, depressions, scars, and facial contouring in most areas of the face	Puragen Plus contains lidocaine	Immediate effect Lasts several months	Puragen Plus under review at FDA Puragen in use outside U.S.

Dermalive/ Dermadeep	60% HA of nonanimal origin and 40% acrylic hydrogel	No	For nasolabial folds, marionette lines, lip contours, cheeks, chin, and facial scars Dermalive is for dermal injection Dermadeep is for subcutaneous injection	Permanent injectable implants	Immediate effect Lasts years	Not FDA approved but in use outside U.S.

BDDE, butanediol-diglycidyl-ether; DVS, divinyl sulfone; FDA, Food and Drug Administration; HA, hyaluronic acid.

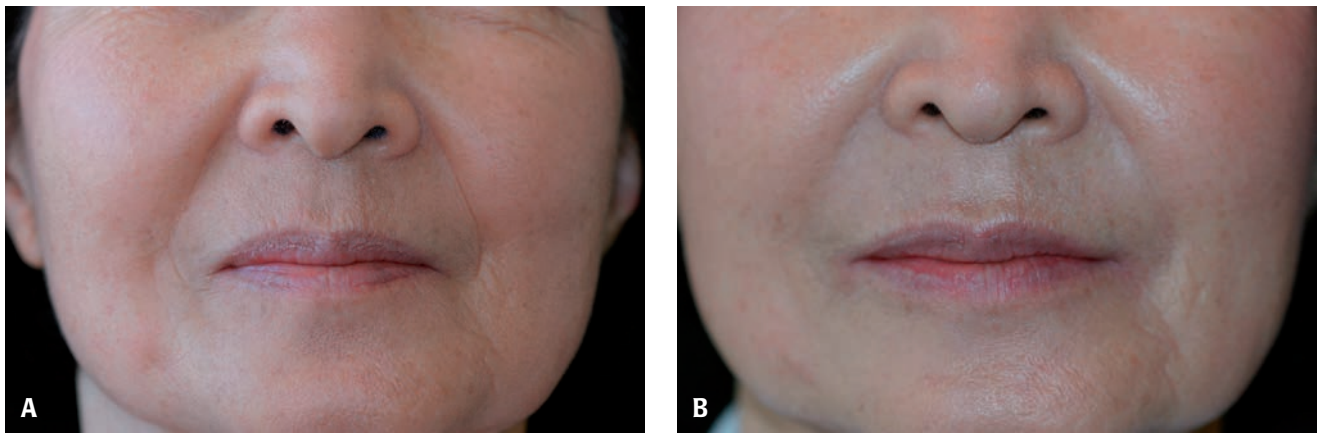

Figure 23-1 **A:** Baseline nasolabial folds of and lips of an Asian patient. **B:** Three weeks post hyaluronic acid injection (Restylane) to lips and nasolabial folds.

needs to be met. These subtypes commonly differ in rate of cross-linking, size, and formulation of HA strands or particles, and HA concentration. Typically one formulation is intended for the treatment of fine lines, a middle formulation is intended for treating medium-depth lines, and one formulation is intended for resolving deeper defects or replacing volume. Statistics from the American Society for Aesthetic Plastic Surgery indicate that the use of HA fillers in the United States grew almost 700% between 2003 and 2004.[1]

COLLAGEN FILLERS

Bovine collagen

Bovine-derived collagen fillers were first approved for soft-tissue augmentation in the 1980s in the United States.These fillers set the standard in filler materials for smoothing facial lines, wrinkles, and scars and in providing lip border definition until HA products became available recently. More than a million treatments have been performed with bovine collagen, and the most widely used products include Zyderm I, Zyderm II, and Zyplast (Table 23-2). The content of collagen concentration varies in these products. For example, Zyderm I contains 95% to 98% type I collagen with some type III collagen. It has 3.5% bovine collagen by weight. Zyderm II is similar to Zyderm I except that it contains 6.5% collagen by weight. Neither Zyderm I nor II are cross-linked. Zyplast has 3.5% bovine collagen cross-linked by glutaraldehyde to form a latticework and is considered less immunogenic and more resistant to degradation than Zyderm I and Zyderm II. All three products contain 0.3% lidocaine and therefore are contraindicated in persons who have lidocaine allergy. Furthermore, these products are contraindicated in patients with hypersensitivity to bovine collagen. Approximately 5% of patients may experience hypersensitivity to injectable bovine collagen and so skin testing is required before treatment. At least two skin tests should be performed at least 2 weeks apart, with the last test at least 2 weeks before treatment for new patients or anyone who has not received the same product within 2 years. A positive test result is defined as erythema, induration, tenderness, or swelling that persists for more than 6 hours after implantation. If any hypersensitivity occurs, it is usually within 1 to 2 weeks of treatment and manifests as erythema and induration, with or without pruritus in the area treated. Treatment of hypersensitivity may include topical immunomodulatory calcineurin inhibitors, topical steroids, intralesional steroids, systemic steroids, and systemic cyclosporine. Observation alone may be enough in mild cases. Contraindications to injectable bovine collagen include a history of an anaphylactic event of any cause, previous sensitivity to bovine collagen, lidocaine sensitivity, pregnancy, and active infection at the treatment site. Although no formal testing has been completed, patients undergoing hormonal fluctuation (e.g., during pregnancy or the menopause) may have an increased risk for hypersensitivity.

Bovine collagen treatments reportedly last between 3 and 18 months, with an average duration of 2 to 6 months, depending on location. In the authors opinion, bovine collagen lasts approximately 2 to 3 months in the nasolabial folds and significantly less in the lips. Zyderm I is injected into papillary dermis to correct superficial facial rhytides. Zyderm II is injected slightly deeper to treat moderate rhytides and scars. Zyplast, injected into the deeper dermis for treatment of moderate to severe rhytides and scars, can be expected to last longer than Zyderm I or II. However, Zyplast is contraindicated in the glabellar area due to reports of skin necrosis after injection into this area.

Table 23-2

Collagen fillers

Injectable	Source	Skin test needed?	Main uses	Characteristics	Duration of effect	FDA approval status
Zyderm I/ Zyderm II/ Zyplast	Bovine	Yes	Zyderm is for fine lines, wrinkles, shallow scars, and thin-skinned areas Zyplast is for pronounced lines and wrinkles, scars, and thicker-skinned areas	Contains lidocaine Zyderm I is 3.5% collagen by weight Zyderm II is 6.5% collagen by weight Zyplast is 3.5% collagen cross-linked by glutaraldehyde	Immediate effect Lasts for a few months	Approved for the correction of contour deformities of the dermis in non–weight-bearing areas
Evolence	Porcine	No	For wrinkles; nasolabial folds; scars; atrophy from disease or trauma; defects secondary to rhinoplasty, skin graft, or other surgically induced irregularities; and other soft-tissue defects or deficiencies	Cross-linking of collagen achieved without use of potentially toxin chemicals Theoretically more immunocompatible with human collagen because of removal of telopeptides (the most antigenic part of collagen) during production	Immediate effect Lasts for at least 1 year	Not FDA approved but in use outside U.S.
Cymetra (micronized AlloDerm)	Human cadaver collagen matrix	No	For lips, nasolabial folds, and deep wrinkles and lines	Multiple treatments needed to build tissue and achieve stable level of defect correction; lasts 2 months	Immediate effect Lasts for a few months	Not required

(*continued*)

Table 23-2

Collagen fillers (*Continued*)

Injectable	Source	Skin test needed?	Main uses	Characteristics	Duration of effect	FDA approval status
Cosmoderm/ Cosmoplast	Human foreskin	No	For the correction of soft-tissue contour deficiencies, such as wrinkles and acne scars Cosmoderm is injected into the superficial papillary dermis Cosmoplast is injected into the mid- to deep dermis	35 mg/mL collagen Contains lidocaine Cosmoderm is not cross-linked and is used for superficial lines Cosmoplast is cross-linked and is primarily used for more pronounced wrinkles	Immediate effect Lasts for a few months	Approved
Fascian	Human cadaver fascia	Usually unnecessary	Stimulates collagen formation, adds bulk	A very thick suspension of solid pieces of fibrous material	Lasts for a few months	Not required
Autologen	Autologous dermal matrix	No	For wrinkles and other skin irregularities An alternative to traditional collagen injections	Small pieces of patient's own skin are harvested (2 square inches required per mL product) and processed Typically, two or three treatments needed over a 6- to 8-week period to correct most depressions of the skin	More than 1 year	Approval not required but product is no longer available

Isolagen	Autologous fibroblasts	No	For facial rhytides and dermal defects	3-mm punch biopsy is sent to a laboratory After 6–8 weeks, cultured fibroblasts are returned to the physician (need to be injected within 48 hrs of leaving laboratory) Usually three sets of injections, 2 weeks apart Fibroblasts may continue to multiply and create collagen in vivo, thus inducing a gradual and continual improvement	Effects visible within 1–3 months Results may theoretically persist indefinitely as autologous cells are unlikely to be degraded by the body However, long-term clinical data are awaited	Anticipated Biologics License Application filing in 2006

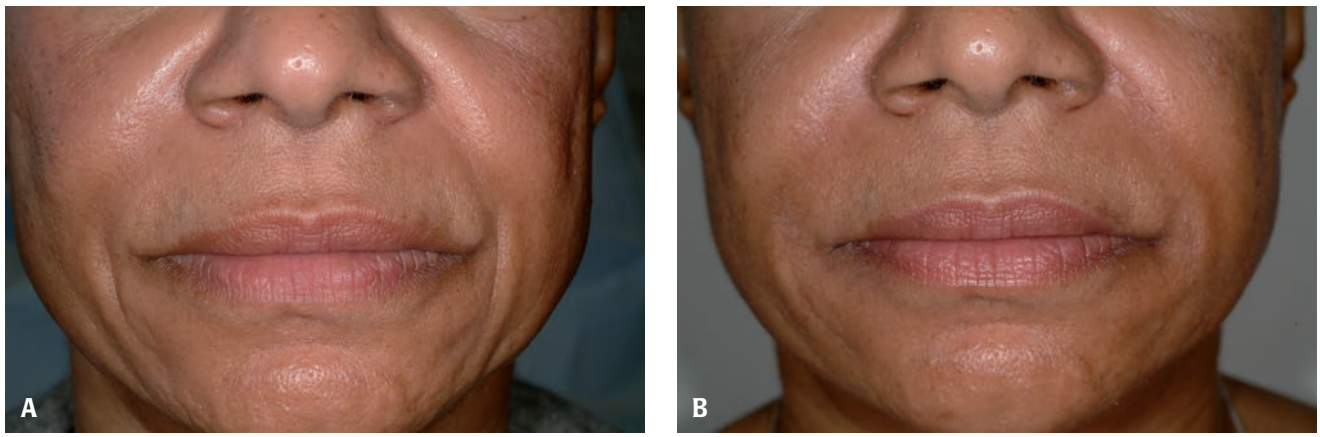

Figure 23-2 **A:** Baseline lower face nasolabial folds. **B:** One month postinjection with human collagen (Cosmoplast). (Courtesy of Pearl E. Grimes, MD.)

Porcine collagen

Evolence is a porcine-derived collagen filler available in some countries outside the United States. It is claimed that a novel cross-linking procedure (Glymatrix technology) used in the production of the material slows the rate of collagen biodegradation and results in a more prolonged clinical improvement. Therefore, maintenance of the effect may be achievable with only one treatment session each year (manufacturer's information). The most antigenic part of the collagen molecule is removed during the production process, so theoretically, the product should be highly immunologically compatible with human collagen. At this time, no public data is available on the duration of the product, which is likely to be critical in determining the demand by physicians and patients.

Autologous collagen

Bovine-derived collagen fillers have been the most widely used type of collagen, but attempts made at reducing the potential for hypersensitivity reactions have resulted in formulations derived from autologous tissue. By using only material derived from the patient's own body, autologous fillers aim to avoid any potential issues of biocompatibility and to use autologous cultured fibroblasts to stimulate long-term collagenesis in vivo. In addition, cryogenic preservation of the source material may offer patients the ability to receive treatment in later years from material harvested when they were younger. Whether this might offer any clinical benefit is unknown.

The manufacturer of Autologen provided autologous collagen, but the product is no longer available. Preliminary phase III data for Isolagen were announced in 2005, and the manufacturer plans to conduct one additional trial before submitting a complete regulatory package to the Food and Drug Administration (FDA) in 2006. Isolagen needs to be injected into the patient within 48 hours of leaving the laboratory. This can create scheduling challenges. Although initially, the idea of autologous collagen was viewed favorably, this technique has not been used to any great degree in the United States despite the technology having been available for years. There have been several drawbacks—mostly, this is a time-consuming and expensive technology to use, the effects may take several weeks to become evident, and long-term data are not available for an adequate assessment of their longevity potential.

Other human collagen

Cosmoderm and Cosmoplast are derived from human collagen and are the human-derived counterparts of bovine-derived Zyderm and Zyplast. Cosmoderm contains 35 mg/mL collagen, is a non–cross-linked formulation, and is used in the treatment of superficial rhytides. Cosmoplast also contains 35 mg/mL collagen, is cross-linked with glutaraldehyde, and is primarily used for the treatment of moderate to deep rhytides (Fig. 23-2A,B). They have little cross-reactivity, and therefore skin testing is not needed. On the other hand, they contain 0.3% lidocaine and therefore are contraindicated in patients who have hypersensitivity to lidocaine. Overcorrection of approximately 20% to 30% is required for optimal improvements, and few studies have evaluated long-term results.

AlloDerm (FDA approved for cosmetic corrective use) is an acellular dermal matrix derived from donated human cadaver skin tissue supplied by U.S. American Association of Tissue Banks–compliant tissue banks. It has been used for a variety of surgical reconstructive procedures. Because it is human derived, no skin test is recommended by the manufacturer. Cymetra is a micronized particulate form of AlloDerm. This material is rehydrated with lidocaine in the physician's office before injection, so the procedure is far less painful. Similar to AlloDerm, Cymetra contains

collagen, elastin, other proteins, and proteoglycans. Because of the small particle size, Cymetra can be delivered by injection as a minimally invasive tissue graft. It is not recommended for use in the glabellar or periorbital region.

NONCOLLAGEN AUTOLOGOUS FILLERS

Autologous fat can be used for lip augmentation and to fill moderate to deep wrinkles and scars. Fat cells from the patient's own thighs, abdomen, or buttocks are processed and then reinjected. The duration of improvement can vary tremendously between patients, from months to years. Neither FDA approval nor skin testing is required. The drawbacks are that an additional surgical procedure to harvest fat cells from patients is required, increasing the risks of surgical complications, such as bleeding and infection. Furthermore, it is more difficult to inject fat with a controlled flow, and this may increase lumpiness at the injection site (e.g., the lips). Although fat cells are derived from the patient's own body, it is unclear from studies whether the injections last any longer than other fillers, such as HA injections.[5,6] Additionally, the harvesting procedure itself can result in temporary or permanent problems, such as hyperpigmentation or scars.

Plasmagel is an emulsion of the patient's own plasma and vitamin C. It has been used to add volume, and its effects are reported to last for up to 3 months. Significant scientific data are not currently available about this product.

PERMANENT FILLERS

Long-lasting and permanent fillers are also available. The lack of biodegradability of these fillers assures that their effects are long term. The corollary to this is that any adverse effects are also likely to be long term, perhaps permanent. Additionally, even when permanent fillers are placed correctly, the face continues to age and change, and what may be in the right place today may be in the wrong location in the future. Therefore, permanent fillers or very long-lasting fillers should only be used with extreme caution in persons with great skill in the use of the specific filler if used at all. It may be worth forsaking the apparent convenience of long-term treatment to avoid the risk of permanent problems or patient dissatisfaction.

Hydroxylapatite (Radiesse, formerly Radiance)

Radiesse is composed of smooth microspheres of synthetic calcium hydroxylapatite suspended in a polysaccharide gel. The gel is resorbed, leaving the particles. It is hypothesized that collagenesis occurs around the particles,[7] but data to substantiate this are not available. The product results in immediate clinical improvements and longer-lasting results, although as is the case with most of the so-called semipermanent fillers, published data on duration are scant. The hydroxylapatite is reported by the company to form a scaffold through which the body's own collagen forms, but fibrosis and foreign body reactions may be the mechanism by which a longer-term filling effect occurs. This longevity may also be a disadvantage in that the product is not easily cleared by the body, and therefore, in the event of excessive injection, tissue reaction, or a poor cosmetic result, the effect cannot be easily corrected. For adverse effects, such as nodules, corticosteroid injections have been used, but the adverse effect may still persist. Radiesse is FDA approved for correction of moderate to severe facial wrinkles and folds, and facial lipoatrophy. Radiesse is used for facial contouring in areas including nasolabial folds, marionettes lines, cheeks, and chin. Because of possible unpredictable tissue reactions, many authors caution against its use in the lips.

Poly-L-lactic acid (Sculptra)

Sculptra contains absorbable non–animal-derived poly-L-lactic acid, and it is FDA approved for restoration and for correction of HIV-induced facial lipoatrophy. It is also used to treat wrinkles and acne scars, as well as to improve facial and lip contouring. Although it has been used for wrinkles and other cosmetic enhancements in several countries for some years, it has not been approved for such use by the FDA. Results are not immediate and usually require multiple treatments spaced 2 to 4 weeks apart. Sculptra induces an immediate local inflammatory response, which leads to a progressive increase in volume. Indeed, the product is promoted as a "volume enhancer" as opposed to "wrinkle filler." Nodules have been reported frequently, and this may be related to technique (dilution, level, and amount of injection). After several injections, the effects can last for up to 1 to 2 years, but touch-ups are usually required.

Silicone

Multiple studies have documented the efficacy of silicone for the correction of wrinkles and volume restoration. However, silicone no doubt is one of the most controversial of all filling agents. Its use has been associated with the migration of silicone particles, causing undesired side effects years after the injection. Other complications of silicone include persistent nodules, ulceration, and cellulitis. In 1994 and 1997, Adatosil 5000 and Silikon 1000 were approved by the FDA for intraocular tamponade to treat retinal detachment. Hence, off-label use of silicone has been permitted since 1997. However, many physicians remain fearful of its complications and potential litigation.

Silicone has recently been used for treatment of human immunodeficiency virus associated facial lipodystrophy,[8] but further studies are warranted to determine long-term safety and efficacy.

INJECTION TECHNIQUE

There is wide variation in the way one injects fillers. The technique will vary depending on the location of the injection site, the types of fillers used, and on the individual patient. There are several general guidelines that are useful. Having the patient in an upright position allows the injector to accurately evaluate the rhytides or defects. Almost everyone has asymmetry in the face, and this should be pointed out to patients before injection and documented with pre- and postprocedure photographs. Applying a topical anesthesia for at least 30 to 60 minutes before injection will reduce the pain of injection. Local nerve blocks, particularly the infraorbial and mental nerve blocks for the mid- and lower face injections, are useful, but care should be taken not to distort the tissues in which the filler will be placed. Waiting at least 20 minutes will allow the block to be more effective. Cosmoderm/Cosmoplast and Zyderm/Zyplast have lidocaine in the formulations and are much less painful to inject than currently avialable HA fillers.

In general for injection of collagen or HA, there are at least two different techniques that are used commonly. A threading technique in which the filler is injected along the entire length of the defect can be used. This allows for a smooth contiguous layering of the filler substance. One advantage of this technique is that there are fewer needle punctures, however, it can lead to a cordlike feel if the injection is not deep enough or too much filler material is placed. The serial puncture technique uses multiple puntures to inject a small amount of filler at a time. This allows for more precise injection into a given area but requires more needle puntures and can lead to a more lumpy result if careful technique is not used. In general, for HAs and collagens, a 27- or 30-gauge needle is used, though each product comes with a specifically recommended needle based on the product's physiological characteristics. For poly-L-lactic acid injection into cheeks, using a 25-gauge needle for the injection will help avoid clotting within the needle. The fanning technique works well for injecting poly-L-lactic acid into the cheeks for lipoatrophy. This technique involves placing the needle through a single entry point in the skin and injecting the material in a linear fashion. From this single entry point, the needle is redirected in a fanlike pattern. In general, the poly-L-lactic acid is injected in a retrograde fashion.

The depth of injection depends on the fillers being used. For example, Zyderm and Cosmoderm are injected into the superficial dermis. The needle should be placed very superficially and with minimal force on the plunger. On the other hand, Zyplast, Cosmoplast, and HA are injected into the mid- to deep dermis by directing the needle in a 45-degree angle. Often, the threading technique is used to inject into the deeper dermis along the nasolabial folds or into the lips for volume. This is followed by a superficial injection using a serial puncture technique to place a small amount of the Zyderm or Cosmoderm to fill the lines and to create definition of the lips. In treating the nasolabial crease, fillers should be placed medial to the crease to avoid further accentuating the cheeks. In the glabella, Zyplast and Cosmoplast should be avoided because of the risk of vascular injury leading to skin necrosis. This complication has also been reported with HAs. Hydroxylapatite and poly-L-lactic acid are usually placed in the deep dermis at the dermal-subcutaneous junction or subdermal plane. Following treatment with fillers, massage and ice applied to the treated area can reduce erythema, ecchymoses, and swelling. In general, there are no specific precautions in injecting patients with darker skin types, but some recommend using fewer needle punctures to decrease the possibility of injection site erythema and postinflammatory hyperpigmentation. However, there are no studies to support use of the threading technique versus the serial puncture technique in darker skin.

USING FILLERS IN DARKER RACIAL ETHNIC GROUPS

There is wide variation in the color and texture of the skin between darker skin types and that of Caucasian skin. In general, darker skin color is due to an increase in melanin and melanosome distribution. The melanin in skin types IV through VI has been reported to provide an inherent sun protection factor of 13, which may result in less skin aging being evident at an early age compared with paler skin.[9] The fine-to-deep rhytides that are characteristic of Caucasian skin are less prevalent in darker skin. Photoaging is minimal in darker racial ethnic groups. As a result, younger patients with darker skin tend to have a lower need for fillers than Caucasian patients, and care should be taken not to overcorrect. On the other hand, the midface aging of darker skin type, in particular African Americans, warrants the use of filler substances to correct nasolabial lines and elemental lines. The thicker and more fibrous dermis of ethnic skin also may have a tendency toward a more vigorous fibroblastic response during wound healing. This may promote hypertrophic scars and keloid formation. Darker skin types are also more prone to dyschromic conditions, including ephiledes, melasma, and postinflammatory hyperpigmentation. Because darker skin types are more prone than Caucasian skin to dyspigmentation, keloid formation, and abnormal scarring, patient selection is important. Thorough exams and detailed patient histories can help to exclude patients who are most prone to scar formation and hyperpigmentation. All injections

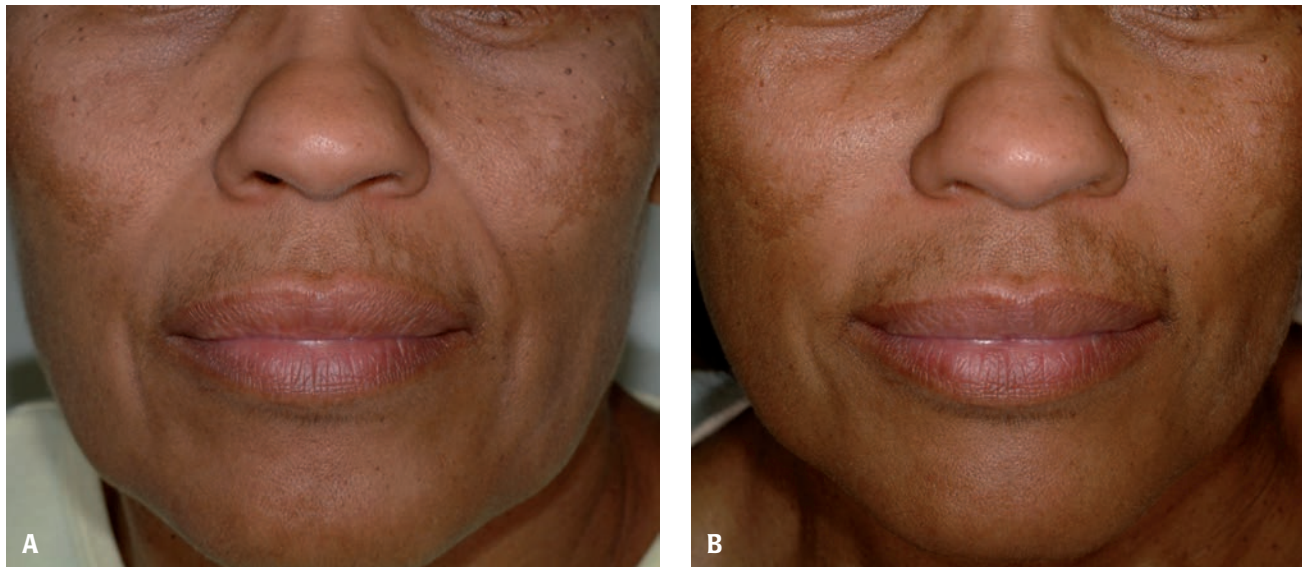

Figure 23-3 **A:** Baseline nasolabial folds in an African American patient. **B:** One month post–hyaluronic acid (Restylane) injection to nasolabial folds and cheeks. (Courtesy of Pearl E. Grimes, MD.)

should proceed gingerly to avoid traumatizing the skin. An initial small test dose followed by a waiting period of a few weeks is not unreasonable in patients for whom the risk of reactions is thought to be possibly high. However, this is not generally needed for skin types IV through VI patients unless recommended for the specific product by the manufacturer. There are no fillers known to be specifically unsuitable for darker skin types. Nevertheless, if fillers are injected too superficially or in thin skin, such as is found in the periorbital areas, they can give the skin a bluish appearance.

Currently, there is no evidence that darker racial groups experience a higher incidence of problems with fillers than Caucasians (Fig. 23-3A,B and Fig. 23-4A,B). Of note, the FDA has been requiring that companies trying to obtain approval for fillers do postmarketing studies in patients of color if they do not include enough of these patients in their registration trials. Current evidence and clinical experience of using fillers in darker skin types suggest that these products are associated with very few adverse events in both Caucasians and non-Caucasians. It appears that any individual demonstrating an inflammatory response is at risk of pigmentation problems regardless of the color of their skin. Thus, Caucasians who show prolonged erythema also have the potential to develop dyspigmentation. For patients with darker skin, injection site dyschromia may persist, and the possibility of this problem should be discussed with patients before treatment. Also, injection technique using fewer injections with a threading technique rather than multiple injections to treat an area should be considered (Fig. 23-5A,B). No reports of keloid formation or hypertrophic scars post–filler injection in darker skin types were found. Any hyperpigmentation that does arise can be treated with the standard therapeutics using bleaching agents, retinoids, and exfoliating agents.

Clinical trials involving more than 400 subjects treated with either Juvederm (30, 24HV, or 30HV) or Zyplast have been completed and reveal some useful information on skin of color treated with fillers. Among patients treated with Juvederm in a split-face study with Zyplast in the treatment of nasolabial folds, no differences in efficacy or adverse events were seen between Caucasians and non-Caucasians. Also, among patients treated with Zyplast, no differences in efficacy or adverse events were seen between Caucasians and non-Caucasians. Hypersensitivity was seen in only one non-Caucasian patient treated with Zyplast and no patients treated with Juvederm. No postinflammatory hyperpigmentation or abnormal scarring was seen in any patient in the trial. These data suggest that both Juvederm and Zyplast are very safe and effective in both Caucasians and non-Caucasians and would not imply that any special precautions are needed in darker skin types (data on file, Allergan, Inc.).

In the U.S. census for 2000, 25% of the population was reported to be nonwhite.[10,11] The percentage of people in the United States with darker skin types has been increasing in recent years, and some shifts have been particularly rapid. For example, between 1980 and 2000, the Hispanic population more than doubled, and the Asian and Pacific Islander population tripled. Furthermore, the proportion of all individuals undergoing cosmetic procedures who are not white has also been increasing (from

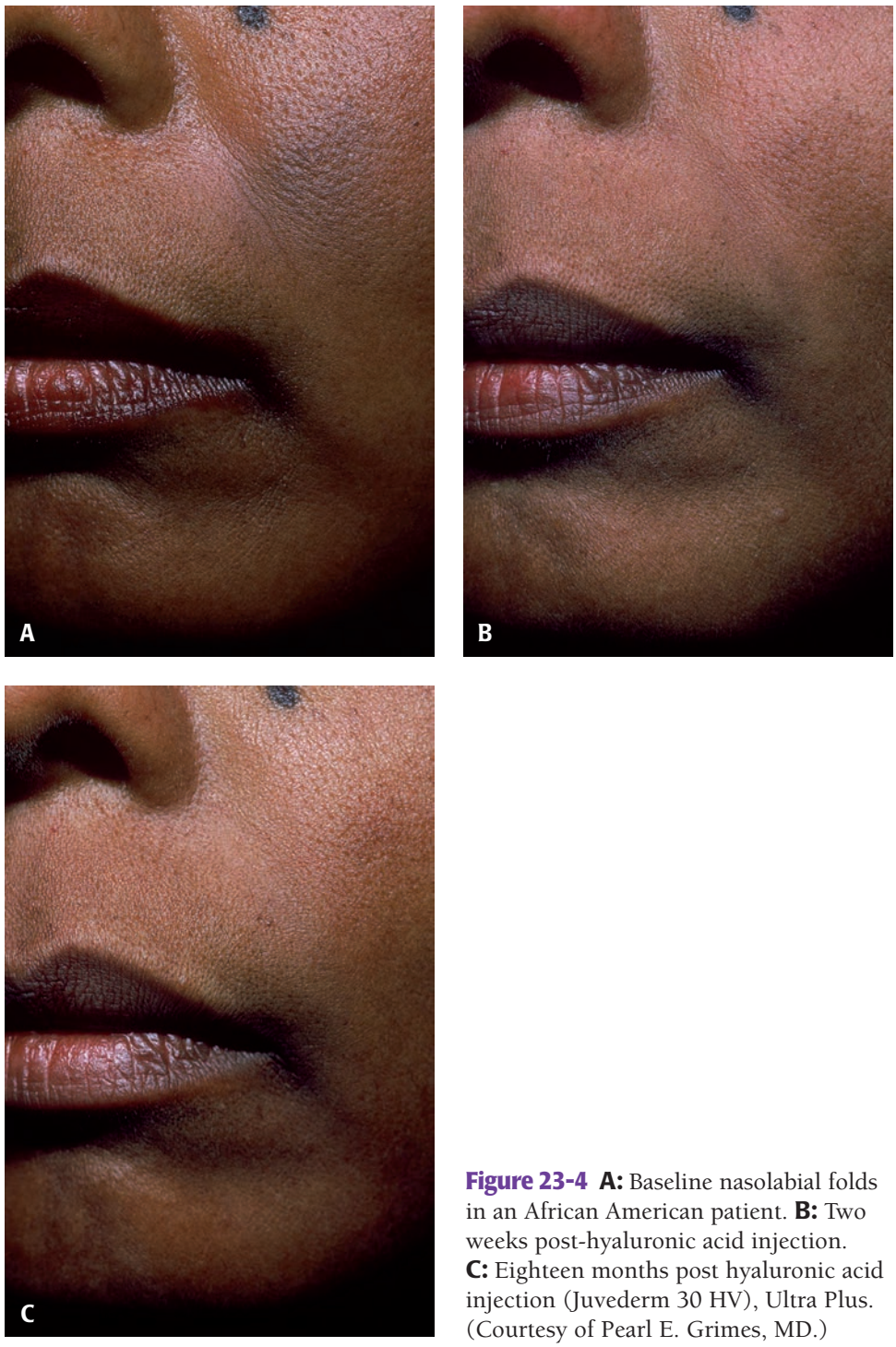

Figure 23-4 **A:** Baseline nasolabial folds in an African American patient. **B:** Two weeks post-hyaluronic acid injection. **C:** Eighteen months post hyaluronic acid injection (Juvederm 30 HV), Ultra Plus. (Courtesy of Pearl E. Grimes, MD.)

15% in 2000 to 17% in 2001, 19% in 2002, and 20% in 2003 and 2004). Despite the trend for more people with darker skin types to undergo cosmetic procedures, there are few data evaluating the use of fillers specifically in patients with skin of color. This is largely because the vast majority of patients in clinical trials have been Caucasians. For example, of 137 patients in a trial that resulted in the approval of Restylane by the FDA in 2003, only 8% were Hispanic, 1.5% were Asian, and 1.5% were black. As a result, and to increase the knowledge base concerning the use of such fillers in darker skin types, the FDA approved Restylane only on condition that its manufacturer conduct a postmarketing study of an additional 100 patients with Fitzpatrick skin type V or VI.[12] The aim of the study was to assess the likelihood of keloid formation, pigmentation changes, and hypersensitivity reactions in such patients

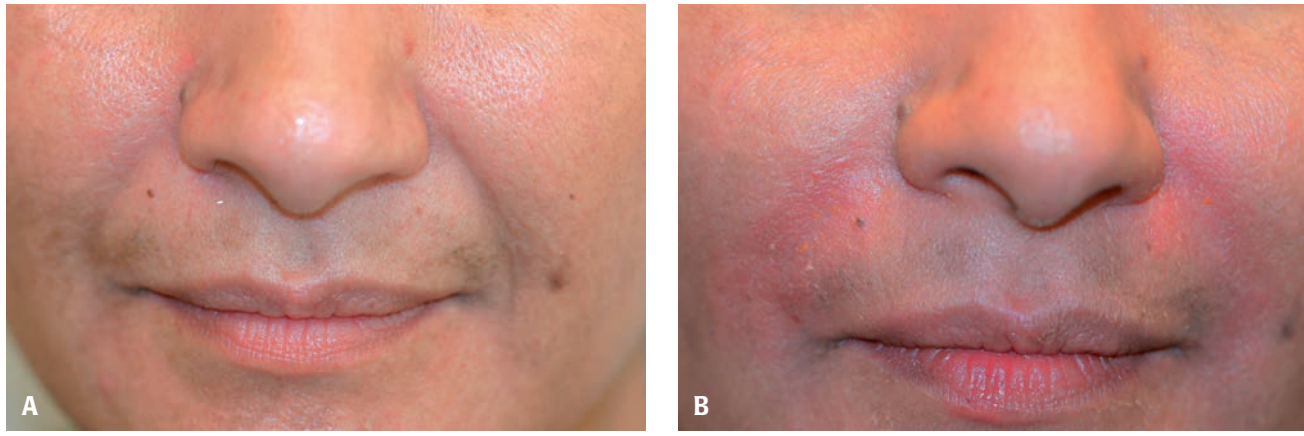

Figure 23-5 **A:** Baseline nasolabial folds of a Hispanic patient. **B:** Immediately after hyaluronic acid injection (Restylane). A threading technique using fewer injections was used to treat the nasolabial folds to minimize injection site dyschromia.

during nasolabial fold treatment. The study required a 6-month follow-up, but no results had been released in print at the time of this writing. A similar requirement for a postmarketing study was also required by the FDA when it approved Hylaform in 2004 because the trial that resulted in its approval had included relatively few nonwhite patients (of 261 patients, 13% were Hispanic, 3% were Asian, 2% were African American, and 2% were other non-Caucasians).[13,14] The postmarketing study was designed to evaluate the incidence of dermal keloid and pigmentation disorders, hypertrophic scarring, and hypersensitivity reactions (Fig. 23-6A,B).

CULTURAL CONSIDERATIONS

The potentially different desires and facial features of various patients of different ethnic backgrounds means that it is important to adjust the goal of treatment to each patient's wishes and to understand both what is culturally acceptable to them and what they particularly desire. They may want to maintain the features that they see as part of their ethnicity and thus treatment should not aim to create the same look in all patients. Also, some races are more likely to opt for certain cosmetic procedures than others. Lip augmentation is particularly common in Caucasian patients. In contrast, few African American women request lip augmentation. Individualization is key, as there is natural variation that can affect treatment decisions.

COMBINATION THERAPIES

The best results in dermatology are often achieved through combination therapy, and cosmetic dermatology is no exception. Different types of fillers can be used

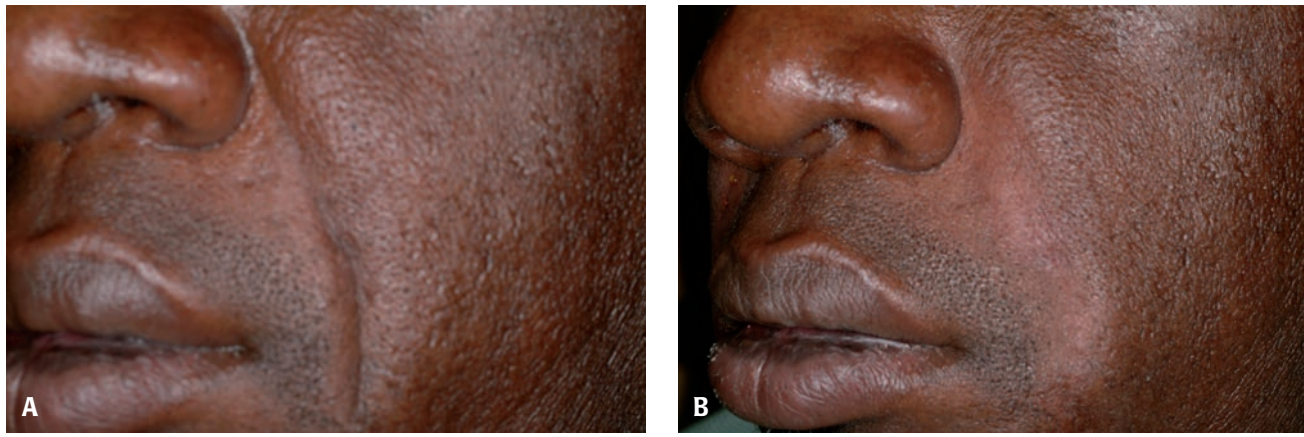

Figure 23-6 **A:** Baseline nasolabial fold of an African American patient. **B:** Immediately after injection of two syringes of hyaluronic acid (Hylaform). (Courtesy of Pearl E. Grimes, MD.)

together with excellent results, and many physicians are using HA fillers and collagen fillers in combination therapy.[15] The HA provides skin volume, and the collagen provides structural support and definition to the skin. Fillers are also used successfully in conjunction with other treatment options, such as botulinum toxin type A. Fillers and botulinum toxin A complement each other particularly well because of their different mechanisms of action. Botulinum toxin type A is most appropriate for dynamic lines associated with facial expressions, and fillers are most appropriate for static wrinkles caused by aging rather than hyperkinesis. Because of this, combination therapy can offer important and dramatic synergies. In a study of glabellar lines, patients who received botulinum toxin type A 1 week before Restylane treatment achieved dramatically greater and more prolonged efficacy than those who received Restylane alone. The median time for return to pretreatment furrow status was 32 weeks with botulinum toxin type A plus Restylane in comparison with 18 weeks with Restylane alone. Furthermore, patients experienced less pain and fewer adverse events.[16]

CONCLUSIONS

Fillers are gaining popularity in all ethnic and racial categories. The growth of cosmetic procedures among darker racial ethnic groups is increasing more rapidly than in Caucasians. Thus far, fillers appear to be equally safe and effective in ethnic populations and Caucasians, but more data are needed and should be forthcoming. Cultural differences and desires should be taken into account when treating all patients with fillers, and such preferences will help determine the optimal treatment. Although hyperpigmentation and aberrant scarring are concerns when instituting any invasive procedure in darker racial ethnic patients, to date there is no evidence that such risks are higher when treating such skin types.

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PART

7

Correction of Specific Anatomic Imperfections

24

Blepharoplasty for Asian Eyes

Yoon-Duck Kim

In Asia, an upper eyelid without a crease is called a *single eyelid,* and an eyelid with a crease a *double eyelid.* The double-eyelid operation, which is the creation of an upper-eyelid crease, has been the most popular cosmetic surgical procedure in Asia. In this chapter, three major surgical techniques to create an upper-lid crease are described.

The characteristic features of the Asian eyelid are a low or absent eyelid crease; an obliquely slanted, smaller palpebral fissure; fullness of the superior sulcus; short, inferiorly directed eyelashes; and the presence of an epicanthal fold. Appreciation of the differences of the upper-eyelid anatomy between Asians and Caucasians is important for the surgeon who performs eyelid procedures on Asian patients. In the Asian eyelid, the orbital septum fuses with the levator aponeurosis below the superior tarsal border, and there are no subcutaneous attachments of the levator aponeurosis.[1–5] This allows the preaponeurotic fat pad to descend anteriorly. The subcutaneous, suborbicularis, and pretarsal fat pads are more prominent[2,3] (Fig. 24-1). These differences create the fullness of the Asian upper lid as well as a low or absent lid crease.

Besides the anatomic differences, the surgeon must take into consideration that many Asian patients may have different standards of beauty and cultural backgrounds that will influence their definition of a successful procedure. The surgeon should try to assess what the Asian patient desires (Fig. 24-2). When performing blepharoplasty in Asian patients, it is important to be aware that most Asians do not want to look Caucasian. Most patients do not want other people to notice that they have undergone blepharoplasty.

Most Asian patients want the double-eyelid operation to create the appearance of a bigger, beautiful eye, not to create a Westernized appearance. In Western eyes, the eyelid crease usually measures 9 to 10 mm from the ciliary margin. However, a low eyelid crease appears more natural in Asian eyes. Thus, for Asian eyes, an eyelid crease of 6 or 7 mm from the ciliary margin in women and 5 or 6 mm from the ciliary margin in men and children is preferable.

There are three approaches in performing the double-eyelid operation: the suture ligation method, the small incision method, and the external incision method.

SUTURE LIGATION METHOD

The simplest approach that results in the most natural initial appearance is the suture technique.[6–9] This technique is most suitable for younger patients with a minimum amount of excess fat and skin. Recovery is rapid, with little postoperative swelling. It is easy to undo the crease if the patient does not like the shape of it, and it can be repeated when necessary. Disappearance of the crease is the most common problem encountered with this technique, especially with the use of absorbable sutures.[7–10]

Surgical procedure

Calipers are used to measure the desired distance from the ciliary margin, and three separate points are marked along the desired crease line. Small amounts of local anesthetic are infiltrated into the skin incision sites and subconjunctivally. After making the skin incisions, the upper lid is everted. Double armed 7-0 nylon suture is placed subconjunctivally above the upper tarsal border. Both ends of the suture are passed from the conjunctival side to the skin incision site. Two ends of the suture are tied, cut, and buried under the skin. This 7-0 nylon buried suture is placed for each skin incision. The skin is closed (Fig. 24-3).

SMALL INCISION METHOD

For patients who want to have a short recovery time and more permanent crease, the small incision method is optimal. This is an intermediate technique between the suture ligation method and the external incision method. This technique is suitable for younger patients with a minimum amount of excess fat and skin. Recovery is rapid with little postoperative swelling.

Surgical procedure

A blunt tip wire is pressed against the eyelid to simulate the created fold. Three incision lines of 2- to 3-mm in length are marked along the desired crease line. After

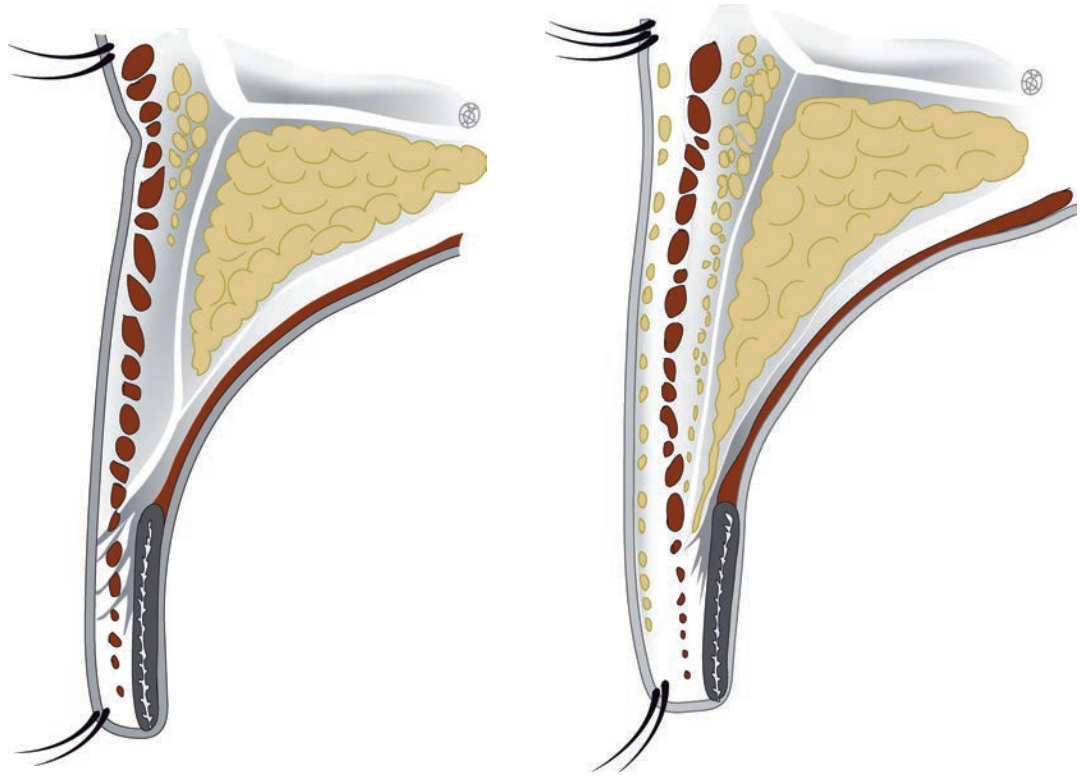

Figure 24-1 Anatomic characteristics of the upper eyelid in Caucasian **(A)** and Asian **(B)**.

infiltration of 1% lidocaine with 1:200,000 epinephrine, the skin incisions are made with a blade. The orbicularis muscle is removed through the incisions with sharp scissors. A small amount of orbital fat could be removed through these incisions in puffy eyelids. The eyelid crease forming sutures are placed between the tarsal plate and the subcutaneous tissue of the inferior incision with a 7-0 nylon suture within the incision sites. The skin is closed (Fig. 24-4).

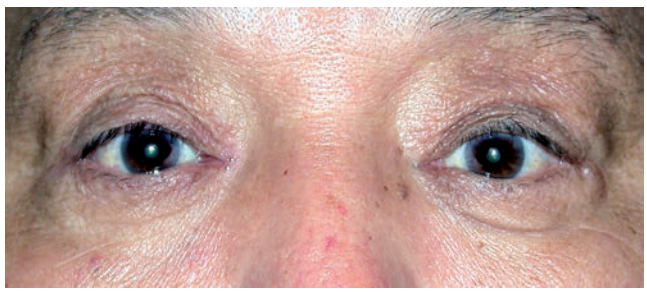

Figure 24-2 This 65-year-old man underwent blepharoplasty in the United States. By western standards, this may represent a good result. However, he was displeased with his cosmetic result because of the high lid crease and unnatural appearance.

EXTERNAL INCISION METHOD

The external incision method is preferable because the resulting crease is more permanent. Depending on the degree of puffiness and redundant skin, various amounts of skin, orbicularis muscle, and orbital fat can be removed.[11–16] The lid crease is formed by skin-levator or tarsus-skin suture or by levator aponeurosis or tarsus to inferior subcutaneous tissue.

Surgical procedure

Using the caliper, the patient's desired size is measured at the midpupillary point. An eyelid crease 6 or 7 mm from the ciliary margin in women and 5 or 6 mm from the ciliary margin in men and children tends to yield the best results in Asian eyelids. By pressing a toothpick or a blunt tip wire to the eyelid, will create the fold. Drawing a line with a marking pen is helpful. To achieve symmetry of the two eyelids, repeated measurements are mandatory. Local anesthetic is injected subcutaneously. After the skin incision is made with a No. 15 blade, the inferior skin and pretarsal orbicularis flap are dissected from the tarsal plate. Some pretarsal orbicularis is removed. Because pretarsal bulging is not acceptable cosmetically for most patients, the pretarsal tissue should be debulked. Cautery is used to achieve hemostasis. The orbital septum is opened, and the excess preaponeurotic fat is removed, especially in puffy eyelids. To create the

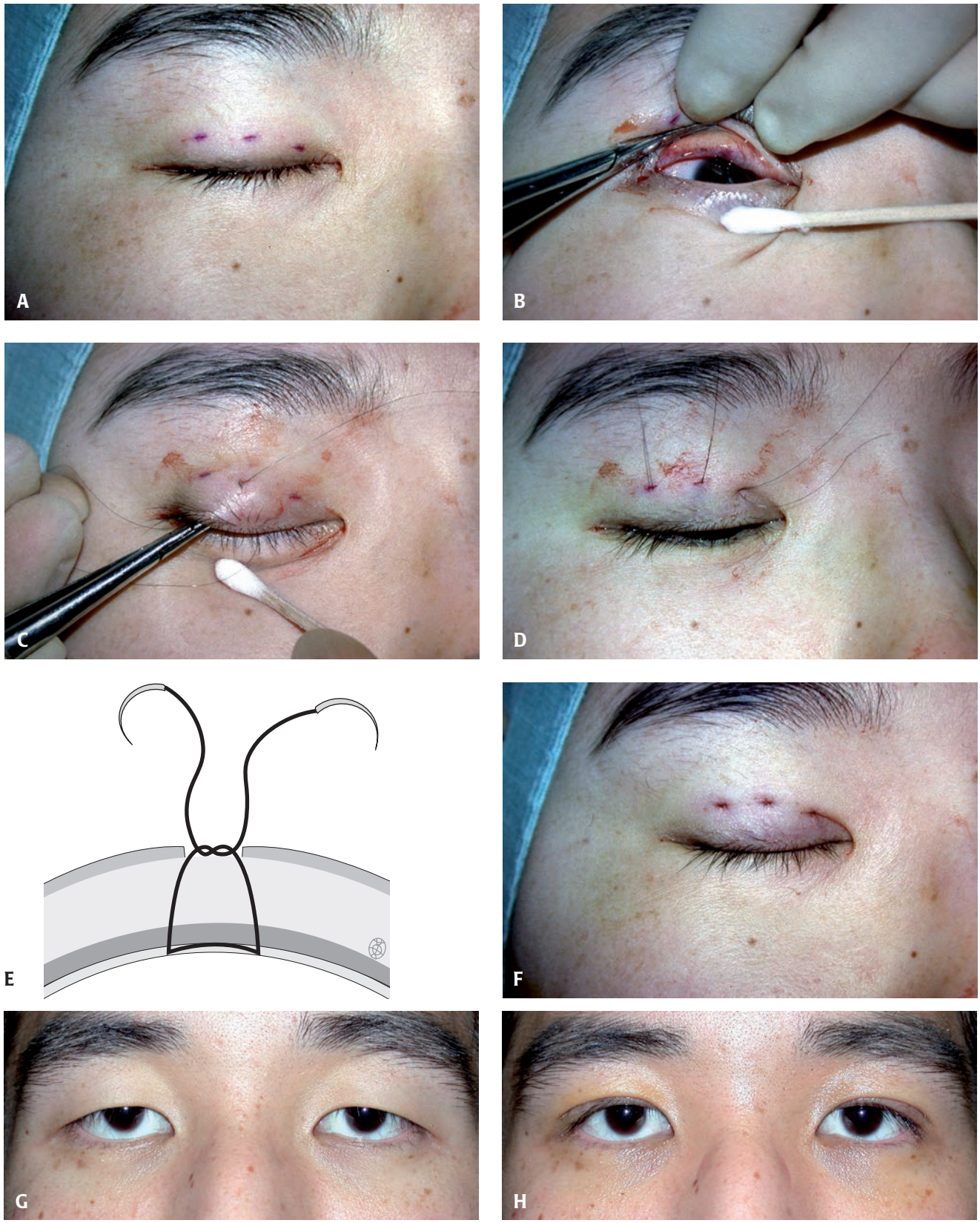

Figure 24-3 Suture ligation method. After three separate points are marked along the desired crease line, skin incisions are made **(A)**. The upper lid is everted, and double-armed 7-0 nylon suture is placed subconjunctivally above the upper tarsal border **(B)**. Both ends of the suture are passed from the conjunctival side to the skin incision site **(C,D)**. Two ends of the suture are tied **(E)**, cut, and buried under the skin. This 7-0 nylon buried suture is placed for each skin incision. The skin is closed **(F)**. Before **(G)** and 2 weeks following the procedure **(H)**. Little swelling is present, and the appearance is natural.

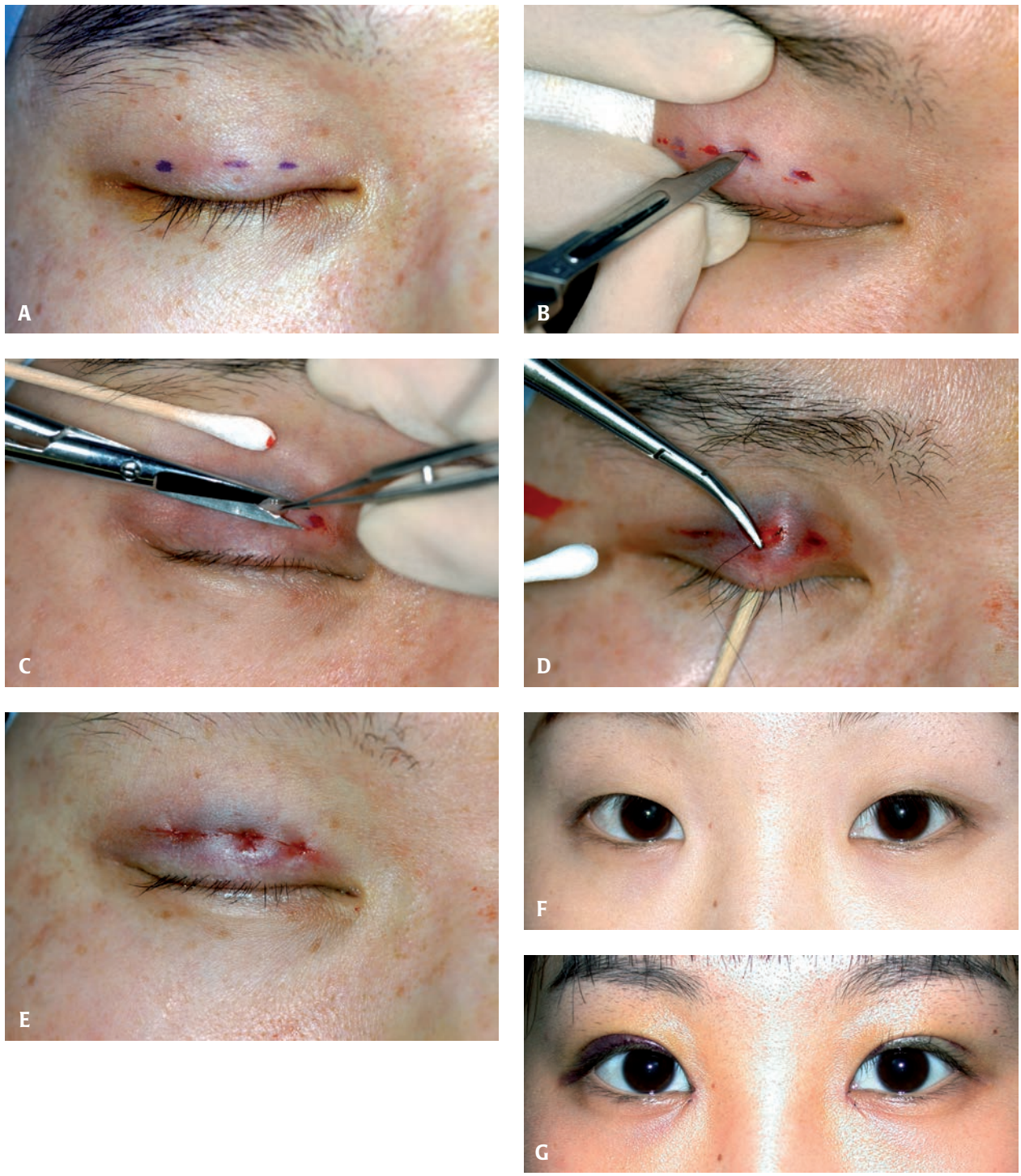

Figure 24-4 Small incision method. Three incision lines of 2- to 3-mm in length are marked along the desired crease line **(A)**. The skin incisions are made with a blade **(B)**. The orbicularis muscle is removed through the incisions with sharp scissors **(C)**. The eyelid crease-forming suture is placed between the tarsal plate and the subcutaneous tissue of the inferior incision with a 7-0 nylon suture **(D)**. The skin is closed **(E)**. Before **(F)** and 6 days after the operation **(G)**. A small epicanthoplasty was performed to make the eyes appear larger.

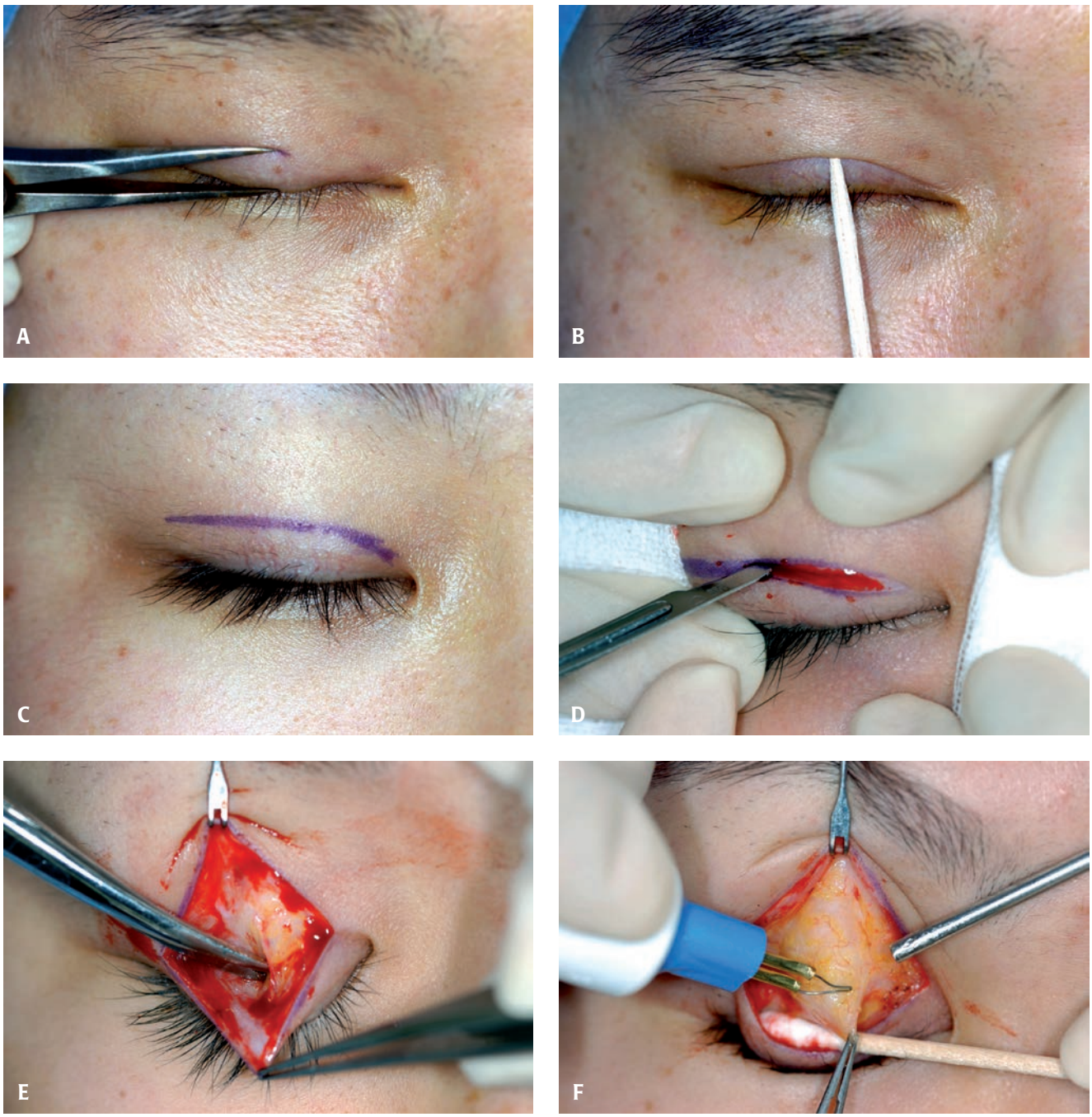

Figure 24-5 External incision method. Using the caliper, the patient's desired size is measured at the midpupillary point **(A)**. Pressing a toothpick or a blunt tip wire, to create the fold **(B)**. Draw a line with a marking pen **(C)**. After the skin incision is made with a No. 15 blade **(D)**, the inferior skin and pretarsal orbicularis flap are dissected from the tarsal plate **(E)**. The orbital septum is opened **(F)**, (*Continued*)

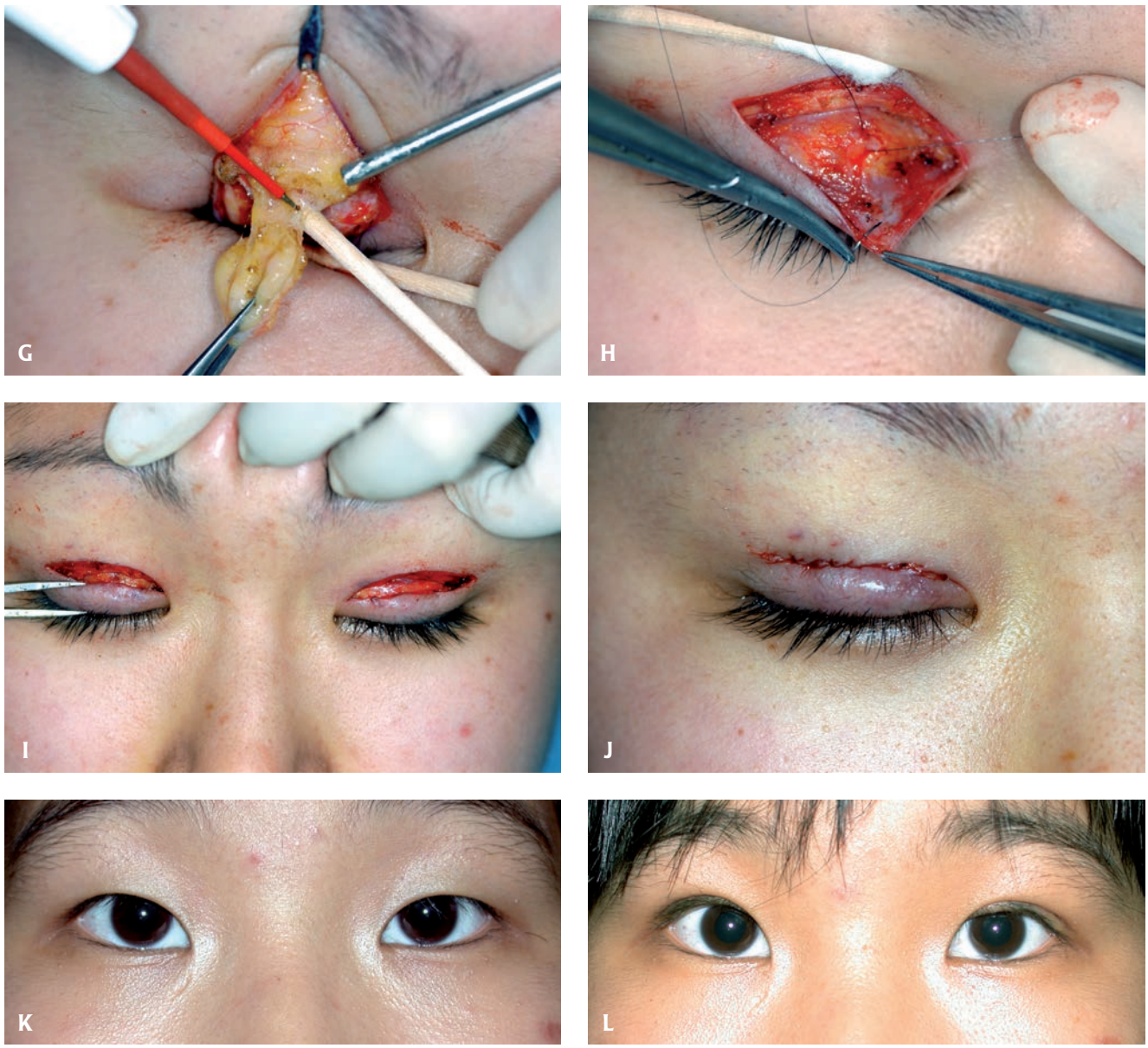

Figure 24-5 (*Continued*) and the excess preaponeurotic fat is removed **(G)**. Buried 7-0 nylon suture is placed between the tarsal plate and the subcutaneous tissue of the inferior incision **(H)**. The symmetry of the two eyelids are measured repeatedly with calipers **(I)**. The skin is closed with a running 6-0 fast absorbable gut suture **(J)**. Before **(K)** and after **(L)** the double-lid operation.

eyelid crease, three to four buried 7-0 nylon sutures are placed between the tarsal plate and the subcutaneous tissue of the inferior incision. The symmetry of the two eyelids are measured repeatedly with the caliper. Alternatively, the eyelid crease can be created by skin-tarsus-skin sutures. The skin is closed with a running 6-0 fast absorbable gut suture (Fig. 24-5).

In performing upper lid blepharoplasty for an older person, it is important to assess the amount of excessive skin and the amount and position of herniated orbital fat. The most important part of the upper-lid blepharoplasty is marking where to place the eyelid crease incision and how much skin to remove vertically. An eyelid crease 6 or 7 mm from the ciliary margin in women and 5 or 6 mm from the ciliary margin in men gives a natural appearance in an Asian aged person. Some older Asians do not desire to have an eyelid crease because they do not want to change their appearance after the surgery (Fig. 24-6). For those patients who do not desire an upper-lid crease, a skin incision 1 to 2 mm above the lash line is optimal.

The marked lid crease is used as the inferior incision line. The amount of skin to be resected is determined by

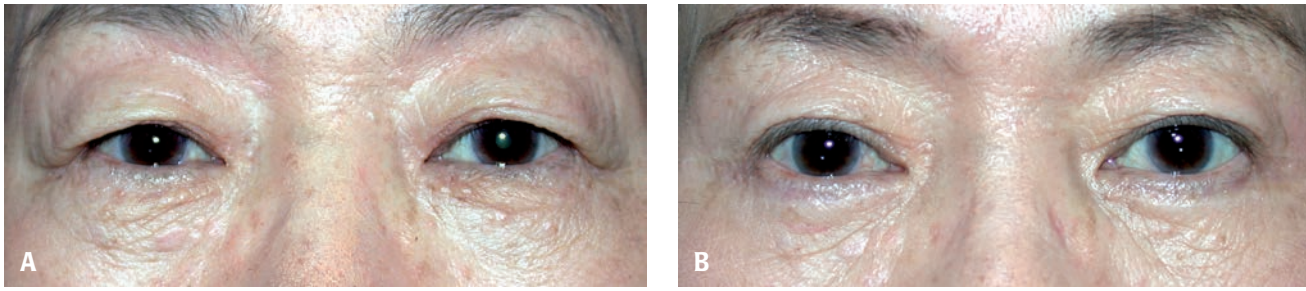

Figure 24-6 A 72-year-old woman with dermatochalasis **(A)** and 6 months after four-lid blepharoplasty **(B)**.

grasping with a smooth forceps until the lashes begin to evert and the superior incision line is marked. Because removing less skin is better than too much skin removal, the amount of skin grasped should be marked conservatively.

The author thanks Sang Won Hwang, MD for his beautiful illustrations.

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25

Blepharoplasty in Blacks and Latinos

Steven C. Dresner and Melanie Ho Erb

Blepharoplasty in patients with darker skin tones is performed similarly to other patients with a few specific variations and considerations. The goal of cosmetic blepharoplasty is to rejuvenate and restore one's appearance while preserving a natural, nonsurgical appearance. A patient's appearance should not be so drastically altered as to lose the patient's identity. Each patient's surgery should be personally tailored to his or her own needs, desires, ethnicity, sex, and individual anatomy.

UPPER BLEPHAROPLASTY

Upper blepharoplasty is used to clear the visual axis and to rejuvenate and restore the effects of aging on the upper eyelid. At the same time, the goal is to preserve the blink mechanism, insure adequate eyelid closure, and preserve a nonsurgical or natural postoperative appearance. These goals are accomplished by employing conservative techniques, such as moderate skin excision, tailored fat removal, and preservation of the orbicularis oculi muscle whenever possible. Preservation of the orbicularis not only preserves a nonsurgical appearance but allows for proper eyelid closure to circumvent postoperative dry eyes.[1]

A tailored, individualized approach to upper blepharoplasty is essential in patients of African descent. Some African American patients may have prominent globes with shallow orbits and relative exophthalmos,[2,3] which require special consideration. In patients with prominent globes, the fuller upper eyelid will help mask any relative exophthalmos. Thus, all aspects of the upper blepharoplasty must be conservative or the globes will appear even more prominent postoperatively in comparison with the paucity of skin, orbicularis, and orbital fat. Skin excision should be very conservative to prevent postoperative lagophthalmos; lid crease incisions should also not be above 8 mm from the lashes in women or above 5 to 7 mm in men to maintain a fuller fold; no orbicularis should be excised to maintain upper eyelid fullness and proper eyelid closure; and fat excision should be minimal or none to avoid a scaphoid or skeletonized appearance.

In black patients without prominent globes, the amount of skin excision and fat removal or sculpting may be increased as necessary. Keloid formations from eyelid incisions are exceedingly rare. In fact, one author has reported uneventful blepharoplasty in a known keloid former.[4] Occasionally, minor scar hypertrophy may occur in any ethnic group, including Caucasians, and may be treated with steroid injections.

In Latinos, an individualized approach is essential as well. Some Latino patients may have a rounder face, so the incision design, skin excision amount, and fat excision amount is tailored to match the patient's facial anatomy to preserve a nonsurgical or natural postoperative appearance. A skeletonized eyelid on a rounder face will look "surgical" and may alter the patient's appearance so significantly that he or she doesn't look like "himself/herself" anymore.

UPPER BLEPHAROPLASTY SURGICAL TECHNIQUE

During the preoperative planning, the height of the lid creases and the amount and location of fat to be excised are determined. Brow asymmetry, margin-to-fold asymmetry, and crease asymmetry are noted and are taken into account when determining the amount of skin to remove from each upper eyelid. Preoperative photos are hung in easy view.

The height of the lid crease incision is measured from the lashes and marked. The authors prefer a lid crease height of 6 to 8 mm in women and 5 to 7 mm in men. Skin excision is estimated by a modified "pinch" technique (Fig. 25-1A). The design varies with the patient's age, anatomy, and ethnicity. The amount of skin to be excised is measured and compared with each side; asymmetrical brow heights or asymmetrical skin overhang will need asymmetrical skin excision amounts. After the skin is marked, local anesthesia consisting of a mixture of 1% lidocaine with epinephrine, 0.5% Marcaine with epinephrine, and hyaluronidase (Vitrase, Amphadase) is injected. Skin incision is made with a diamond blade, the author's preference (Fig. 25-1B), or a

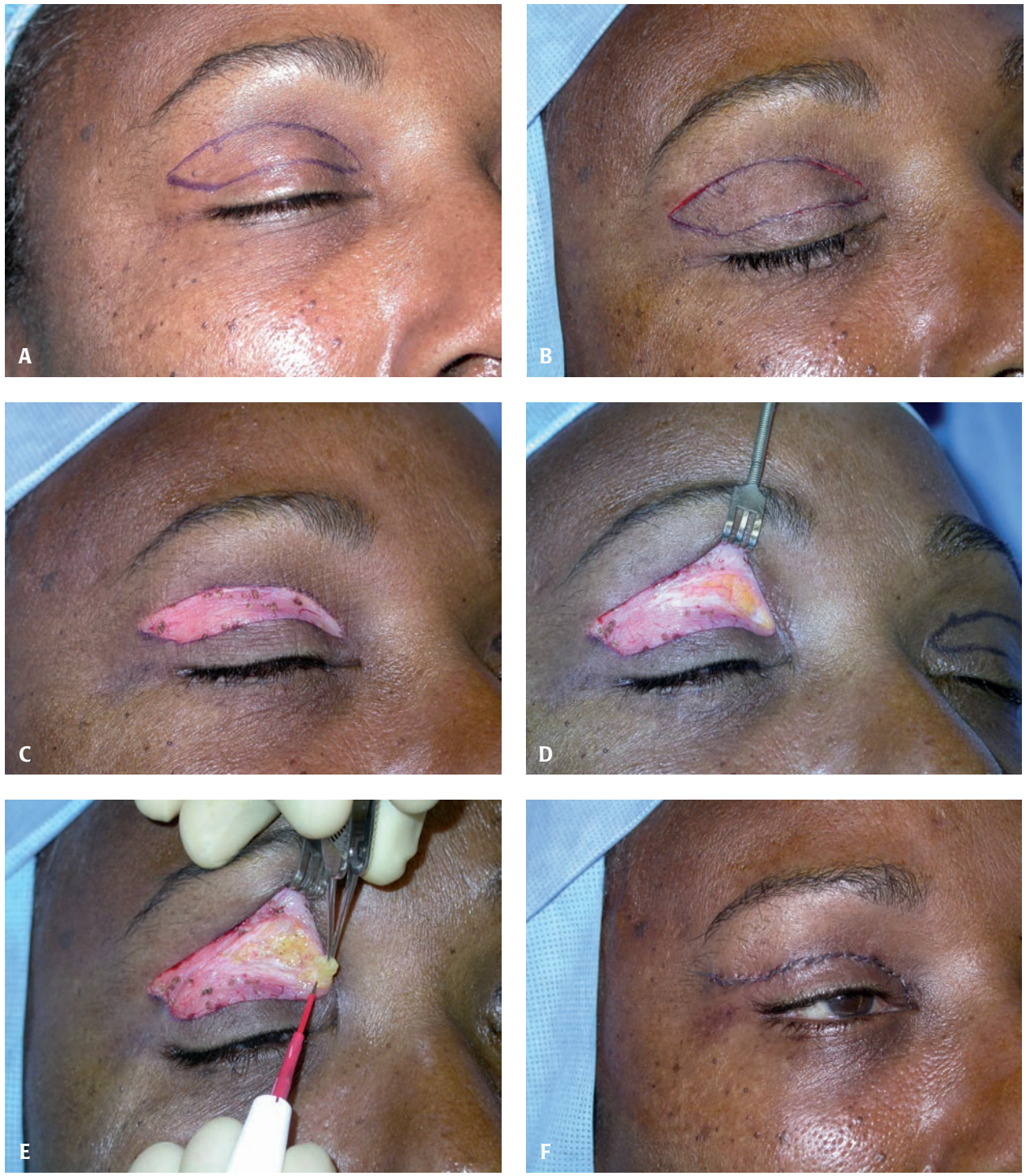

Figure 25-1 Upper blepharoplasty. **A:** Eyelid is marked using a modified "pinch" technique. **B:** Skin incision is made with a diamond blade. **C:** The skin-only flap is excised with a diamond blade. The orbicularis muscle is preserved. Hemostasis obtained with monopolar electrocautery. **D:** The orbicularis and orbital septum are incised over the compartments where tailored fat excision or sculpting is planned. Here, the medial two thirds of the orbicularis and the orbital septum is opened but not removed. The central fat pad is seen first. **E:** An appropriate amount of fat is excised with monopolar cautery. **F:** Skin incision is closed with running 6-0 Prolene suture.

Bard Parker No. 15 blade. CO_2 laser can be used; however, darker skin tones may be more subject to pigmentary disturbance after laser incision, and there is no proven advantage to do so. The skin-only flap can be removed with a diamond blade (the author's preference), No. 15 blade, scissors, or Colorado needle monopolar cautery. The orbicularis muscle is preserved (Fig. 25-1C). Preserving the muscle helps to ensure adequate blinking and closure and preserves the normal bulk of the upper eyelid sulcus. A buttonhole incision through the orbicularis and septum are made medially to remove the medial fat pad. This incision can be extended laterally to remove the central pad, if needed (Fig. 25-1D). This approach preserves the innervation and function of the orbicularis muscle. An appropriate amount of fat is excised (Fig. 25-1E) and sculpted. Meticulous hemostasis is obtained with monopolar cautery to prevent orbital hemorrhage. The skin incision is closed with running 6-0 Prolene suture (Fig. 25-1F), which is removed in 1 week. Supratarsal fixation is not recommended and will result in a more surgical appearance in these patients. Keloid formation is exceedingly rare. Occasionally, minor scar hypertrophy may occur in any ethnic group and may be treated with steroid injections.

LOWER BLEPHAROPLASTY

Lower blepharoplasty is used to eliminate unsightly contours and restore the effects of aging on the lower eyelid complex. The author's approach to the lower eyelid is similar to their approach for the upper eyelid. Each surgery is tailored based on individual anatomy. The goal is to preserve the integrity of the orbicularis oculi muscle to preserve a natural, nonsurgical appearance and to prevent postoperative lower eyelid malposition, such as eyelid retraction, scleral show, eyelid rounding, canthal dystopia, and/or frank ectropion.

An individualized, tailored approach to lower eyelid surgery is necessary. At consultation, the fat, redundant skin, eyelid tone, nasojugal groove, festoons, fluid, midface hypoplasia, and midface ptosis are assessed. For fat removal or fat repositioning, the transconjunctival lower blepharoplasty (TCB) is usually the procedure of choice. This can be combined with a "pinch" skin excision when there is excess skin to remove, leaving the orbicularis intact. This technique will remove redundant lower-eyelid skin without altering the eyelid position. If lower-eyelid laxity is present, a lateral canthopexy to stabilize the eyelid or a full canthoplasty with a lateral tarsal strip to tighten the eyelid is combined with the "pinch" skin excision and TCB to prevent retraction and scleral show. With a deep nasojugal groove, the fat is repositioned rather than removed to fill the contour. Patients with midface ptosis may have a transconjunctival blepharoplasty and transconjunctival preperiosteal midface lift with canthoplasty. In patients with festoons, a transcutaneous, infraciliary, skin-muscle flap using approach to lower blepharoplasty is recommended with horizontal tightening with lateral tarsal strip, along with a preperiosteal midface lift. Each individual component of the lower eyelid and cheek complex is evaluated preoperatively and the surgical approach is tailored to each patient's anatomy. Careful assessment preoperatively will help prevent postoperative "complications" or suboptimal results.

For lower blepharoplasty fat removal and sculpting, a transconjunctival surgical approach is preferred whenever possible. This approach avoids a skin incision and can be used in patients with darker skin pigmentation. The transconjunctival approach is the most direct route to the lower fat compartments. This technique is also relatively bloodless and more time efficient than other approaches. It does not cause postoperative lower eyelid malposition. Keloid formation from this approach has not been observed.

LOWER BLEPHAROPLASTY SURGICAL TECHNIQUE

For transconjunctival lower blepharoplasty, local anesthesia consisting of a mixture of 1% lidocaine with epinephrine, 0.5% Marcaine with epinephrine, and hyaluronidase (Vitrase, Amphadase) is injected through the conjunctiva in the inferior cul-de-sac. A coated Desmarres retractor pulls the lower lid down and away from the globe. A plastic or coated Jaeger lid plate is placed over the globe. Monopolar electrocautery with a Colorado needle is used for the incision, which begins lateral to the lower puncta and about 3 mm below the inferior tarsal border and extends to the lateral canthus (Fig. 25-2A). Blunt dissection is performed with cotton-tipped applicators (Fig. 25-2B). The incision is continued with cautery, staying closer to the tarsal border and avoiding moving inferiorly into the fornix (Fig. 25-2C). All three fat pads are encountered. The fat can be excised in appropriate amounts with monopolar cautery (Fig. 25-2D,E,F). Care must be taken to avoid the inferior oblique muscle, which lies between the medial and central fat pads. Instead of removal, fat may be repositioned into the nasojugal groove. Meticulous hemostasis is obtained with monopolar cautery. CO_2 laser can be used as an alternative to incise the conjunctiva; however, CO_2 laser is not helpful to excise the orbital fat as the vessels are too large to achieve adequate hemostasis with laser alone. The transconjunctival incision is left open, and no closure is necessary. Tobradex solution or ointment is used postoperatively.

If a "pinch" skin excision is desired, it can be used alone or performed after the TCB. First, local anesthesia consisting of the mixture above is injected subcutaneously. The skin is pinched just below the cilia with two forceps. The skin is excised with scissors. The orbicularis muscle is left intact. The skin is closed with 6-0 or 7-0 running

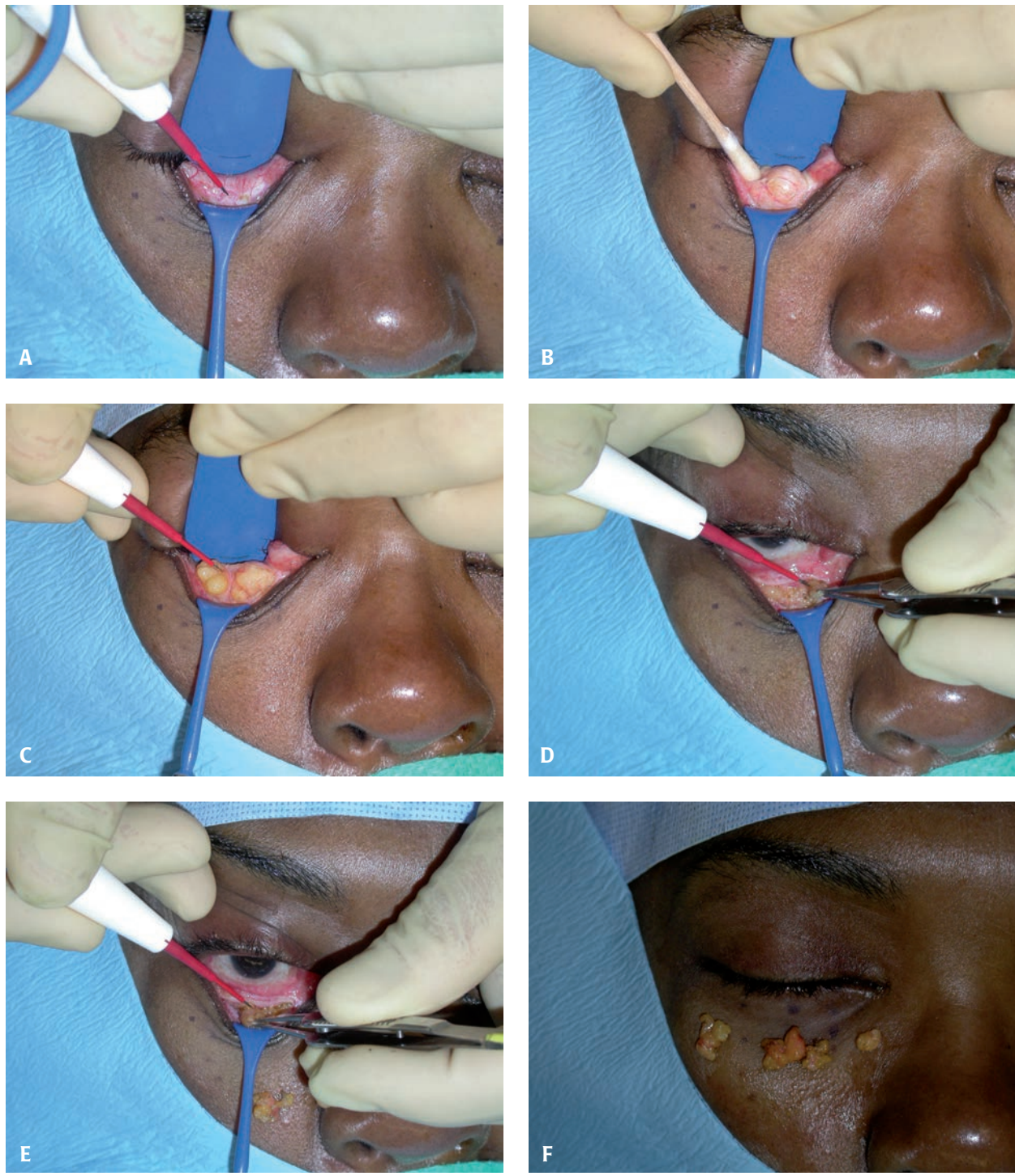

Figure 25-2 Lower blepharoplasty. **A:** A coated Desmarres retractor pulls the lower lid down and away from the globe. A plastic or coated Jaeger lid plate is placed over the globe. Monopolar electrocautery with a Colorado needle is used for the incision, which begins lateral to the lower puncta and about 3 mm below the inferior tarsal border and extends to the lateral canthus. **B:** Blunt dissection is performed with cotton-tipped applicators. **C:** The incision is continued with cautery, staying closer to the tarsal border and avoiding moving inferiorly into the fornix. **D:** Medial fat is excised with monopolar cautery. **E:** Central fat is excised with monopolar cautery. **F:** An example of the amount of fat excised from the three lower orbital compartments.

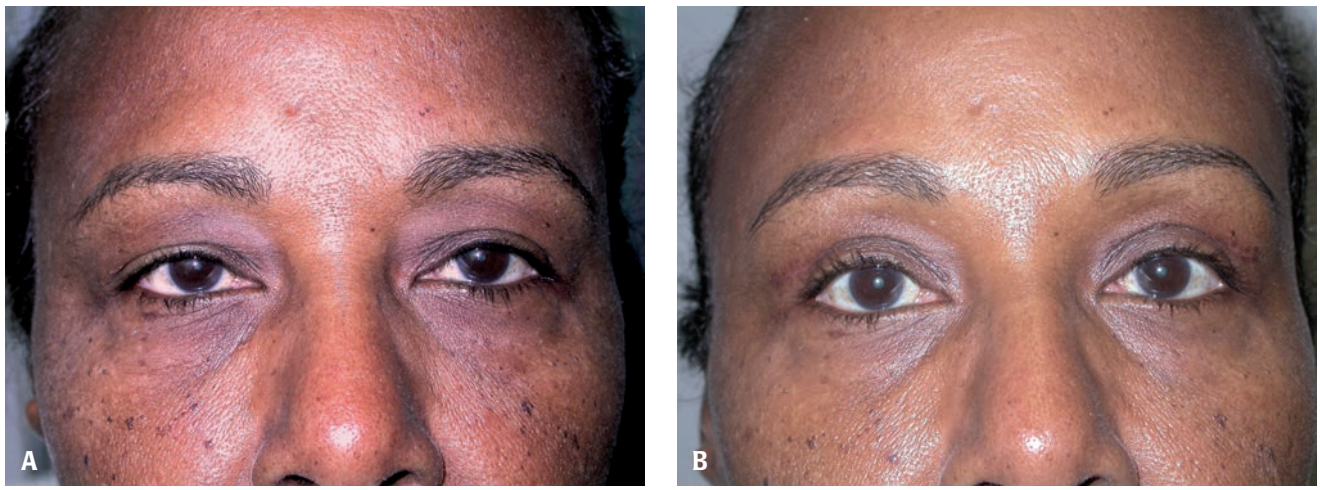

Figure 25-3 **A:** Preoperative photo of an African American woman before upper blepharoplasty. **B:** Postoperative photo of African American woman after upper blepharoplasty.

Prolene and removed in 1 week (Figs. 25-3, 25-4, 25-5, and 25-6).

COMPLICATIONS

Most "complications" of blepharoplasty are actually suboptimal surgical results. Suboptimal surgical results occur from poor preoperative planning and design of the procedure necessary for the individual patient and his or her anatomy. True intraoperative complications are rare.

True complications of upper blepharoplasty include orbital hemorrhage, infection, ptosis, lid retraction, and wound dehiscence. Ptosis may be caused by surgical disinsertion of the levator aponeurosis (Fig. 25-7). Lid retraction may be caused by inadvertent cautery of the levator aponeurosis. Suboptimal surgical results of upper blepharoplasty include undercorrection, overcorrection, asymmetry, lagophthalmos, poor blink, ptosis, lid retraction, and feminization of the male eyelid. Lagophthalmos, poor blink, and lid retraction are caused by overaggressive excision of skin or orbicularis. Ptosis can be observed postoperatively when the surgeon does not fully appreciate the ptosis under the heavy dermatochalasis preoperatively. The male upper eyelid requires special considerations and must be fully evaluated preoperatively. The lids must remain rather "full," and the lid crease must be very low, or the result is a feminization of the male eyelid. The feminized male eyelid has a high crease with aggressive skin, orbicularis, and fat removal (Fig. 25-8). Low creases with moderate skin and fat removal and no orbicularis removal will achieve both a rejuvenated and a male appearance.

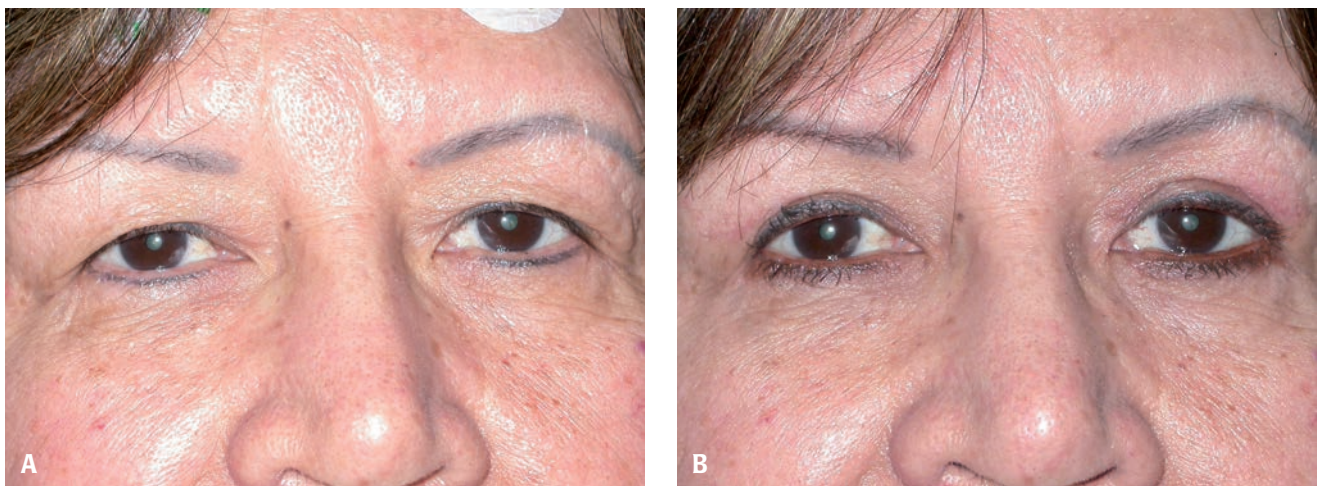

Figure 25-4 **A:** Preoperative photo of a Latina woman before upper blepharoplasty. **B:** Postoperative photo of Latina woman after upper blepharoplasty.

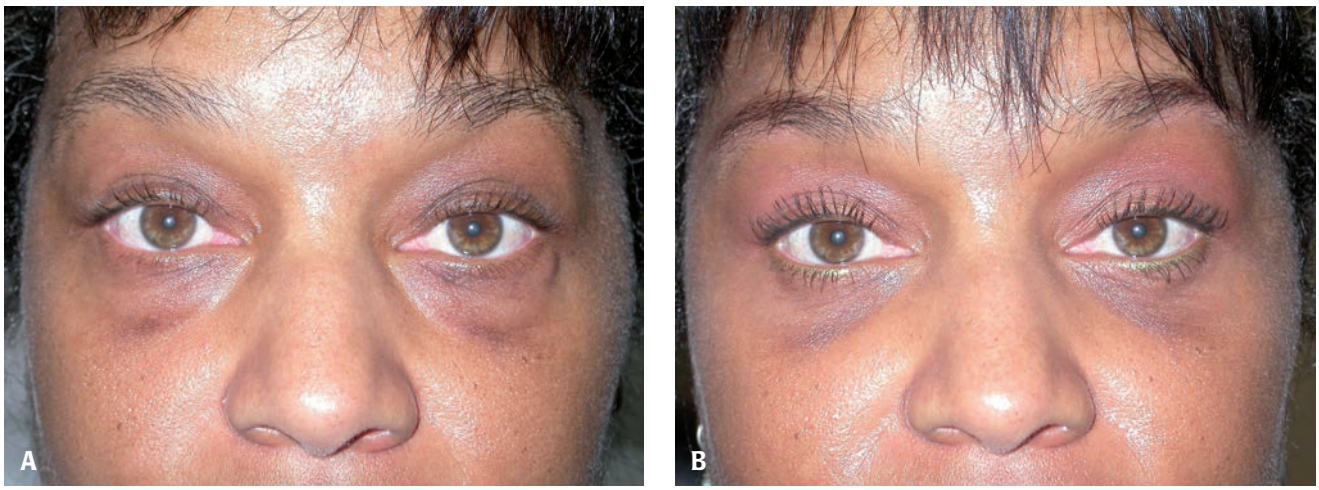

Figure 25-5 **A:** Preoperative photo of an African American woman with herniated lower orbital fat and skin hyperpigmentation. **B:** Postoperative photo of an African American woman after lower transconjunctival blepharoplasty. The hyperpigmentation remains.

True complications of lower blepharoplasty include orbital hemorrhage, infection, conjunctival chemosis, and wound dehiscence. Suboptimal surgical results of lower blepharoplasty include undercorrection, overcorrection, asymmetry, lid retraction, canthal dystopia, and ectropion. Lid retraction, canthal dystopia, and ectropion occur from a transcutaneous, skin-muscle flap lower blepharoplasty (Fig. 25-8); these complications can be avoided using a transconjunctival approach. Lid retraction, canthal dystopia, and ectropion may also rarely occur after a "pinch" skin lower blepharoplasty if horizontal laxity is not properly assessed preoperatively, and additional procedures, such as a canthopexy or canthoplasty with lateral tarsal strip, are not performed concurrently. Indeed, many patients who are seen in referral have lower eyelid retraction, scleral show, canthal dystopia, eyelid rounding, and/or frank ectropion after having previous skin-muscle flap lower blepharoplasty.

Some black patients may have prominent eyes and shallow orbits, and the relative exophthalmos may be concealed with the full eyelids. Careful preoperative evaluation for the prominent eye is necessary, and blepharoplasty in the patient with a prominent eye must be extremely conservative because aggressive skin, muscle, and fat excision of the upper and/or lower eyelids will make the eyes appear more prominent and proptotic postoperatively.

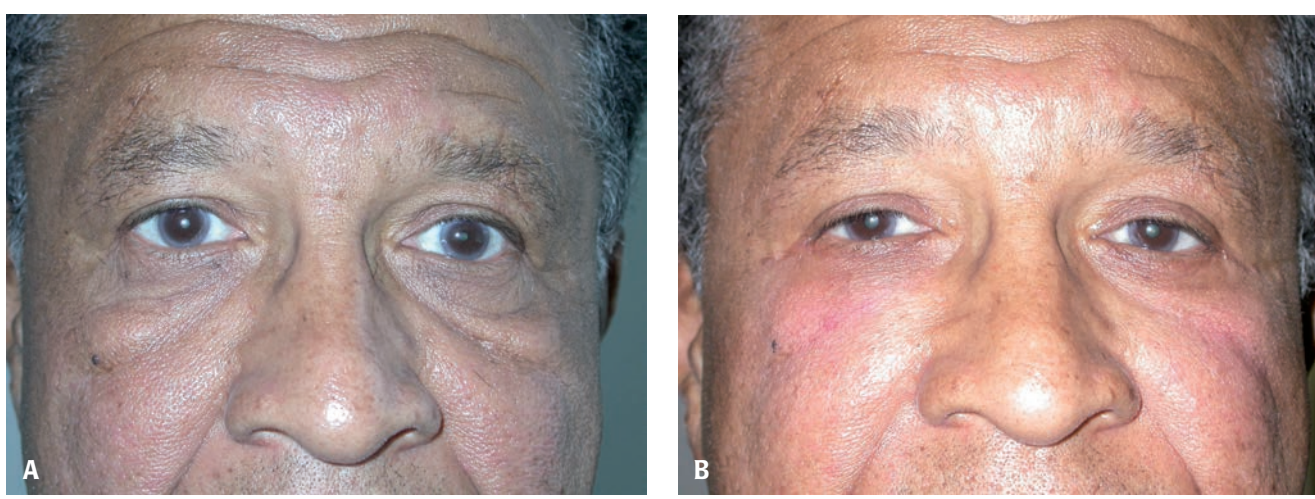

Figure 25-6 **A:** Preoperative photo of an African American man with herniated lower orbital fat, excess skin, lower eyelid laxity, festoons, and midface ptosis. **B:** Postoperative photo of an African American man after skin-muscle-flap lower blepharoplasty, pinch-skin excision, lateral canthopexy, preperiosteal midface lift, and Restylane injection.

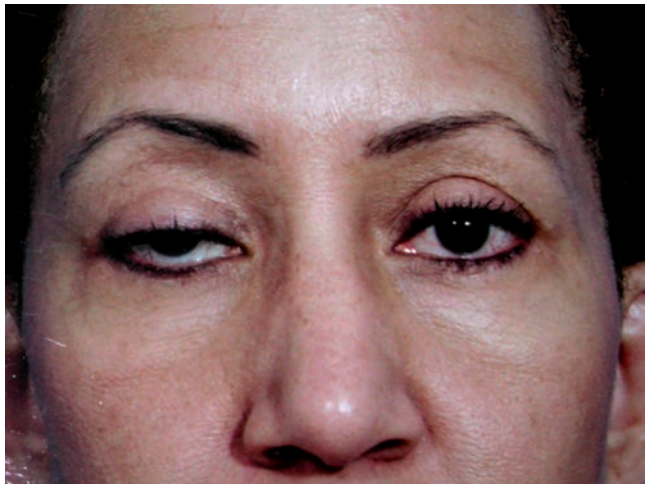

Figure 25-7 African American woman referred for complications. Right upper blepharoptosis occurred after upper blepharoplasty. There is also overcorrection of left upper lid with a high eyelid crease and scaphoid appearance.

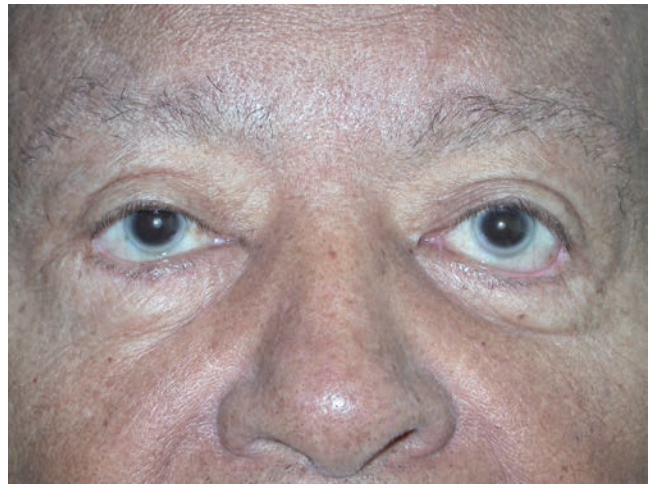

Figure 25-8 African American man referred for complications after four-eyelid blepharoplasty. Lower lid retraction and ectropion are present after transcutaneous, infraciliary, skin-muscle-flap lower blepharoplasty. Note the feminization of the male upper eyelids after upper blepharoplasty.

CONCLUSION

Blepharoplasty in patients with darker skin tones is performed similarly to other patients with a few specific variations and considerations. Upper blepharoplasty should be performed with appropriate, moderate skin and fat excision, with preservation of the orbicularis oculi muscle to preserve the blink mechanism, insure adequate eyelid closure, and preserve a natural, nonsurgical appearance. Transconjunctival lower blepharoplasty should be used whenever possible to prevent postoperative lid retraction, canthal dystopia, and ectropion. Keloid formation after blepharoplasty is extremely rare. Each patient's surgery should be personally tailored to his or her own needs, desires, ethnicity, sex, and individual anatomy.

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26

Ethnic Rhinoplasty

Matthew R. Kaufman, Reza Jarrahy, and Michael Jones

The demand for cosmetic rhinoplasty within ethnic populations has risen dramatically in the last two decades. Evidence of this trend was provided by a 2005 survey conducted by the American Academy of Facial Plastic Surgery, which revealed that African Americans and Hispanics were more likely to seek rhinoplasty than any other facial cosmetic procedure.[1] Concomitant with this increasing interest in rhinoplasty among ethnic populations has been a shift in the surgical approach to the ethnic nose by rhinoplasty surgeons.

The surgeon attempting to successfully treat the ethnic rhinoplasty patient must appreciate that variations exist not only between Caucasian and non-Caucasian noses, but also between each of the non-Caucasian ethnic groups. In fact, the term *ethnic rhinoplasty* is too simplistic; it tends to group together individuals with vastly different features. A detailed understanding of nasal anatomy and the specific differences that exist between all non-Caucasian groups (African American, Asian, Hispanic, Mediterranean, and Middle Eastern) is the only way to effectively treat these patients. Even within the African American population, morphological differences have been subcategorized into three groups: African, Afro-Caucasian, and Afro-Indian.[2]

Among the most challenging aspects of rhinoplasty surgery is the ability to precisely identify any structural abnormalities that exist and reconcile these anatomic realities with the patient's perception of what the problem is. No two rhinoplasty procedures are the same; each intervention must be customized to the anatomy and desired outcome of each individual patient. However, there are some general surgical approaches to different nose types—often categorized by ethnicity—that may be broadly applied. For example, one relatively common goal of the Caucasian rhinoplasty is to decrease the overall nasal size in the pursuit of an aesthetic ideal. This may be accomplished, for example, by reduction of the dorsal hump or trimming of the lower lateral cartilages.

Historically, the Caucasian model of nasal reduction was applied to the African American nose. Results were often unsatisfactory, reflecting a lack of sensitivity to the impact of ethnicity on "ideal" outcomes in rhinoplasty. A misunderstanding existed regarding the disparity between excessive bulky soft tissues and deficient osteocartilaginous support.[3] As surgeons came to understand that it was rarely desirable to create the ideal Caucasian nose in an African American patient, but rather to correct structural abnormalities while preserving favorable ethnicity-specific features, a unique set of rhinoplasty techniques for this patient population evolved. For example, rather than prioritizing reduction of the size of the nose to achieve an aesthetic ideal, rhinoplasty in most ethnic groups today often incorporates some degree of augmentation to achieve desired aesthetic outcomes.

The primary lesson to be learned—and the underlying principle behind all truly successful rhinoplasty surgery—was eloquently elaborated by Pitanguy in 1972, who stated that the nose must be in harmony with the rest of the face *as well as* the race of the individual.[4]

NASAL ANATOMY

Nasal anatomy may be divided into the internal framework and the external soft-tissue envelope. The osseocartilaginous structures that make up the internal framework include the paired nasal bones and bony septum in the upper third of the nose, the upper lateral cartilages in the middle third, and the lower lateral cartilages in the lower third (Fig. 26-1). The midline cartilaginous septum provides structural support to the midvault and lower third of the nose. It is also functionally important in regulating nasal airflow. The soft-tissue envelope consists of the subcutaneous tissues and overlying skin. Skin quality varies among different parts of the nose (e.g., nasal skin is thicker and more sebaceous at the tip than over the dorsum). Variations in both osseocartilaginous and soft-tissue elements seen in ethnic groups, although not uniformly present, are common enough to distinguish the particular ethnicities from typical Caucasian noses.

The literature is replete with detailed descriptions of and comparisons between Caucasian and African American nasal anatomy.[5–7] Fundamental differences are noted in both structural and coverage components. For example,

Figure 26-1 Internal nasal anatomy depicting the paired nasal bones, the upper and lower lateral cartilages, and the midline nasal septum.

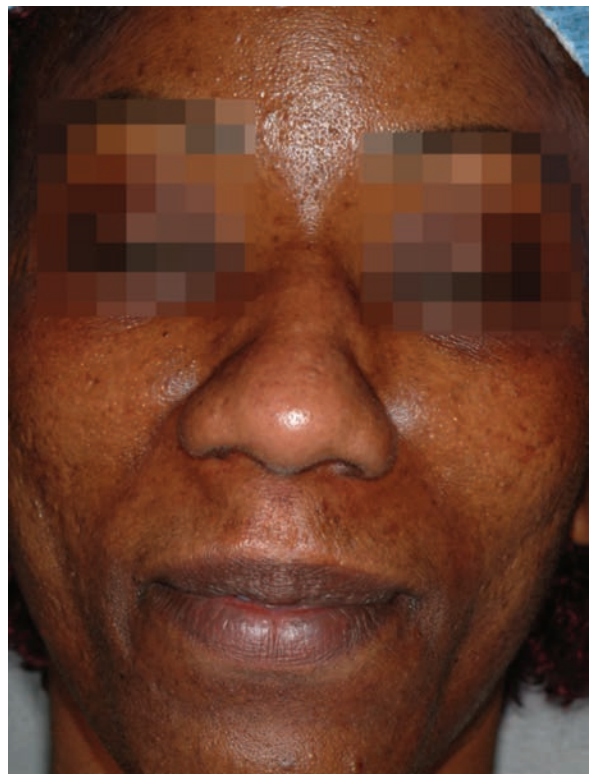

Figure 26-2 This patient has many of the commonly described African American nasal features, including short, widely based nasal bones, an amorphous nasal tip, and flared ala.

the bony pyramid that accounts for the structural support of the upper third of the nose is very different in many African American noses when compared with the typical Caucasian nose: The nasal bones are often smaller, and there is a widened angle between them, creating the appearance of a flattened nasal bridge and dorsum and a deep nasofrontal angle. Additionally, in African Americans, the premaxilla and nasal spine are often relatively underdeveloped. This bony variation results in a foreshortened columella and contributes to a poorly projecting nasal tip. Furthermore, the thick skin and dense subcutaneous tissues present at the tip produces an amorphous appearance. Finally, flared ala and a widened pyriform contribute to poor definition in the lower third of the nose (Fig. 26-2).

There are several similarities between the general characteristics of Asian and Hispanic noses and the African American nose. The nasal skin and subcutaneous tissues of Asians and Hispanics are often moderately to very thick. There is often weak tip support, a widened lobule, and a foreshortened columella. The dorsum is often shallow, and the nasal bridge appears wide. By comparison, Mediterranean patients traditionally demonstrate a straight to convex nasal dorsum and a plunging tip, whereas Middle Easterners often exhibit a high arching dorsum with a long nasal contour on profile.[8]

PREOPERATIVE ASSESSMENT

Patients presenting for ethnic rhinoplasty must express their desires to the surgeon, who must in turn decide whether these are indeed realistic. Although the majority of ethnic patients will indicate the importance of preserving their ethnic features, occasionally patients will have expectations that reveal an underlying wish to eliminate features of ethnicity from their faces. These patients require extensive counseling by the physician regarding why such an approach risks disturbing overall facial harmony. They may also benefit from preoperative psychological analysis. Ultimately, patients whose expectations prove to be unrealistic or irrational should not be considered for surgery.

Following a complete medical history, the physician should perform a thorough examination of the nose, including an internal and external assessment. Using inspection and palpation, a systematic inspection should include quality of skin, amount of tip support, alar width, dorsal height and width, internal valve angle, septal shape, and the relationship between the nose and other facial elements (e.g., nasofrontal and nasolabial angles). The findings on physical examination should be reassessed and corroborated with photodocumentation, which should include frontal, oblique, lateral, and basal views. All of this

information should be documented in the medical record, along with a description of the informed consent that is obtained.

SURGICAL TECHNIQUES

There are several different approaches that allow for surgical access to the structural and soft-tissue elements of the nose. The open rhinoplasty approach provides optimal visualization of the internal nasal framework, permitting accurate graft placement and easy fixation. There is, however, increased risk associated with the transcolumellar incision in ethnic patients, as their thick sebaceous skin may be more prone to scarring. Closed rhinoplasty offers an opportunity to access the bony-cartilaginous framework without external incisions. When limited tip work is planned, the nondelivery closed rhinoplasty approach with an intercartilaginous incision is sufficient to access the nasal dorsum. This may be combined with a retrograde dissection of the lower lateral cartilages to modify portions of the lower third of the nose. For improved access to the nasal tip, the delivery approach is a better option. This technique involves performing intercartilaginous and marginal incisions, permitting a full dissection and exposure of the lower lateral cartilages and nasal tip without the need for a skin incision.

As noted above, rhinoplasty for the ethnic patient often incorporates some degree of augmentation. Dorsal augmentation is a key component whenever there is a broad, flat nasal dorsum (Fig. 26-3). Although there remains some debate about the value (and risks) of nasal bone osteotomies, most surgeons do agree that dorsal grafts are necessary. There are many available options for dorsal grafts, including autologous tissue and allograft options. Despite the fact that most surgeons prefer to use autologous tissues, some investigators have proposed algorithms in which the choice of graft substrate is predicated upon the amount of desired augmentation: autologous cartilage for up to 3 mm, allograft for 3 to 8 mm, and autologous bone for more than 8 mm.[9] Septal and auricular grafts are the most common sources of autologous cartilage; preferred sites for harvesting bone grafts are calvarium, iliac crest, and rib. A variety of alloplastic materials have been used as dorsal nasal implants. Currently, the most common are solid silicone (Silastic) and high-density porous polyethylene (Medpor).

Treatment of the poorly defined and poorly supported nasal tip involves multiple sequential steps. Routinely, the thick fibrofatty tissue present in the subcutaneous layer of the nasal tip is thinned (it is important not to devascularize the skin or dermis while performing this maneuver). The lower lateral cartilages are modified with domal suture techniques and cartilaginous tip grafts that enhance projection and improve definition (Fig. 26-4). Columellar strut grafts placed in pockets between the medial crurae anterior to the nasal septum help improve tip support. Alternatively, aggressive use of the cephalic strip technique is not recommended, as it has been attributed to alar collapse and instability of the external nasal valva. A

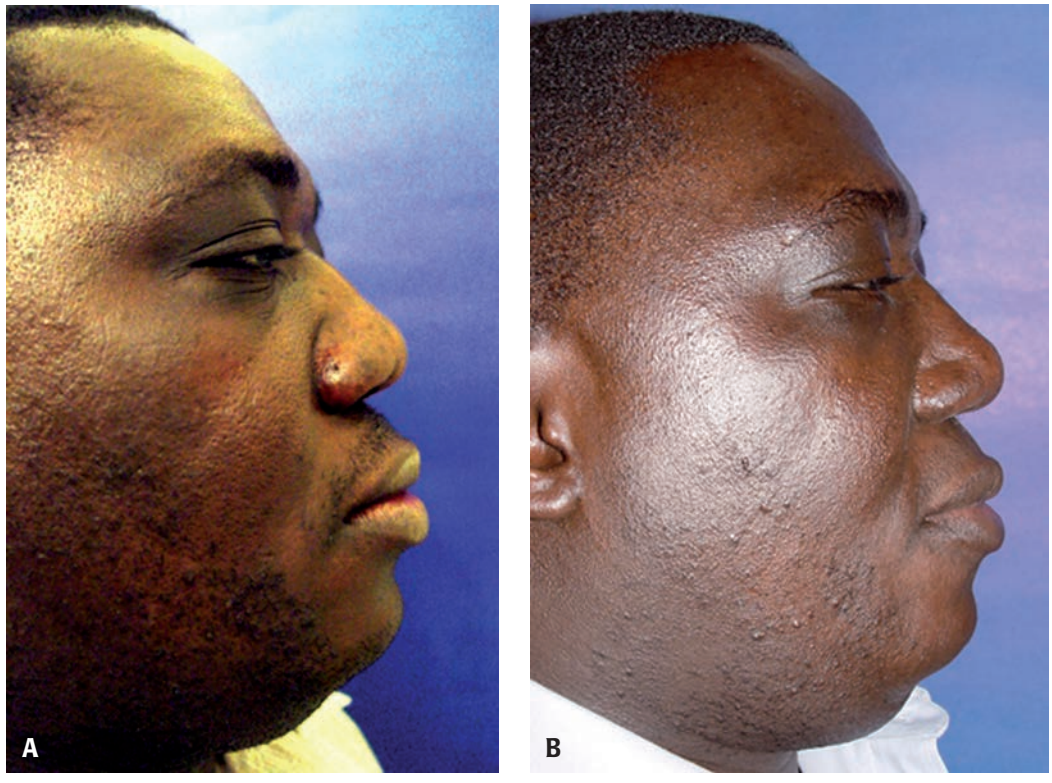

Figure 26-3 Pre- **(A)** and postoperative **(B)** views of rhinoplasty patient with dorsal grafting to improve dorsal height and contour.

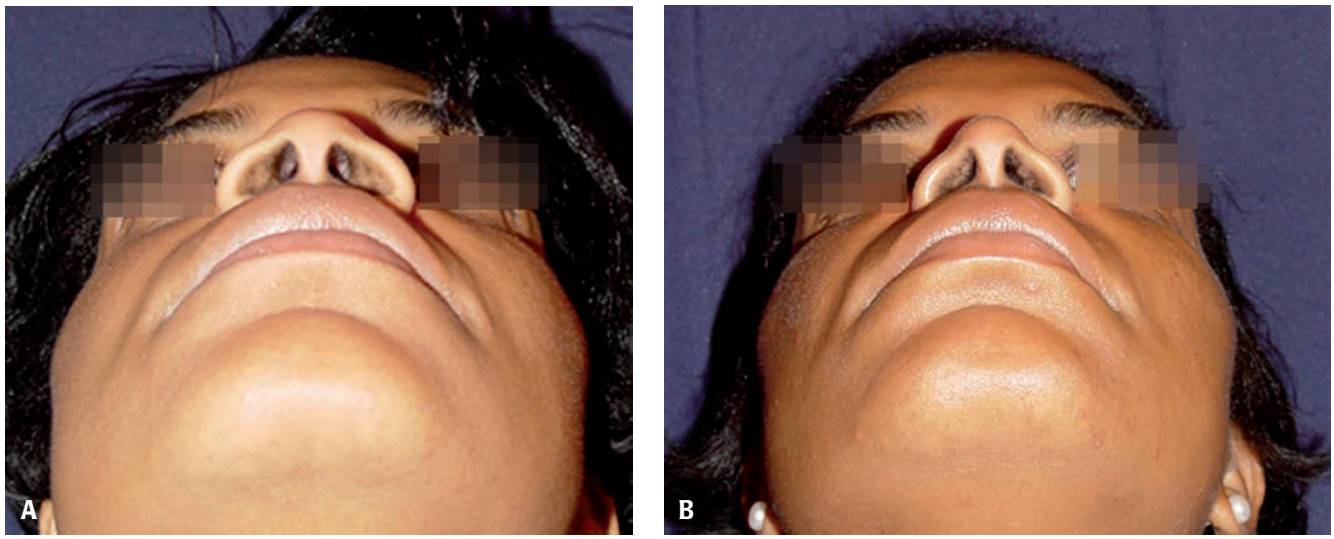

Figure 26-4 Pre- **(A)** and postoperative **(B)** views of a rhinoplasty patient using tip-defining techniques, such as domal sutures and cartilage grafting.

"plumping" graft of fibrofatty tissue or cartilage placed into a premaxillary pocket will reduce the appearance of the contracted columella and improve the contour of the nasolabial angle.

Alar base reductions are often performed to reduce the width of the nose to fall within the boundaries of a vertical line drawn from the medial canthi (Fig. 26-5). It is important to maintain symmetry on both sides by removing the same amount of tissue while still preserving the natural alar groove. Small monofilament sutures should be used and subsequently removed early to minimize the risk of scarring. Another technique used to minimize visible scars is to perform internal alar reductions by placing the incision in the nasal sill.

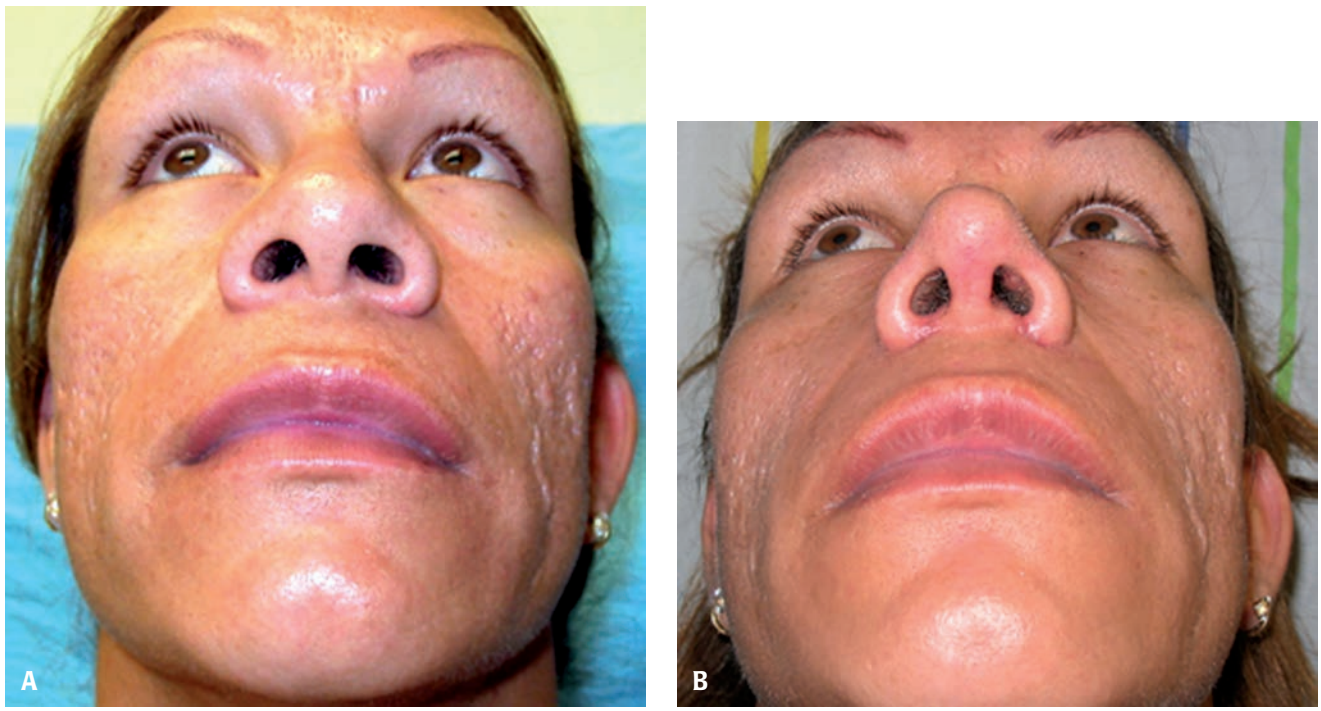

Figure 26-5 Pre- **(A)** and postoperative **(B)** view of patient who had tip-defining rhinoplasty with alar base reduction.

COMPLICATIONS

Ethnic rhinoplasty is associated with certain postoperative complications unique to this procedure. This is in addition to the more generalized problems of bleeding, infection, functional abnormalities, and poor aesthetic outcome, which are occasionally observed in all cosmetic nasal surgery.

Alloplastic dorsal nasal implants, especially those made of silicone, have an established rate of extrusion, usually through the nasal tip. Patients should understand that threatened exposure almost always requires early removal of the implant to prevent further complications. Alteration in skin color, either hyperpigmentation or hypopigmentation, may result from incisions or minor trauma. Treatment of these problems may require adjunctive topical therapies, depending on their temporal relationship to surgery and the specific type of pigment abnormality. Although it is rare to see true keloids forming at the sites of open rhinoplasty incisions or alar base reductions, hypertrophic scars have been reported. Additionally, a thickened scar along the columella incision may result in an inadvertent visible notching.

SUMMARY

Rhinoplasty in ethnic populations has been a challenge to plastic surgeons for many years. There was previously a misconception regarding nasal morphology that led to overresection of nasal structures, yielding poor surgical outcomes. With a greater understanding of nasal anatomy in different ethnic groups, surgical techniques that permit nasal refinement without losing facial harmony have been developed. These techniques are often very different than those used in traditional rhinoplasty for Caucasian populations and must be mastered to achieve optimal results.

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27

Reduction and Augmentation of the Breasts

Matthew R. Kaufman, Reza Jarrahy, and Michael Jones

REDUCTION MAMMAPLASTY

Although it is not altogether clear why many women in certain racial ethnic populations suffer from breast hypertrophy, the etiology is suspected to be some combination of hormonal, genetic, and developmental factors. Large-breasted women often have significant functional and psychosocial impairments, prompting them to investigate surgical options. In addition, these patients are prone to developing comorbid conditions, such as chronic back and neck pain, and often there are multiple medical professionals involved in the search for effective treatments.

Because reduction mammaplasty offers a cosmetic and functional resolution to the consequences of large breasts, it is associated with high rates of patient satisfaction. During the initial patient assessment, the physician must determine the patient's desired breast size and be able to meet this desire using one of the various descriptions of surgical techniques.[1–3] Some of the more common surgical methods are the inferior and superior pedicle techniques, whereas partial breast amputation with free nipple grafting is reserved for patients with massive breasts or significant risk factors.

Darker-complexioned women presenting for breast reduction surgery must be informed of the risk of unsightly breast scars and the possibility of needing scar revision treatments in the months to years that follow the initial procedure. Despite the increased risk of scarring that is present in these patient populations compared with their lighter skinned counterparts, most women will still undergo the procedure and achieve satisfaction because of the significant functional improvements.

Patient assessment and selection

Candidates for breast reduction surgery encompass a wide range of age groups, including young girls with virginal hypertrophy to elderly women seeking to reverse the effects of aging on large, uncomfortable, sagging breasts. During the initial assessment, a full history must be obtained, including age of breast development, pregnancy and lactation history, previous breast surgery, weight change, smoking, family history of breast cancer, and how past scars have healed. The patient should specifically state her goals regarding the desired breast size. During the physical assessment, a full breast exam must be performed. The physician should determine the degree of breast symmetry (or asymmetry) and the distances from the sternal notch to the nipple and from the nipple to the inframammary fold. These measurements will be important in determining the vertical lift requirements and the safest method of accomplishing the reduction; a common rule is that when the nipple to inframammary fold distance is greater than 17 cm, the inferior pedicle is less likely to support survival of the nipple. Another important consideration, especially pertinent in the darker-skinned patient, is the diameter of the nipple-areolar complex. In many women with mammary hyperplasia, this diameter will be greater than normal, and patients must be informed that it too will be reduced, along with the breast volume. Objective signs of breast hypertrophy should be elicited, such as bra-strap grooving, skin rashes or irritations, striae, postural abnormalities, and early kyphosis of the cervicolumbar spine. Preoperative assessment should include screening mammograms, especially for women older than 30 and for patients with a personal or family history of breast disease. It is also recommend that patients undergo mammography 6 months after surgery to establish a postoperative baseline. Patients with comorbid back pain conditions should be evaluated by an appropriate specialist and may require magnetic resonance imaging to objectify the chronic effects of breast hypertrophy on the spine.

Appropriate candidates for breast reduction surgery usually present with long-standing symptoms of back and neck pain resulting from large, pendulous breasts. Skin rashes, or intertrigo, and bra-strap grooving make up some of the cutaneous manifestations of breast hypertrophy. Women with severe breast asymmetry will also desire breast reduction to alleviate the unilateral symptoms plaguing their daily lives. Just as important are the psychosocial effects of breast hypertrophy that are especially disturbing to younger women or teenage girls suffering from virginal hypertrophy. The daily embarrassment that is often associated with this condition can be detrimental

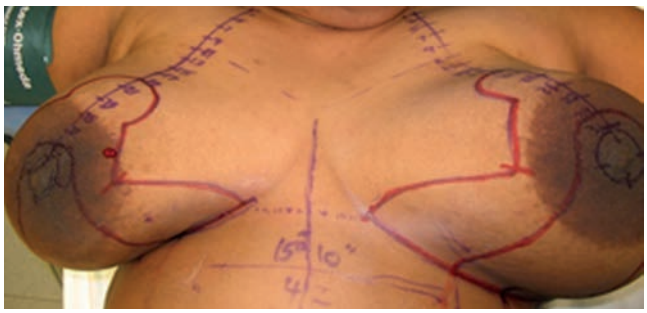

Figure 27-1 This patient had been previously marked for surgery, using an inferior pedicled technique, while in a standing position.

to a teenager or young woman, thus negatively affecting both physical and mental development.

The prevalence of obesity in ethnic populations has increased the number of people seeking breast reduction surgery as a way of treating the effects of weight gain on the breasts. Unfortunately, it is inappropriate to view reduction mammaplasty as a weight reduction procedure, and the best course of action is to recommend the patient lose weight before breast surgery. Ideally, a woman should be within 30 pounds of her ideal weight to be a surgical candidate. Abiding by this philosophy will improve patient satisfaction and reduce the rate of perioperative complications associated with surgery in obese patients.

Surgical techniques

Arguably, the most common method of breast reduction surgery is the inferior pedicle technique, whereby the majority of parenchyma is removed from the medial, lateral, and superior quadrants, and the blood supply to the nipple-areolar complex is maintained from the inferiorly based soft tissues. The key to achieving surgical success is careful, accurate preoperative markings made with the patient seated or standing, usually in the holding area (Fig. 27-1). A complete technical description of the markings is beyond the scope of this chapter, so the reader is referred to previous publications that thoroughly outline the procedure.[4–5] Notable aspects of the preoperative markings include setting the new nipple-areolar position by transposing the inframammary fold onto the breast mound and use of the keyhole pattern to design the resultant shape of the new nipple-areolar complex and determine the extent of skin resection. The markings will ultimately guide the surgeon toward the resultant breast scars, which include a periareolar incision and an "inverted T" incision at the base of the breast (Fig. 27-2). During the surgery, it is important to proceed in a systematic way, as even the most experienced surgeons can sometimes lose sight of the three-dimensional nature of the reduction procedure. It is also critical that there be attention to detail to achieve absolute breast symmetry and minimize resultant scarring (Fig. 27-3).

There are many other techniques available, some of which have been developed in an attempt to minimize incisions. For example, the vertical mammaplasty, popularized by Lejour, accomplishes reduction of the breast parenchyma and skin excision without a resultant horizontal incision at the base of the breast.[6] Although this technique may have applications for smaller-volume breast reductions, the skin "bunching" and increased tension that is often required along the vertical limb of the incision may not be ideal for darker-skinned patients in whom there may be a higher chance of hypertrophic scarring.

For patients with massive breast hypertrophy, a safe, reliable method of reduction involves partial breast amputation with free nipple grafting. The basic design is similar to the inferior pedicle technique, but the glandular

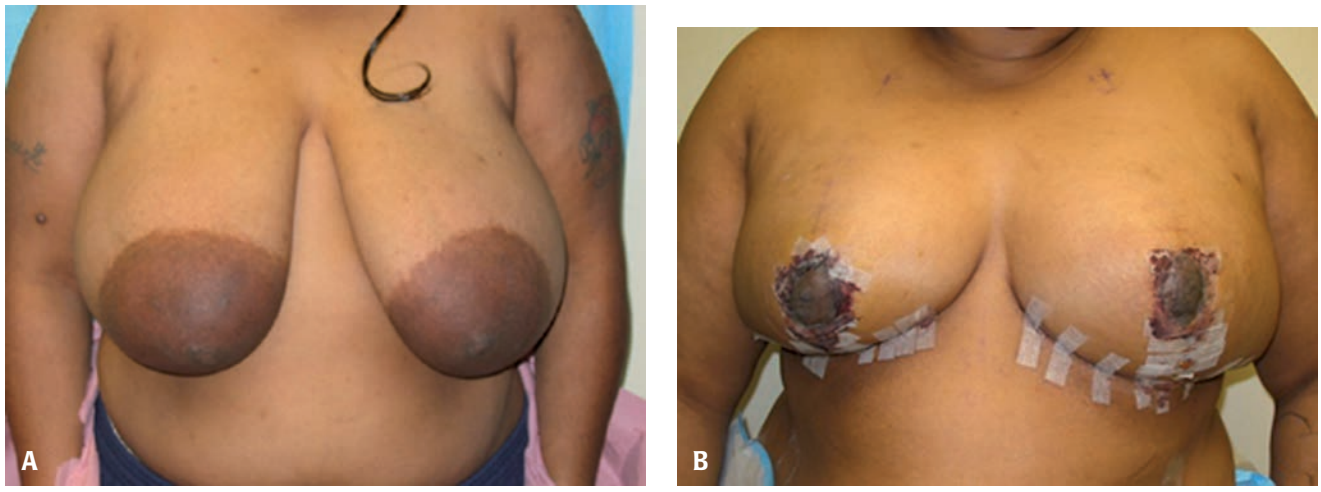

Figure 27-2 **A:** Preoperative photo. **B:** Two days post breast reduction. Note the Steri-strips along the incision lines, including the periareolar incision and the inverted "T" at the base of the breast.

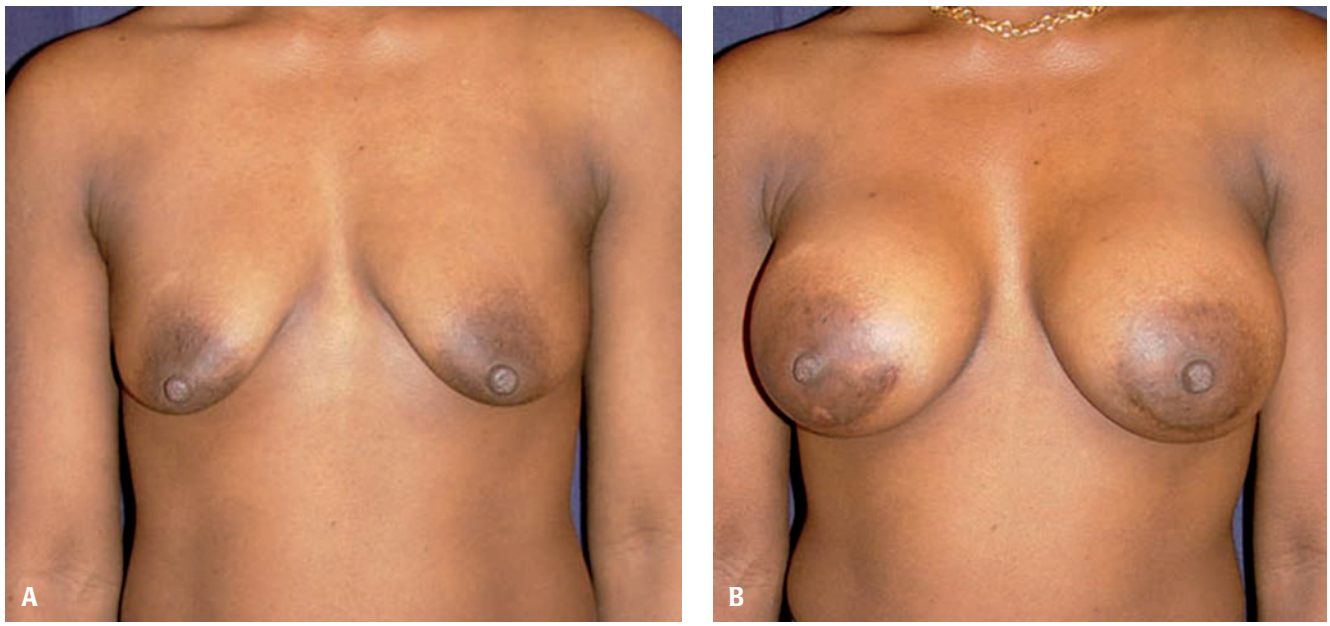

Figure 27-3 Pre- **(A)** and postoperative **(B)** photos of a patient undergoing breast augmentation. In this patient, the implants were placed in a subglandular position. Because she has moderate breast ptosis, subglandular implant placement was suggested by her surgeon to avoid an unnatural ("double-bubble") appearance.

resection includes the inferior pole, and the nipple-areolar complex is excised completely and replaced at the end of the procedure as a full-thickness graft. The main advantage of this technique is avoiding problems with nipple-areolar necrosis that may occur in a large-volume breast reduction when there is an excessively long distance of the inferior pedicle. The obvious consequences of complete nipple excision are the loss of sensation to this area and the inability for subsequent lactation. Other breast reduction techniques often will preserve nursing functions, especially when an effort is made to limit parenchymal excision directly under the nipple.

BREAST AUGMENTATION

Although physicians have been using various materials to augment the breasts for more than a century, the modern age of augmentation mammaplasty began in 1962, when Cronin and Gerow first performed silicone gel–filled prosthesis augmentation.[7] Since that time, breast augmentation has become one of the most common plastic surgery procedures in women. In 2005, the number of breast augmentation procedures in ethnic patients increased dramatically, especially in Hispanic and Asian women. In these groups, breast augmentation surgery was among the three most commonly requested cosmetic procedures.[8] The type of implants most commonly used are saline filled. After a prolonged moratorium due to concerns raised about the safety of implantable silicone, the Food and Drug Administration recently re-approved silicone filled breast implants. Preoperative discussion is necessary to elicit a realistic expectation on the part of the prospective patient, as well as a clear understanding of the risks and limitations of breast implants.

Patient assessment and selection

Patients seeking breast augmentation must have a clear understanding of the procedure and the possible adverse sequelae, especially those related to the implants themselves. In addition, the desired outcome of the patient should be elicited so the physician can determine if it is a realistic expectation. A thorough patient interview should include pregnancy and lactation history, as well as the prevalence of breast cancer in family members. Physical examination should focus on—amongst other things—breast shape, symmetry, and degree of ptosis. Furthermore, the physician should assess the quality of the skin overlying the breast and the thickness of the pectoralis muscle to determine the optimal implant recipient site (subglandular or submuscular).

Discussion of the surgical plan should commence with the options for surgical access: periareolar, inframammary, transaxillary, or transumbilical (transumbilical breast augmentation, or TUBA). The choice depends on several factors, including body habitus, site of previous scars, patient desire, and surgical expertise. The issue of surgical access is especially important in ethnic patients, in whom scarring is almost always a significant concern. It is the author's opinion that the periareolar incision is

preferable to the inframammary incision because the scar is camouflaged in the junction between the outer edge of the areola and the adjacent breast skin. The transaxillary and TUBA approaches also limit visible scars; however, they tend to provide less visibility of the pocket and thus may be less forgiving when attempting to adjust implant position to achieve ideal breast symmetry. The patient should be informed whether she would be a better candidate for a subglandular or submuscular procedure, with a clear rationale justifying one or the other. For example, patients with extremely well-developed pectoralis major muscles may be poor candidates for submuscular implantation, whereas in those patients with extremely thin, pliable skin, it may not be suitable to perform subglandular implantation. Furthermore, in patients with mild-to-moderate breast ptosis, subglandular placement of implants may reduce the chances of a "double-bubble" or "snoopy" deformity—an unsightly condition in which the epicenter of the breast parenchyma is at a different level than that of the implant (Fig. 27-3).

Until just recently saline implants were the only option for women presenting for primary augmentation, whereas silicone-gel implants were restricted to patients with prior breast surgery, breast ptosis, or breast reconstruction patients following cancer ablation. As of this writing, silicone-gel breast implants have been FDA approved for use in primary breast augmentation. The major advantage of silicone-gel breast implants over saline implants is their natural shape and feel, however they require a larger incision for placement because, unlike saline implants, they are manufactured in a prefilled state.

Surgical techniques

Patients should be marked in the preoperative holding area. Marks should delineate the vertical midline between the two breasts as well as the location of the inframammary folds bilaterally. Many surgeons also delineate the borders of the pocket dissection to guide accurate subglandular or subpectoral pocket development. In patients undergoing TUBA, additional marks are made extending superolaterally from the umbilicus to demarcate the path of tunnel creation from the surgical access site to the lateral inframammary fold.

Surgery is performed either with local plus sedation, or general anesthesia, with special care to use strict sterile technique, especially during handling and insertion of the implants. The sequence of steps involves making the appropriate incision, creating the subglandular or submuscular pocket, irrigating the pocket, achieving hemostasis, and placing the deflated saline implant (or sizer). The implant is then inflated to the appropriate size, and the same maneuvers are then performed on the contralateral breast. Before closing the incisions, a critical inspection is made with the patient in a near upright position. The surgeon must assess breast size, symmetry, and mobility of the implant in the pocket. Final adjustments are made, and the wounds are then closed in a layered fashion. The patient is dressed with fluff gauze and a support bra that she will wear for at least 3 weeks. The patient generally requires anywhere from 6 to 12 weeks before resolution of all postoperative edema and scars (Fig. 27-4 and Fig. 27-5).

Complications

Although there is often almost immediate patient satisfaction after breast augmentation, there are several potential complications that may develop over time. Patients must be aware (especially those younger than 40) that they are very likely to require one or more operations during the course of their lifetime because of mechanical complications of breast implants. The most common of these local complications in both silicone gel–filled and saline implants are capsular contracture and rupture/deflation.[9]

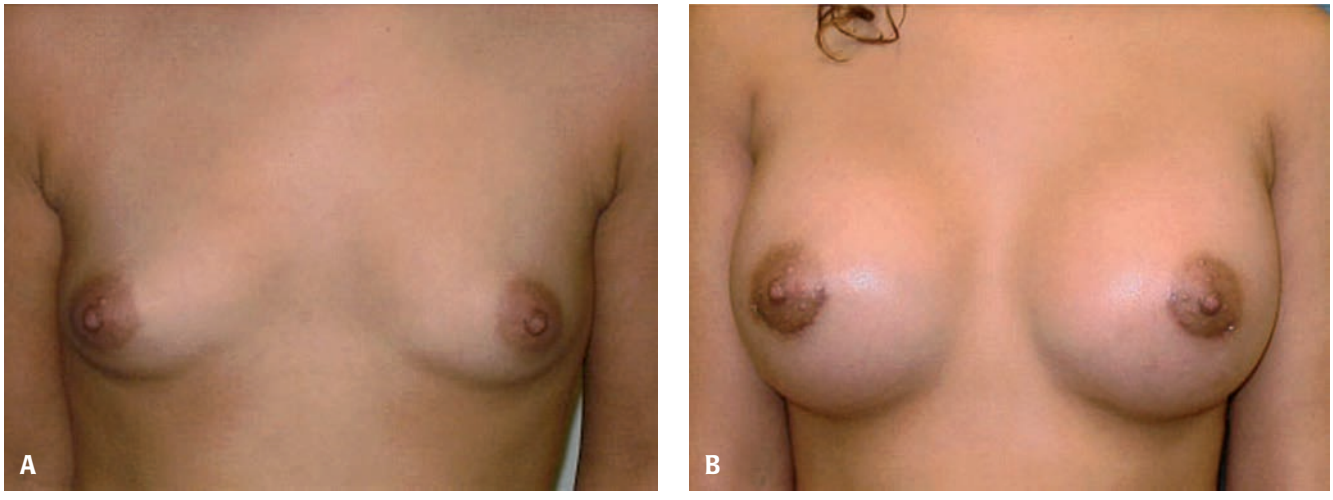

Figure 27-4 Pre- **(A)** and postoperative **(B)** photos of patient who received periareolar, submuscular breast augmentation.

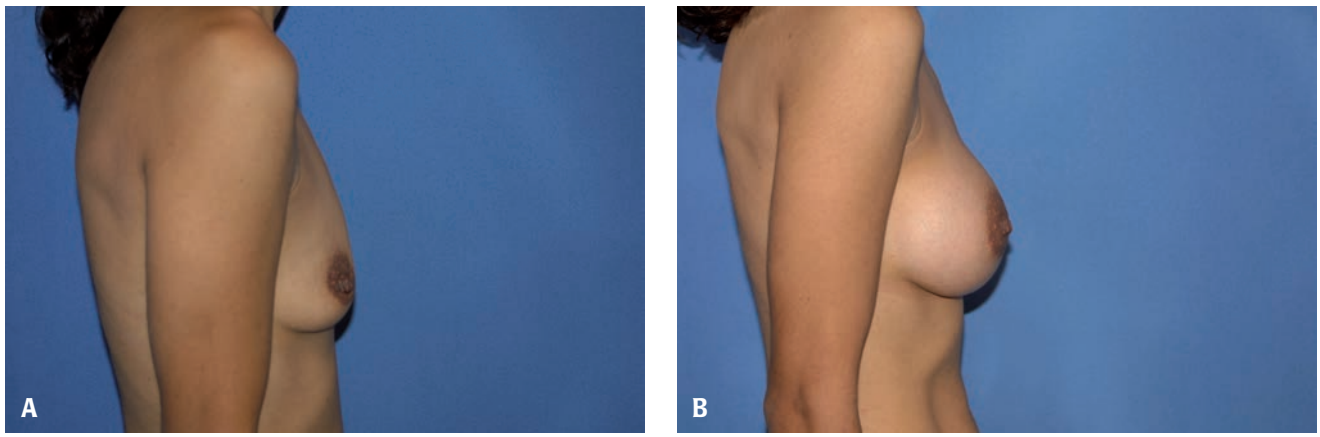

Figure 27-5 Lateral images of 32-year-old Asian woman pre- **(A)** and postoperative **(B)** breast augmentation. (Courtesy of Arthur Jensen, MD.)

Capsular contracture is the development of scar tissue between the implant and the native breast tissue. The etiology of capsular contracture is not completely understood; however, it has been established that higher rates of this undesirable occurrence follow hematoma and/or infection. There are four grades of capsular contracture known as Baker grades (Table 27-1).[10]

For patients with the more severe forms of capsular contracture, treatment often involves reoperation to remove or release the capsule. The implants may be left in place, replaced, and/or moved to a different plane (i.e., subglandular to submuscular) (Fig. 27-6).

Implant rupture and/or deflation occurs at a reported rate of 8% after 11 years.[11] It may be iatrogenic from excessive or rough handling during the initial procedure or, alternatively, from compression or external stresses during the day-to-day life of the patient. Critics of the TUBA attribute this method of insertion to a higher rate of deflation because of the increased manipulation of the implant required for proper positioning. The patient will often note this event by visualizing an acute decrease in the size of her breast. Appropriate treatment involves reoperation to remove and replace the implant.

Table 27-1

Baker grades of capsular contracture

Grade	Sign
Grade I	Breast is normally soft and looks natural
Grade II	Breast is a little firm but looks normal
Grade III	Breast is firm and looks abnormal
Grade IV	Breast is hard, painful, and looks abnormal

SUMMARY

Breast reduction and augmentation are some of the most common cosmetic procedures performed in ethnic groups. Reduction mammaplasty is often more than simply a cosmetic procedure, as many patients with breast hypertrophy have significant functional and psychosocial limitations. For these reasons, in patients undergoing breast reduction surgery, there is a great deal of patient satisfaction.

Many plastic surgeons are observing a significant increase in the number of ethnic patients presenting for breast enhancement. The importance of preoperative counseling cannot be overstated, as it is the key to achieving surgical success and patient expectations. Important

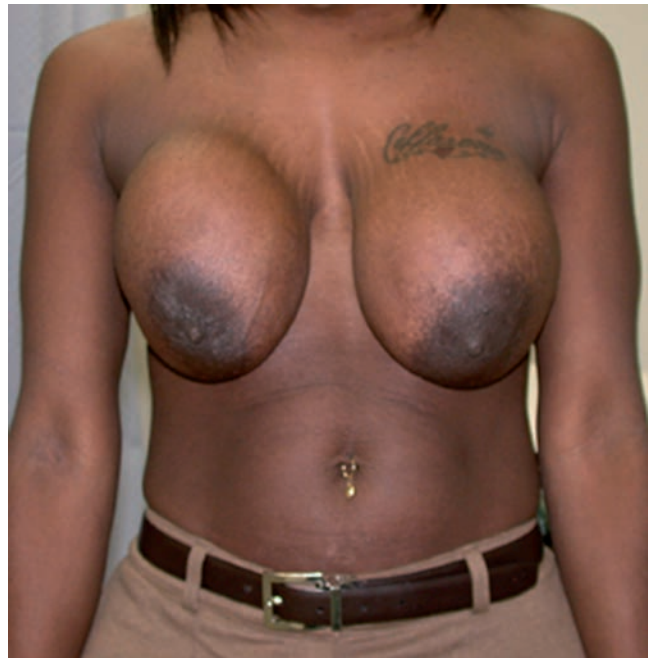

Figure 27-6 Patient with grade IV capsular contracture on the right and grade III capsular contracture on the left.

technical details include the incision site, the size and style of the implants that are to be used, and the tissue plane in which the implant will be placed. Patients must understand the risks of the procedure, including implant-related complications that may require reoperation.

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28

Body-Contouring Procedures

Luiz S. Toledo

Lipoplasty or liposuction has changed the way aesthetic body-contouring procedures are performed. Before its evolution in the late 1970s and early 1980s, every technique involved long and permanent scars. Liposuction now allows the surgeon to reshape the body through minimal invasion. In Brazil, abdominoplasty is the procedure most commonly associated with lipoplasty: 73% of all procedures. From a historical perspective, liposuction began with descriptions of hollow cannula liposuction by Fischer in 1976.[1] The technique was subsequently refined, improved, and practiced by Illouz and Fournier in the late 1970s and early 1980s.[1]

Body-contour treatments are frequently performed on the breasts, abdomen, thighs, and buttocks, either for reduction, augmentation, or lifting. Today, most reduction procedures of the body involve lipoplasty to some extent, with or without dermolipectomy. Augmentation can be done with autologous fat (except on the breasts) or silicone implants. Choosing the right technique is especially important when treating darker-skinned patients because of the higher possibility of hypertrophic scarring and keloid formation. However, in general, techniques are similar in all skin types and races. Body-contouring procedures are popular among blacks and Hispanics.

CLASSIFICATION AND CONTOURING OF THE ABDOMEN

Although there are several classifications for the abdomen, some of which are outdated, the author prefers to classify the abdomen into six types as a template for optimal selection of lipoplasty and for abdominoplasty procedures.[2] (Fig. 28-1).

A *type I abdomen* has excess fat, with no excess skin and no muscle aponeurotic laxity. The flanks and waist should be treated as an aesthetic unit with the abdomen when indicated. Most of these patients are treated with lipoplasty alone: either deep liposculpture for patients with good skin elasticity or superficial liposculpture (applied only in the areas where retraction is needed) for patients with skin flaccidity. Superficial liposculpture in the abdomen should be performed only by experienced surgeons. Common complications can be irregularities, skin hyperchromia, or even skin necrosis. The abdomen should be treated with the operating table hyperextended to avoid penetration of the abdominal wall.

The *type II abdomen*—with a high umbilicus, with moderate suprapubic excess skin, with or without excess fat, with or without muscle-aponeurotic flaccidity—can be treated with liposuction and suprapubic skin resection. The amount of skin to be resected varies from case to case. The suprapubic incision is usually a Cesarean Pfannenstiel incision with small extension into the inguinal fold.

The *type III abdomen* has a normally placed umbilicus, moderate excess skin in the epigastrium and hypogastrium, but not enough excess to perform a classic abdominoplasty, with or without excess fat and muscle laxity. The excess skin can be resected through a suprapubic incision and the excess fat removed through lipoplasty, thus, freeing the stalk of the umbilicus and suturing it 2 to 3 cm lower. Midline placation can be performed through the same incision, flattening the abdomen and improving the supraumbilical skin excess. If the epigastrium needs skin resection, it can be done through submammary incisions. If necessary, the epigastrium can be suctioned, without dissection, to preserve the perforators.

The *type IV abdomen* has muscle-aponeurotic flaccidity, excess skin, and minimum excess fat. It is treated by abdominoplasty through a suprapubic incision, skin excision, midline dissection, and muscle-aponeurotic placation, with or without umbilical repositioning. It might be necessary to close the old umbilical scar with a small vertical scar and reposition the umbilicus.

The *type V abdomen* has excess skin and fat in the epigastrium and hypogastrium that need muscle-aponeurotic correction. These patients should be treated with the classical abdominoplasty (Callia technique) with umbilical repositioning. The skin and fat flap from the hypogastrium are resected, and excess fat in the epigastrium and flanks is removed through lipoplasty.

The *type VI abdomen* with circumferential skin laxity, muscle laxity, and excess fat should be treated with a complete circumferential abdominoplasty, umbilical repositioning, and flankplasty. If dermolipectomy is continued

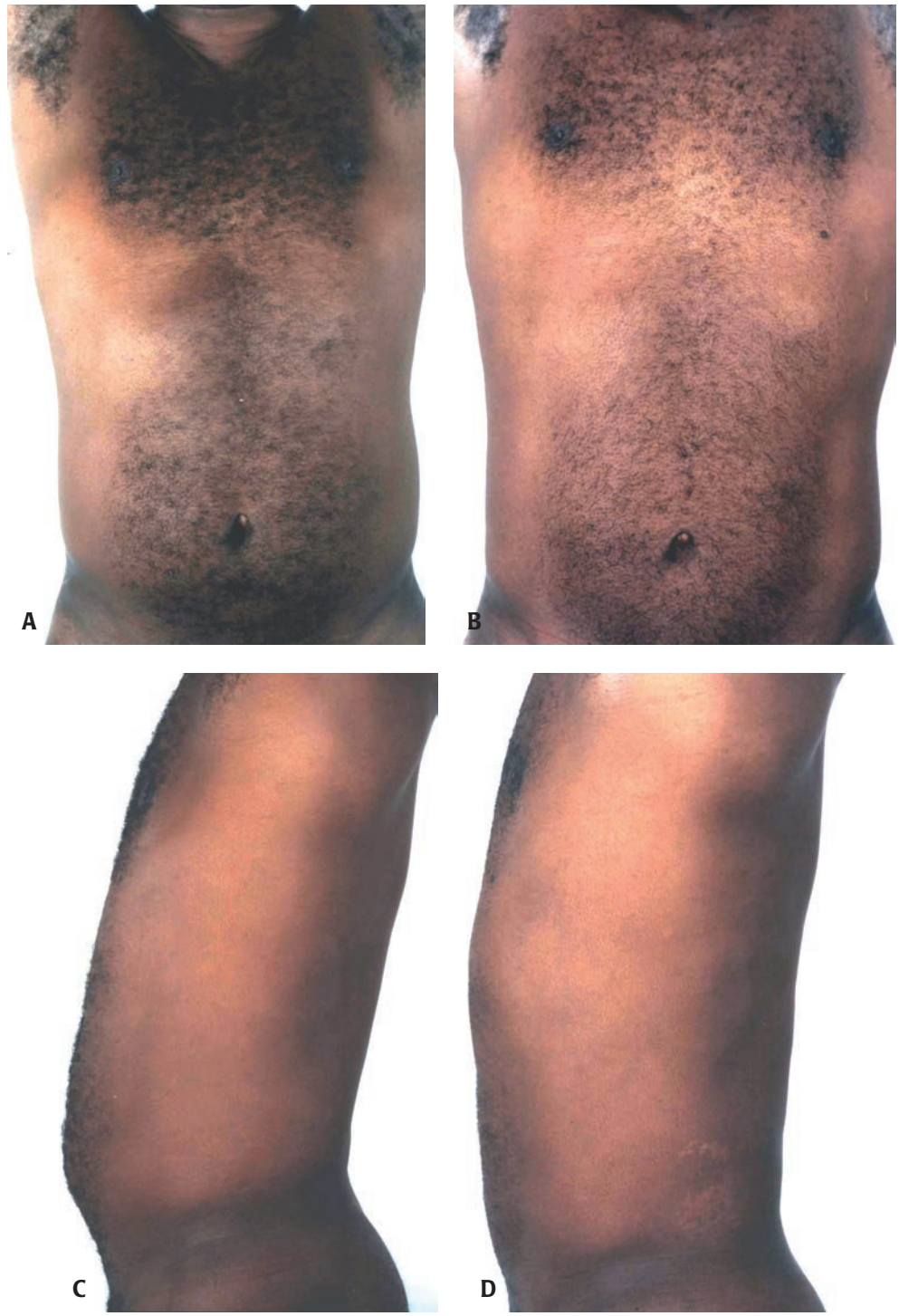

Figure 28-1 **A, C, E:** Preoperative photographs of a 32-year-old man wanting to improve his abdomen and flanks. **B, D, F:** One-year postoperative, showing improvement of the abdominal area and waist, with a 2-inch circumferential reduction after syringe liposculpture with a total removal of 1,200 cc of aspirate.

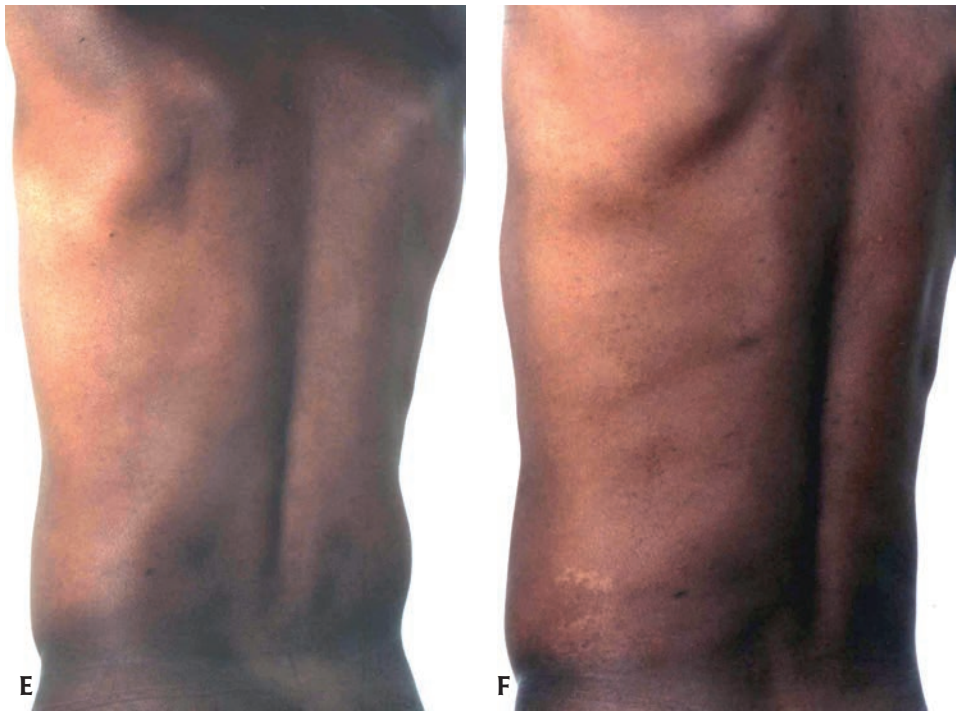

Figure 28-1 (*continued*)

with lipoplasty, the dissected flap should be sutured to the aponeurosis with a quilting suture to avoid seromas.

Patients with a vertical abdominal scar are better treated using the same scar to remove excess skin combined with lipoplasty, when indicated (*special type I abdomen*). In the author's opinion, the vertical skin excision in a patient with a previous scar can produce a good shape for the waist. Excess skin excision can lead to wide postoperative scars.

THIGH CONTOURING

There are specific treatments for different parts of the thighs. Some areas, like the lateral thighs, are more forgiving than others, and better results with simpler approaches, such as deep liposuction to remove the excess, can be obtained. Others are more difficult to treat, such as the anterior thigh and the posterior area below the gluteal fold, the so-called banana fold. These are areas that have to be treated very cautiously because of the higher possibility of provoking depressions or a "dropped buttock" look.[3] The medial thigh can be a simple area to treat on a younger patient, but very difficult on an older one, with the possibility of creating skin folds that can only be fixed through a thigh lift. Usually the only area of the thighs that needs augmentation through fat grafting is the internal midthigh to correct the "cowboy leg" deformity (Fig. 28-2 and Fig. 28-3).

The thigh lift is often performed through an incision that starts in the pubic area and follows the crease of the thigh back to the gluteal fold. Skin is resected, and the subcutaneous tissue is sutured tightly to the fascia to avoid the descent of the incision below the area covered by underwear.

BUTTOCKS CONTOURING

Buttocks can be reduced, augmented, or lifted. Sometimes a combination of techniques is necessary. Reduction is done by aspiration, respecting the "Bermuda triangle" mentioned by Illouz.[4] To give the illusion of a buttock lift, the author combines the superficial aspiration of the lower third of the buttock with the injection of up to 500 cc of fat per side in the higher two thirds of the buttock.[5] The area below the gluteal fold superficially suctioned, but this is a difficult procedure that should be performed with great care. When the patient does not have enough fat for harvesting, a silicone implant to augment the buttock, inserted through a vertical sacral incision in the intragluteal area, can be used. This augmentation also helps to eliminate some of the ptosis of the buttock without the need for skin resection. When indicated, skin resection can be performed in the gluteal fold or through a V incision on the waist (the angle of the V at the sacral area, where the intergluteal fold begins) (Fig. 28-4).

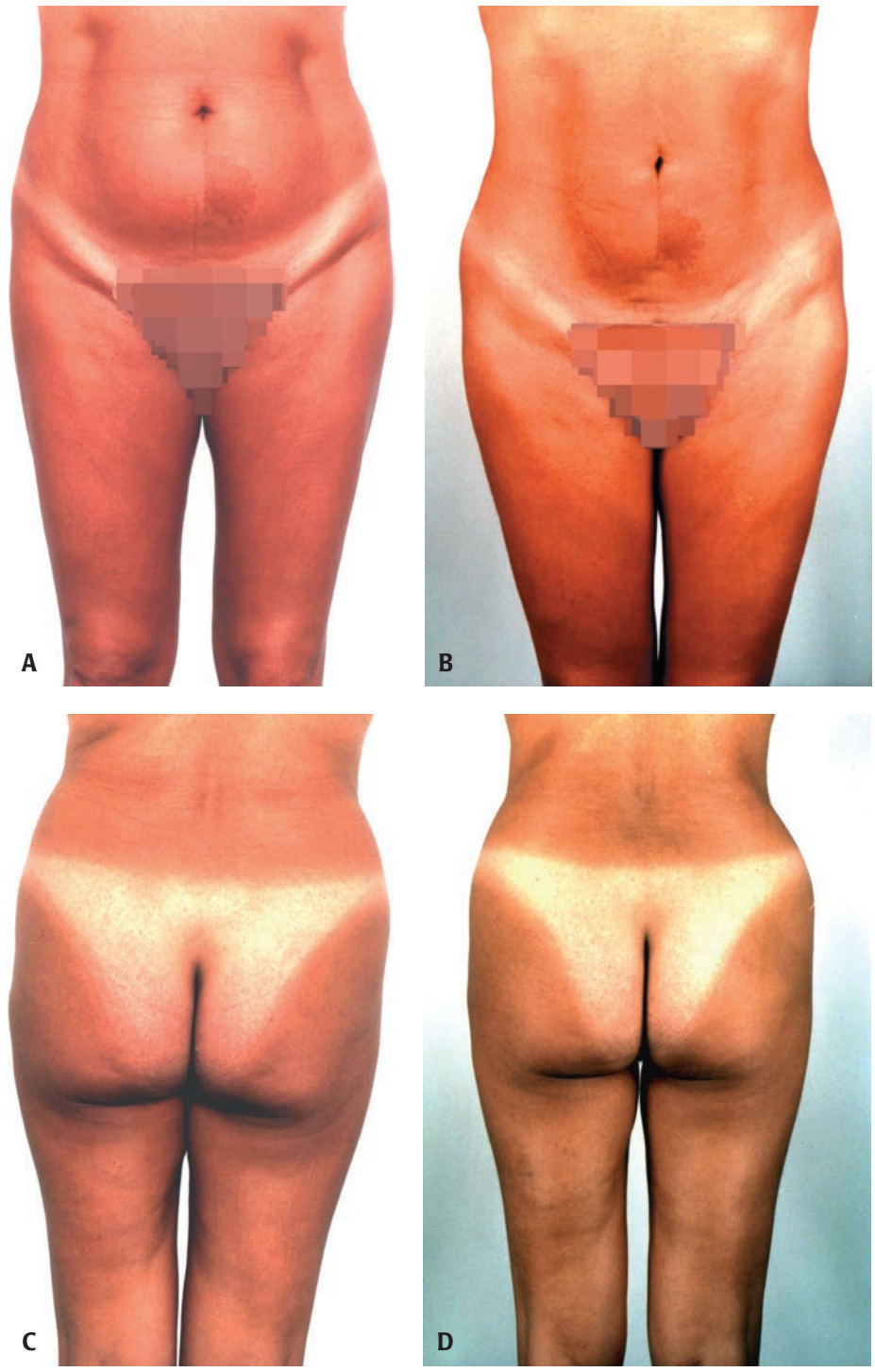

Figure 28-2 **A, C:** Preoperative photograph of a 42-year-old woman wanting to improve her abdomen and flanks. **B, D:** One-year postoperative, with a reduction of the abdominal area and waist after syringe liposculpture with a total removal of 2,800 cc of aspirate.

TECHNIQUE AND ANESTHESIA

For local anesthesia, the author uses a modification of the Klein tumescent solution, which contains 20 mL of 2% lidocaine, 5 mL of 3% sodium bicarbonate, 1 mL adrenaline 1:1,000, and Ringer's lactate quantitie suffisante pour (qsp) 500 mL. Up to 2 L of this solution at body temperature is injected into the abdominal tissue and suctioning begins after 10 to 15 minutes. Infiltration is performed one area at a time, and only after suctioning this area does the author infiltrate the other side. If the flanks are going to be treated in the same procedure, they should be treated first in the lateral position. Local anesthesia can be combined with oral or intravenous sedation. Combination procedures require epidural or general anesthesia. Oral sedation with midazolam 15 mg is used to remove up to 1 L of aspirate. For larger procedures, intravenous sedation with midazolam, fentanyl, and propofol is preferred. The

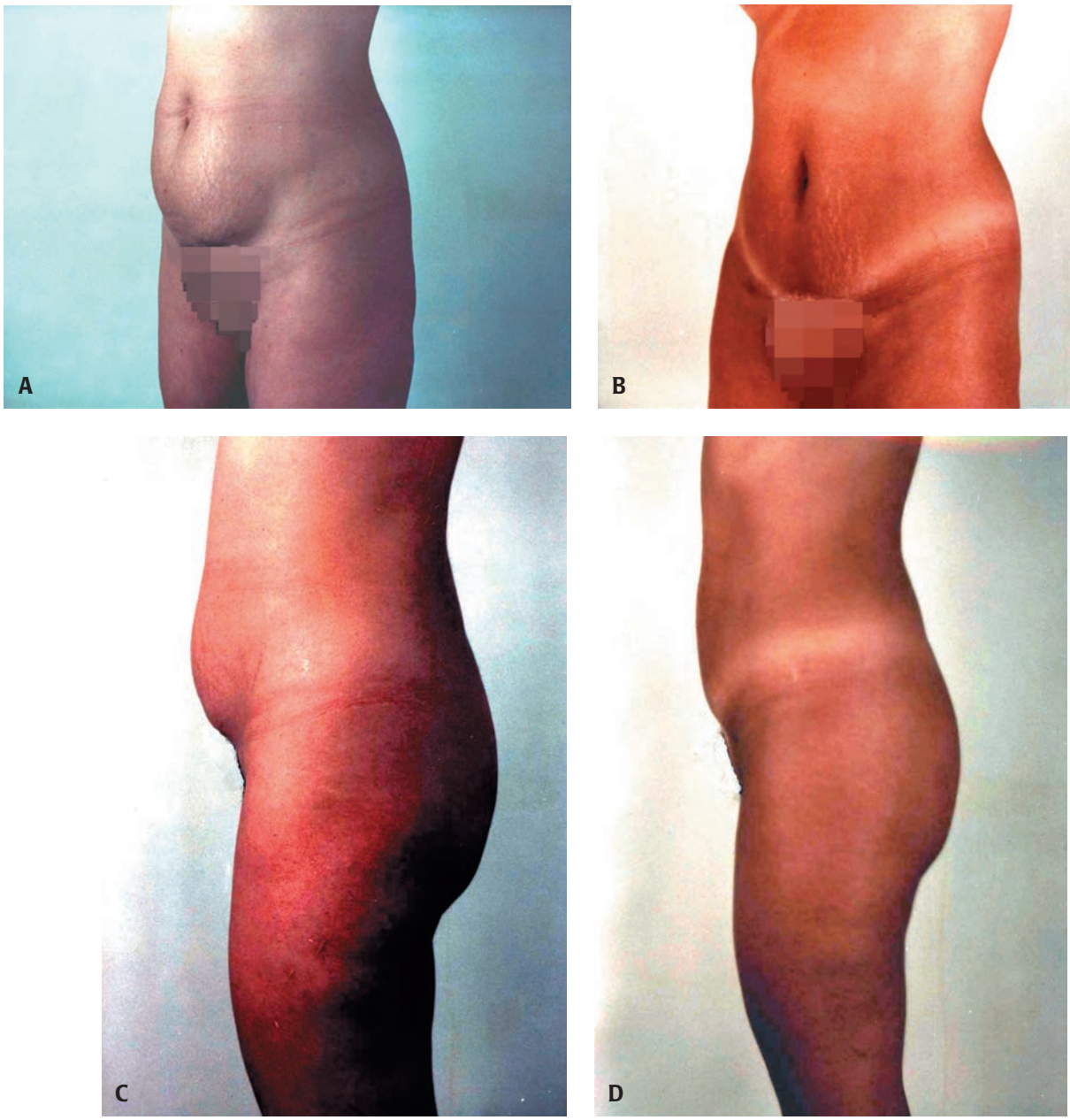

Figure 28-3 **A, C:** Preoperative photographs of a 42-year-old woman wanting to improve her abdomen. **B, D:** Two-year postoperative, showing improvement of the abdominal area after syringe liposculpture with a total removal of 1,000 cc of aspirate, combined with a suprapubic skin resection and placation of recti muscles.

induction is done with tenoxicam 20 mg, Dramin DL 10 mL, dipyrone 2 mL, dexamethasone 4 mg, and meperidine 1.0 to 1.5 mg/kg. Maintenance is with midazolam 0.1 mg/kg to 0.3 mg/kg, propofol 0.025 mg/kg/min, fentanyl 50 μg, slowly. Cephalexin 2 g is administered intravenously (6 g in 8 hours). The local infiltration solution contains 20 cc 2% lidocaine, 1 cc adrenaline, 500 cc Ringer's lactate, and 5 cc 3% sodium bicarbonate.[6]

This solution is heated to 37°C and injected slowly at a rate of 1:1 to 1.5:1 (injecting 1 cc of fluid per cc of fat is estimated to aspirate). This proportion avoids pulmonary edema and lidocaine overdose. By warming the solution, hypothermia and shivering is avoided.[7]

SAFETY

Liposuction has been promoted as a safe, easy-to-learn outpatient procedure. Plastic surgeons and dermatologists have developed safety measures to perform the technique, but

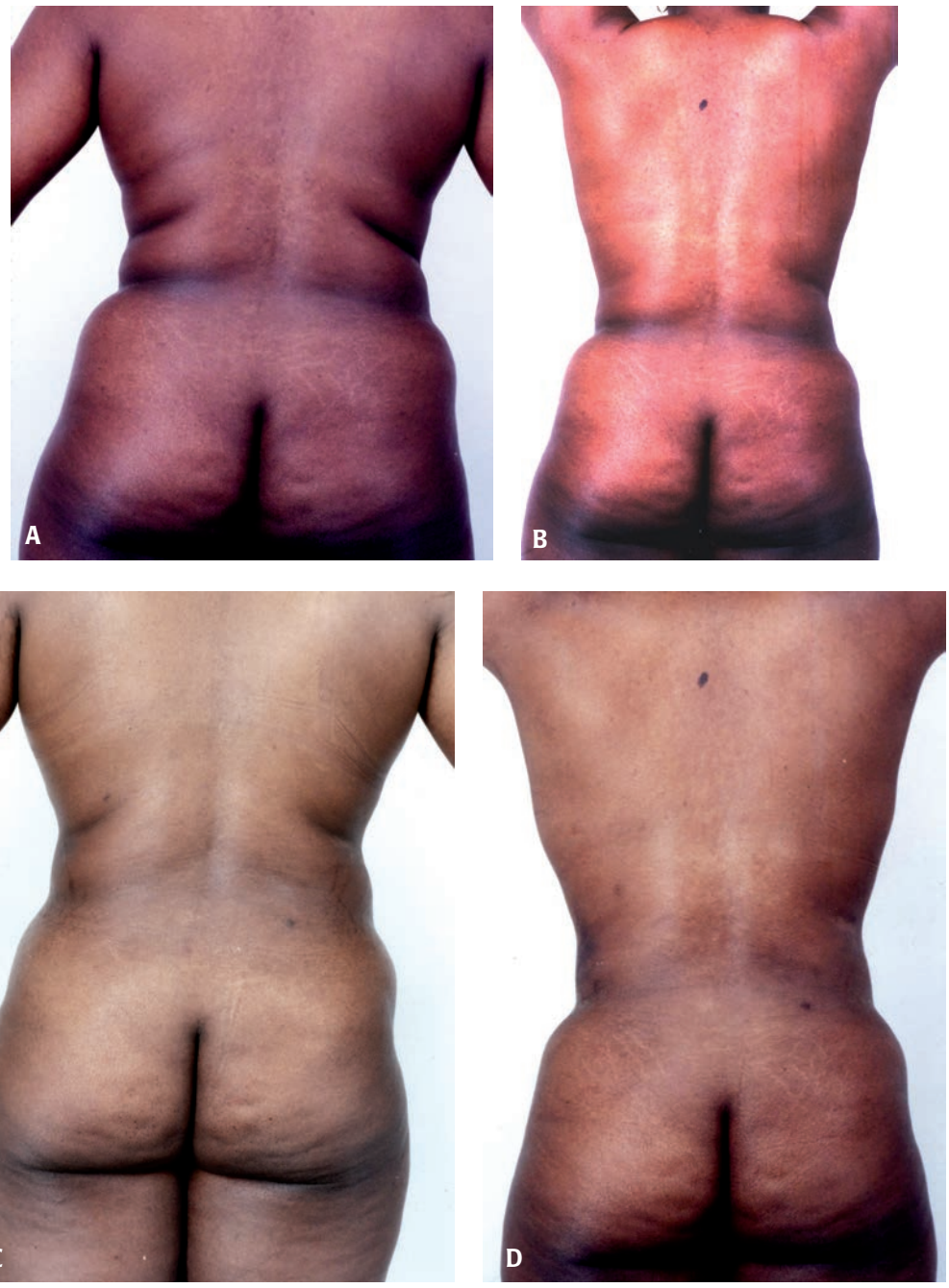

Figure 28-4 **A, C:** Preoperative photographs of a 28-year-old woman wanting to improve her dorsal region and flanks. **B, D:** Three-weeks postoperative after syringe liposculpture of the scapular, dorsal, flanks, and waist regions, with a total removal of 3,200 cc of aspirate.

there can be serious risks, including death at a rate of 1/5,000 procedures.[8] By 2000, the numbers of liposuction fatalities were 67 for the previous 3 years nationwide related only to board-certified plastic surgeons (not including other doctor groups performing liposuction). The American Society of Plastic Surgery enforced a rule limiting the extracted fat to a 5,000-cc maximum, and the mortalities dropped to zero the next year.[9] Dermatologists, aesthetic medicine practitioners, gynecologists, oral surgeons, and otolaryngologists also perform liposuction in facilities from hospital to outpatient surgery centers to private offices.

Although the complication rate seems high, according to the French Society of Plastic Reconstructive and Aesthetic Surgery,[10] liposuction is among the techniques for which there are complications in less than 5%. The techniques which produce between 5% and 10% of complications are rhinoplasty, facelift, and breast augmentation.

When more than 1 L of fat is removed, the procedure should be performed in an accredited facility with an anesthesiologist present. The facility will have a cardiac monitor, pulse oximeter, noninvasive blood-pressure monitor, defibrillator, intubation equipment, laryngeal mask, reanimation material, vasoactive drugs, support equipment, infusion pump, a gas central, and an aspirator.

LIFE-THREATENING COMPLICATIONS

The main factors that increase risk in lipoplasty (according to the American Society of Aesthetic Plastic Surgeons Lipoplasty Task Force) are injecting too much fluid and local anesthesia, removing too much fat, performing too many procedures during the same surgical act, having the wrong indication for surgery (health problems, etc.), and inadequate monitoring of megaliposuction patients (Table 28-1).[11]

Safety measures in body-contour procedures should avoid life-threatening complications and aesthetic complications. Life-threatening complications are pulmonary embolism, hemorrhage, perforation, infection, lidocaine and epinephrine toxicity, third-space fluid shifts, and fat embolism syndrome. Pulmonary embolism should be prevented in patients with a higher risk of deep venous thrombosis, either with intraoperative drugs or massaging devices. Hemorrhage can be caused by major vessel perforation, coagulopathy, or simply a bad surgical technique. Extra caution should be used when using vibrating cannulas for power-assisted liposuction and internal ultrasound assisted liposuction.

Treating the abdominal wall without proper planning can cause perforation that is due to bad positioning of the patient during surgery or to misdirection of the cannula. By hyperextending the abdominal region, the cannula introduced in the pubic area will tend to come up through the skin of the epigastrium rather than perforating the abdomen. Infection can be avoided with total antisepsis and proper antibiotics, intra- and postoperatively. Lidocaine and epinephrine toxicity can occur when performing tumescent anesthesia. Care and caution should be used regarding the amount of lidocaine and epinephrine injected, injecting 1 cc of solution for each cc of aspirate removal. Excessive infiltration of wetting solution, in a proportion of 3:1, can cause lidocaine toxicity, cardiotoxicity, convulsions, drug interaction, and overdose. A patient should not be released too soon after surgery, because the peak of lidocaine absorption happens 8 to 12 hours after the injection. Third-space fluid shifts can occur in megaliposuction procedures when 8 to 10 L of fat or more are removed from a patient in a single procedure. The limit on aspirate should be less than 5% of the body weight, and less than 30% of the body surface should be treated, keeping in mind that it is safer to repeat the procedure to remove more fat. The possibility of hypothermia is reduced by heating every intravenous and subcutaneous fluid to 37° C and by using hot-air blankets pre- and postoperatively. This avoids complications, such as infections, blood loss, heart attacks, and even death. Fat embolism syndrome is very rare after liposuction,[12] and only five cases have been reported.[13]

Table 28-1
Life-threatening complications

Pulmonary embolism
Hemorrhage
Perforation
Lidocaine toxicity
Epinephrine toxicity
Third-space fluid shifts
Fat embolism syndrome

AESTHETIC COMPLICATIONS

Photographing, weighing, and measuring the patient are important for the surgeon during the surgery and for postoperative comparisons. When a patient does not see any change with the procedure, it is time to show preoperative records. Patients are usually several kilos lighter after the surgery.

The aesthetic complications can be undercorrection (insufficient fat removal), overcorrection (excess fat removal), irregular fat removal with palpable and visible irregularities, edema, and seroma, local infection (because of insufficient sterilization or a patient with low immunity) (Table 28.2). Bad patient selection is a common cause of problems, especially when a patient who needs skin resection is treated with liposuction alone. Cutaneous slough, hyperpigmentation, vasculopathies, hypertrophic scars, and permanent color changes in the skin are some other possible complications. Hypertrophic scars and hyperpigmentation are more common in deeply pigmented skin.

The most common complications of lipoplasty are undercorrection, overcorrection, and irregular fat removal with palpable and/or visible irregularities. The syringe technique allows a precise measurement of the aspirated and injected amount of fat. The aspirator vial is too big to measure the aspirated fat with precision. Using a 60-cc syringe, the exact amount of aspiration can be determined.

Table 28-2
Aesthetic complications

Undercorrections (insufficient fat removal)
Overcorrection (excess fat removal)
Irregularities (irregular fat removal)
Hyperpigmentation
Cutaneous slough
Hypertrophic scars

To treat undercorrection, additional fat has to be aspirated. Overcorrection is treated with fat injection. Irregularities can be treated with fat suction, fat injection, subcision, fat shifting or mobilization, and, finally, skin resection. Depressions are addressed by first freeing the fibrous adherences with the V-tip Toledo cannula and injecting fat to obtain a 40% to 50% improvement on the irregularities.

CONCLUSION

Lipoplasty can be a safe outpatient procedure. There are serious risks involved, including a death rate of 1/5,000 procedures. Surgeons should limit procedures to the safety limits of their surgical skills, always keeping in mind that the safety of the patient comes first. When complications occur, surgeons should be prepared to treat them.

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29

Vascular Surgery in Darker Racial Ethnic Groups

Parrish Sadeghi

This chapter will focus on modalities used to treat visible lower-extremity venous diseases, such as spider veins and varicose veins. There is an absolute paucity of published data regarding the treatment of spider veins and varicosities in darker racial ethnic groups. Treatment modalities using sclerosing agents are similar in lighter and darker skin types.

Venous disease of the legs encompasses a variety of conditions affecting the veins, including visible disease—such as spider veins, varicose veins, trophic changes, or edema—and functional disease—such as reflux, obstruction, phlebitis, or thrombosis. Venous disease in the legs occurs very commonly in the general population of industrialized countries and is a substantial source of morbidity in the United States and the Western world.[1,2] Many patients seek leg vein treatment for symptomatic relief, whereas others find varicose veins cosmetically unsightly and seek treatment for that reason. According to a 2005 survey by the American Society of Dermatologic Surgery, the eradication of leg veins was one of the most commonly reported procedures by dermasurgeons in the United States.[3]

EPIDEMIOLOGY AND RISK FACTORS

Estimates of the prevalence of venous disease are varied. Although it is difficult to estimate the overall prevalence of venous disease worldwide, a large U.S. survey, the Framingham study, reported that 27% of the American adult population had some form of venous disease in their legs.[4] There is evidence that geographic location and race can influence susceptibility to superficial venous disease. People living in North American and Western European countries seem to be at a greater risk for venous disease as compared with those who live in South America, India, the Far East, or Africa.[1] Venous disease is less prevalent in African Americans, Hispanics, and Asians.[5] It has been suggested that the low prevalence of varicose veins in Africans (1%–2%) may be associated with the higher number of venous valves in their lower extremities as compared with Caucasians.[6]

To date, most studies have investigated factors that influence susceptibility to superficial venous disease. The data suggest that female sex,[7] increased age,[8] pregnancy,[9] and oral contraceptive use[10] are risk factors for varicose veins. There are also reports that chronic venous disease is higher in those whose job involves prolonged standing and those working under conditions of high temperature and humidity.[11,12] Although some studies have suggested that obesity is associated with varicose veins, a number of studies have not confirmed this finding.[1,13] There is no evidence that there is a strong genetic component to these disorders.[14]

CLINICAL PRESENTATION

The clinical presentation of patients with venous disease of the lower extremities can be variable. Visible venous disease can manifest as telangiectasias or varicose veins, whereas functional disease involves reflux or obstruction of the veins. Leg swelling has been shown to be the most specific predictor of visible and functional leg vein disease.[15] Ankle edema is usually the first manifestation of chronic venous insufficiency (CVI) and can lead to venous stasis. Stasis dermatitis and pigmentary changes, resulting from extravasation of erythrocytes and hemosiderin deposition, are common sequelae of long-standing venous stasis. Recurrent or chronic cellulitis, ulceration, scarring, and malignant degeneration are more serious complications of leg vein disease.[16]

Many patients with visible venous disease have minimal to no symptoms, whereas others may report localized pain, burning, itching, or more generalized leg fatigue, aching, and swelling. Symptomatic varicose veins occur in approximately 15% of men and 25% of women;[1] women are more likely to report symptoms than men.[15,17,18]

ANATOMY

In the leg there are two systems of veins: the deep and the superficial. The deep venous system consists of veins that lie within the muscular system. The superficial venous

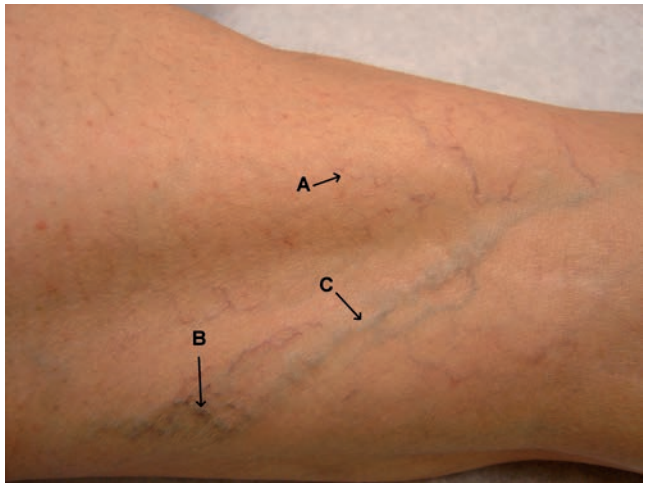

Figure 29-1 Telangiectasia **(A)**, venulectasias **(B)**, reticular veins **(C)**, and varicose veins of the lower extremities.

system has two main veins: the greater saphenous vein (also known as the long saphenous vein) and the lesser saphenous vein (also referred to as the short saphenous vein). The greater saphenous vein (GSV) originates at the medial side of the foot and runs superiorly along the medial aspect of the leg to empty into the femoral vein at the saphenofemoral junction. The lesser saphenous vein starts at the lateral aspect of the foot and runs along the back of the calf and typically joins the popliteal vein at the saphenopopliteal junction. The deep and superficial veins are connected via perforator veins. Veins in the same fascial plane are often interconnected by a complex of communicating veins.

Venous valves are a significant part of the venous system, maintaining the blood's upward flow. Valves are present between the superficial and deep systems at the saphenofemoral and saphenopopliteal junctions. More valves are located below the knee than above. Elevated venous pressure is most often the result of venous insufficiency with reflux through incompetent valves in the deep or superficial veins. Telangiectasias, venulectasias, reticular veins, and varicose veins represent the undesirable pathways by which venous blood refluxes back into the congested extremity (Fig. 29-1). Although most large varices arise from tributaries of incompetent truncal vessels, failed perforating veins or connecting veins can also give rise to independent varices in the greater saphenous distribution without involving the saphenous system itself.

APPROACH TO A PATIENT WITH VARICOSE VEINS

History and physical examination are important in the evaluation of patients with venous disease. Risk factors such as prior pregnancies, use of oral contraceptives, and history of superficial thrombophlebitis or deep venous thrombosis should be noted. A careful physical examination should be done to determine the nature, extent, and location of varicose veins. Photographs of the affected areas are helpful for tracking disease progression and response to treatment. Laboratory workup to evaluate hypercoagulability or bleeding risks may be appropriate if indicated by the patient's history.

Extensive diagnostic imaging is often unnecessary before treating spider veins and venulectasias, however, for largely dilated (>4 mm) vessels or for more severe cases, imaging modalities are available and should be used to evaluate and determine the extent of the venous disease. Duplex ultrasound has become the most widely used mode of investigation for both arterial and venous disease. This noninvasive and inexpensive technique enables the physician to evaluate competence of the deep and superficial venous valves as well as the competence of the saphenofemoral and saphenopopliteal junctions. Photoplethysmography can be used to measure venous refilling time and distinguish between deep and superficial venous insufficiency.

COMPRESSION THERAPY

Graded compression stockings are often prescribed for patients with varicose veins as a method of relieving symptoms. They may be prescribed either as a definitive treatment or temporarily after varicose vein treatment.[19] Compression stockings are designed to provide a pressure gradient that is greatest at the ankle and decreases proximally, mimicking the normal hydrostatic pressures of the lower extremity.[20] Therapy with compression stockings has been shown to improve venolymphatic drainage substantially in both healthy patients and those suffering from CVI.[21] Most clinicians advocate the use of compression stockings after sclerotherapy; however, there are variations in the suggested duration of use, ranging from 48 hours to several weeks.

SCLEROTHERAPY

For treatment of leg veins less than 4 mm in diameter, sclerotherapy has been considered to be the gold standard.[22] Sclerotherapy involves the direct injection of a sclerosing agent into a visible vein or telangiectasia. The solutions are designed to either irritate, dehydrate, change the surface tension of, or completely destroy the venous endothelial cells, thereby creating a thrombus. Ultimately, the vein is permanently occluded as the thrombus is replaced by fibrosis. There are three types of sclerosant agents: osmotic agents, detergents, and chemical irritants. The most commonly used sclerosants in the United States are hypertonic saline, sodium tetradecyl sulfate, and polidocanol.

Osmotic agents

Osmotic agents, such as hypertonic saline or hypertonic saline with dextrose, cause thrombus formation through dehydration and disruption of the cell walls of endothelial cells and erythrocytes. Osmotic agents are best for treatment of smaller vessels and for low-flow vessels, because rapid dilution can diminish the efficacy of the sclerosant.[23] Severe muscle cramping as a result of transient hyperosmolality induced by hypertonic saline may be experienced.[23] A more serious potential complication—cutaneous ulceration and necrosis—can arise if these agents extravasate into surrounding tissue. One advantage of these agents is that there is a very low risk of allergenicity.

Hypertonic saline is used as a 23.4% solution of sodium chloride, and at this concentration, it can be directly injected into reticular veins and larger vessels.[24] For treatment of smaller vessels, it can be diluted with either normal saline or bacteriostatic water to achieve a concentration of 11.7% solution.[25] In very fine vessels or in vessels near the ankle, a solution of approximately 6% sodium chloride may be more appropriate.[26]

A solution composed of 10% saline, 5% dextrose, propylene glycol, and phenethyl alcohol is manufactured under the brand name Sclerodex. This product is not FDA approved in the United States, although it is approved in Canada. It has limited use because it can only be used in very small vessels (<1 mm in diameter).[26] It is associated with a decreased incidence of muscle cramping, presumably because of the lower percentage of saline, but has an increased risk of pigmentation, allergenicity, and necrosis. The manufacturer recommends a maximum volume of 1 cc at any injection site, with a total per session of no more than 10 cc.

Detergents

Detergent sclerosants produce vascular injury by interfering with cell surface lipids and altering the surface tension around endothelial cells. This results in irritation of the vein intimal endothelium, endothelial cell death,[27] and subsequent thrombus formation and vein fibrosis.

Sodium tetradecyl sulfate (STS), a long-chain fatty acid salt with strong detergent properties, is FDA approved for the treatment of varicose veins. Concentrations of 0.1% to 0.3% are commonly used for the treatment of telangiectatic veins from 0.2 to 1.0 mm in diameter, 0.5% to 1% for treatment of uncomplicated varicose veins that are 2 to 4 mm in diameter, and 1.5% to 3% for the treatment of larger varicose veins.[28] At high concentrations, it is associated with an increased incidence of postsclerosing hyperpigmentation and cutaneous necrosis. Allergic reactions to STS have been reported and include generalized urticaria, bronchospasm, and anaphylactic shock.[29]

Polidocanol (POL), a synthetic fatty alcohol with detergent activity, is currently not FDA approved for use in the United States, but is used extensively in Australia and Europe. In a 2-year Australian study of the efficacy and safety of POL, POL appeared to be superior to STS and hypertonic saline in terms of efficacy and had fewer associated side effects.[30] Other studies have shown comparable results between POL and STS[28,31] or POL and hypertonic saline.[32] POL has been used as an anesthetic and is therefore painless upon injection and well tolerated by patients for that reason.[27] In a double-blind, placebo-controlled study, POL 0.25% was found to have fewer adverse reactions and afforded the greatest patient comfort when compared with STS 0.5%.[33]

Fitzpatrick skin types V and VI treated with POL appear to have less incidence of postsclerosis pigmentary change than skin types I and II.[34] Liquid POL is associated with decreased incidence of ulceration and urticaria,[28] however, its negative features include slower fading of treated vessels and risk of allergic reaction. Because of this latter risk, a test dose of 0.5% solution should be injected into a vessel before a treatment session.[26] The solutions should be diluted appropriately as follows: 0.25% to 0.75% for telangiectasias, 1% for vessels of 1 to 2 mm, and 2% solution for vessels of 2 to 4 mm. There are total daily dose limitations with polidocanol based on body weight (2 mg/kg/d).

Chemical irritants

Chemical irritants injure cells by acting as corrosives. Chromated glycerin has been used in Europe but is not approved for use by the FDA. It can be used for telangiectasias and has a low potential of hyperpigmentation. Only a total of a 0.1 cc prediluted solution should be used in a single session.[26] Chromated glycerin can be painful upon injection and should be avoided in patients with chronic renal insufficiency.[35]

Polyiodinated iodine is one of the strongest currently available sclerosing solutions worldwide. It is mainly indicated as a last resort for treatment of saphenofemoral and saphenopopliteal junction-related vein abnormalities.[23] It is contraindicated in patients with hyperthyroidism.

FOAM SCLEROTHERAPY

Foam sclerotherapy has become an increasingly popular modality in the treatment of varicose veins. In foam sclerotherapy, a sclerosing solution is mixed with oxygen to produce foam. This technique was first described in 1939,[36] and since then, various methods of producing foam agents have been described.[37–40] Foam sclerotherapy is considered to be more effective by some clinicians because a smaller quantity of sclerosant is needed to treat a greater surface area. The most popular agents used for foam sclerotherapy worldwide are STS and POL.

Studies comparing foamed and liquid POL and STS found both agents to be safe and effective sclerosing agents

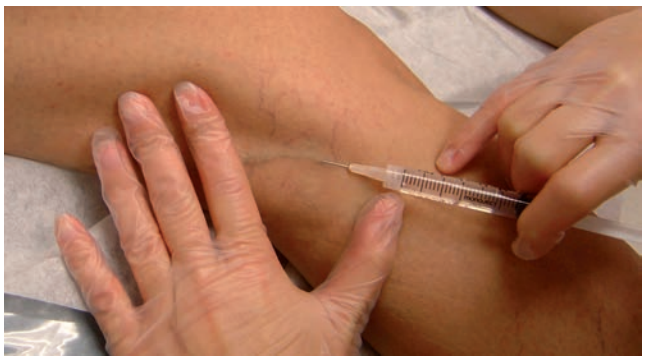

Figure 29-2 Sclerotherapy technique. The needle is placed parallel to the skin with a 1- or 3-mL Luer-Lok syringe firmly held into place between the thumb and index finger and supported by the other fingers. The needle is then carefully inserted into the vessel while using slow and steady injection with light pressure.

in the treatment of varicose and telangiectatic leg veins.[31] In addition to potential adverse effects of liquid detergent sclerotherapy, when treating larger veins, foam detergent sclerotherapy has been associated with transient visual disturbances, such as scotomas[37,41] and phlebitis.[41]

A recent study demonstrated that for the same given concentration of POL, the foam preparation has greater sclerosant efficacy compared with the liquid form in the treatment of reticular and postoperative varices not involving the saphenofemoral junction.[34] However, minor adverse effects, such as pain, inflammation, and skin pigmentation, are more frequent with foam POL.[42]

SCLEROTHERAPY TECHNIQUE

As before any procedure, the patient must be appropriately evaluated, the affected areas photographed, and informed consent obtained. The patient is positioned in either the supine or prone position. The area to be treated is liberally cleansed with 70% isopropyl alcohol, which reduces light reflection and allows for better visualization of the vessels. A 30-gauge needle is bent to an angle that is comfortable for the practitioner, usually between 10° to 30° with the bevel facing upward. The needle is placed parallel to the skin with a 1- or 3-mL Luer-Lok syringe firmly held into place between the thumb and index finger and supported by the other fingers (Fig. 29-2). The needle is then carefully inserted into the vessel while using slow and steady injection with light pressure. A small bolus of air may be injected into telangiectasias to ensure proper cannulation of the vessel. For reticular veins, the plunger may slightly be drawn to ensure a return of blood before injection. The first treatment session is usually limited to a few areas to observe for any adverse reactions, primarily being allergic. Because most telangiectasias arise from reticular veins, these feeding veins should be treated before injecting the telangiectasias.[16] It is advised that no more than 0.5 cc of sclerosant be injected at each site. After the treatment session, pressure is applied to the area with the use of an elastic bandage, compression stocking, or both. The patient is encouraged to wear the stocking or bandage during the daytime for several days and is permitted to resume normal activity immediately after treatment (Fig. 29-3A,B)

COMPLICATIONS OF SCLEROTHERAPY

Common side effects of sclerotherapy include pain, postinjection urticaria, skin necrosis with ulceration, telangiectatic matting, and hyperpigmentation. The use of compression stockings postsclerotherapy has been shown to decrease the incidence of hyperpigmentation.[43] Postsclerotherapy hyperpigmentation is the most common side effect of sclerotherapy in darker skin types, occurring in the majority of patients. It is caused by hemosiderin and melanin deposition. Topical bleaching agents containing hydroquinone and retinoids often expedite resolution of postsclerotherapy hyperpigmentation. In addition, ankle and calf edema is lessened if a graduated compression stocking is worn immediately after sclerotherapy.[43] If sclerosant flow to small end arterioles, as evidenced by persistent blanching of all the tissues in a roughly circular area, is suspected, application of topical nitroglycerin may prevent or mitigate ulceration.[44] Injection of hyaluronidase or tumescing the skin with lidocaine or normal saline may also prevent or decrease ulceration associated with sclerosant extravasation.[45] Postsclerotherapy telangiectatic matting (TM), which appears as new, fine, red blushlike telangiectasias, occurs in up to 24% of individuals treated with sclerotherapy and may occur from 2 to 3 days to months following sclerotherapy.[46] Thighs, medial ankles, and medial and lateral calves are common locations for appearance of posttreatment TM.[47] A small percentage of patients (10%–20%) will have spontaneous resolution of TM within 3 months.[48] However, another 10% to 20% may experience persistence of such vessels[49] (Fig. 29-4).

CONTRAINDICATIONS TO SCLEROTHERAPY

Sclerotherapy is contraindicated in pregnancy, breast-feeding, and in patients with allergy to the sclerosant, lack of mobility, significant deep-vein incompetence, or a history of thrombophilia.[50]

LASER AND LIGHT MODALITIES

Although lasers have successfully been used to treat many vascular lesions and facial telangiectasias, this modality

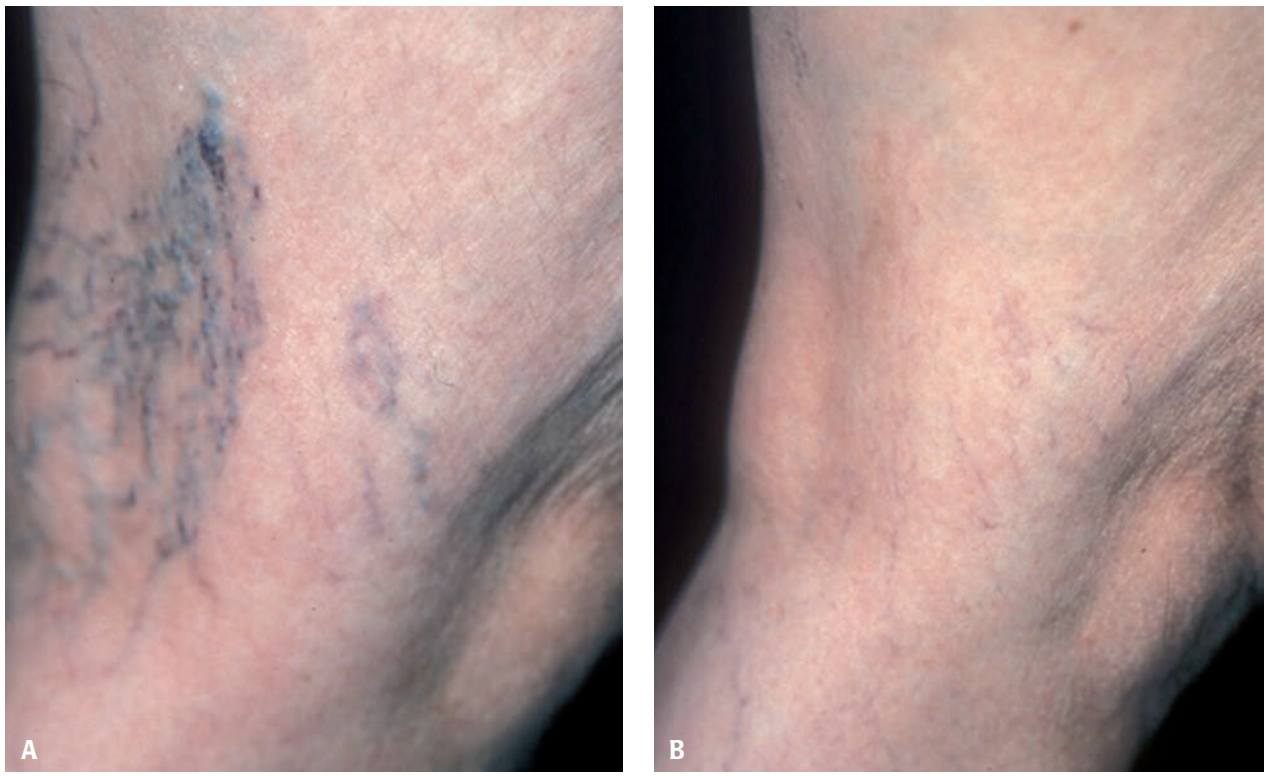

Figure 29-3 Before **(A)** and after **(B)** sclerotherapy. These photographs present results obtained following one injection. (Courtesy of David Duffy, MD.)

has had limited use in the treatment of leg veins. Laser leg vein treatment appears to be most beneficial in special circumstances, such as patients with hard-to-cannulate small vessels (0.1–0.3 mm), TM, needle phobia, or sclerosant allergy.[51,52] Laser therapy more commonly is used adjunctively with sclerotherapy techniques.[23,53] Combination approaches of sclerotherapy plus laser treatments performed during the same treatment session may produce synergistic results in selected individuals.[54] In general, laser therapies should be used with care and extreme caution in darker skin types to avoid hyperpigmentation, hypopigmentation, and scarring.

Lasers have been shown to induce endothelial cell injury.[55] The extended-pulse, longer-wavelength technologies, such as 1,064-nm Nd:YAG laser, have allowed the treatment of individuals with darker skin as well as treatment of deep blue reticular veins that are up to 3 mm in diameter.[54] The 1,064-nm Nd:YAG allows darker skin types to be treated with minimal risk to the epidermis because of decreased interaction with melanin, thus minimizing the potential for irregularities in epidermal contour and pigmentation.[56] Hyperpigmentation is most commonly observed with larger veins and appears to be primarily related to hemosiderin deposition.

The 755-nm alexandrite laser at fluences of 60 to 70 J/cm^2, 3-msec pulse width, and an 8-mm spot can be effective for larger leg veins, but the inflammatory response, purpura, and long-term pigmentary alterations limit its usefulness.[57] The KTP (532 nm) laser has been shown to be effective for treating spider leg veins with a vascular diameter under 0.7 mm.[58] Pulsed diode laser therapy (810 nm) is another treatment option for spider leg veins,[59] but results can be unpredictable.[60]

A bimodal wavelength approach of short and long wavelengths using an intense pulsed light source (550-nm cut-off filter), and the 1,064-nm Nd:YAG laser has been also shown to be effective in treating variably colored 0.1- to 4-mm telangiectasias and venulectasias.[61]

In summary, for leg vein treatment, the 1,064-nm wavelength is very safe for Fitzpatrick skin type V skin, the 810-nm wavelength at superlong pulse widths of 400 to 1,000 msec is very safe for type IV and marginal for type V skin, and the 755-nm wavelength is limited to nontanned type I to III skin.[60]

MINIMALLY INVASIVE PROCEDURES

For varicosities greater than 4 mm, GSV reflux, or sapheno-femoral incompetence, minimally invasive treatments, such as endovascular modalities, are alternatives to surgical treatment. Following the procedure, a compression stocking is worn for 5 to 7 days. Patients are able to walk immediately after the procedure, and most individuals are able to return to work the next day. There are three types of endovenous procedures: ultrasound-guided scle-

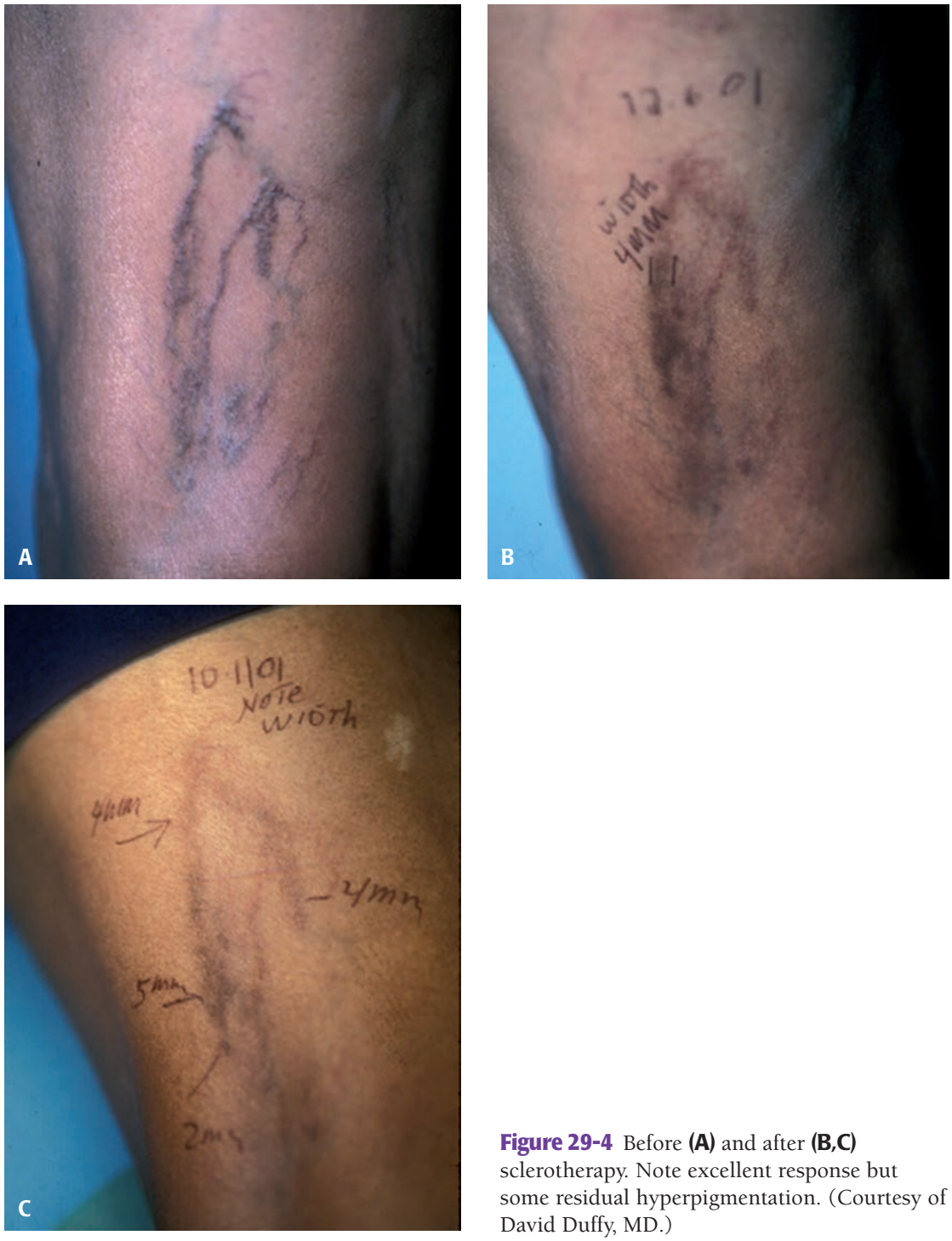

Figure 29-4 Before **(A)** and after **(B,C)** sclerotherapy. Note excellent response but some residual hyperpigmentation. (Courtesy of David Duffy, MD.)

rotherapy, endovenous laser treatment, and endovenous radiofrequency ablation.

Ultrasound-guided sclerotherapy

With this technique, ultrasound equipment is used to both map the veins and guide the physician during the injection of the sclerosing agent. The map provides the physician with the location of the veins and the valves, the size of each vein, the point of reflux, and the presence of thrombosis. Using the map, the physician determines the locations to be injected as well as the amount and type of sclerosant that is required. The ultrasound device is used to guide the injections to the precise locations.[22] Possible complications of ultrasound-guided sclerotherapy include transient visual disturbances and deep vein thrombosis.[41,62]

Endovenous laser treatment

Endovenous laser treatment is an alternative to surgical stripping of the GSV. Instead of removing the saphenous vein, it is ablated from within by resistive heating. The skin on the inside of the knee is anesthetized, and under ultrasound guidance, a laser fiber is inserted into the saphenous vein. The laser is fired, and as the fiber is withdrawn, the vein collapses and seals shut.[63] Endovenous laser treatment is FDA approved. Possible complications of endovenous laser treatment are thermal skin burns and transient numbness.

Endovenous radiofrequency ablation

Endovenous radiofrequency ablation (closure procedure) is another minimally invasive, FDA-approved, in-office treatment alternative to surgical stripping. The procedure is similar to endovenous laser treatment, except that instead of a laser fiber, a radiofrequency catheter is used. Postprocedure care is similar to other endovenous procedures. Possible complications of endovenous radiofrequency ablation are deep vein thrombosis, thermal skin burns, and transient numbness.[64–66]

Vein stripping and ligation

Traditional surgical ligation and stripping of the GSV is done under general anesthesia and usually performed in an outpatient surgical center or in a hospital operating room. PIN stripping is an updated method of vein stripping. A small incision is made in the leg, and the PIN stripper is inserted and advanced through the vein. The tip of the PIN stripper is sewn to the end of the vein, and as the PIN stripper is withdrawn, the vein is pulled on itself and is stripped out.[67] This procedure can be done under local anesthesia with intravenous sedation or general anesthesia and is thought to achieve better cosmesis than traditional stripping.[68]

Ambulatory phlebectomy

Ambulatory phlebectomy is an in-office procedure that can be performed using local tumescent anesthesia. It allows for complete removal of affected veins by hook avulsion below the saphenofemoral and saphenopopliteal junctions. The area surrounding the varicose veins is tumesced with anesthetic fluid. A needle is then used to make a puncture near the varicose vein, a small hook is inserted into the needle hole, and the vein is grasped and removed.

SURGERY

There are several surgical options for varicose veins: traditional ligation and stripping, Perforate Invaginate (PIN) stripping, and ambulatory phlebectomy.

CONCLUSION

Venous disease of the legs is a common cosmetic and medical problem. Fortunately, the clinician now has a sizable armamentarium for treating these affected vessels (Fig. 29-5).

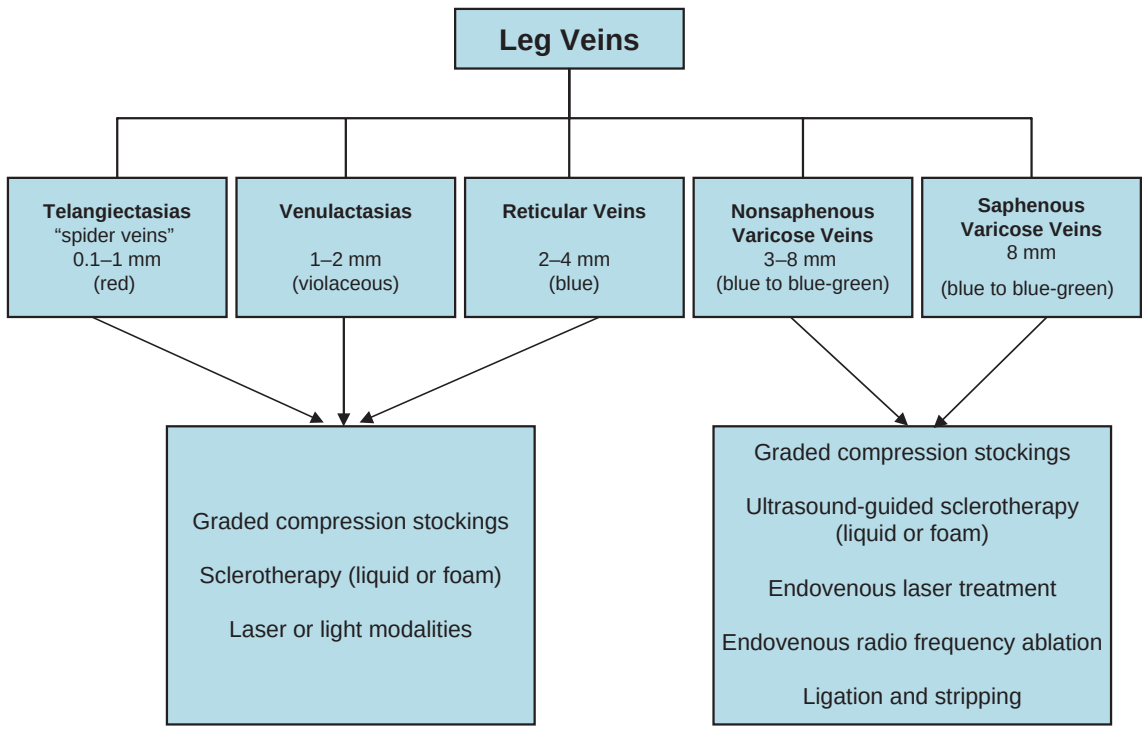

Figure 29-5 Leg vein classification and treatment options.

Sclerotherapy remains the gold standard for treatment of telangiectasias and small veins. New and emerging lasers and light sources can be used as adjuvant treatment. For larger veins, endovenous procedures are available as less-invasive alternatives to traditional surgical vein stripping and ligation.

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PART

8

Surgical Approaches for Hair Disorders

30

Alopecias and Hair Restoration in Women

Valerie D. Callender and Cherie M. Young

Alopecia is a common cosmetic concern in women of color. Epidemiological data addressing the true incidence of alopecia in women of color is lacking, but dermatologic practices with high proportional numbers of ethnic patients have found that there are increasing numbers of female patients with alopecia presenting for treatment.[1] Halder et al. reported alopecias as the fifth most common dermatosis seen in a dermatologic private practice that treats mainly African American patients.[2] Although the most common form of alopecia in women is female pattern hair loss (FPHL), chemical alopecia and traction alopecia were identified as the top forms of hair loss in this study of patients with darker skin types.

There are several causes of hair loss in women of color (Table 30-1). The unique characteristics of black hair, along with the plethora of hairstyles and hair-grooming practices, have been associated with the traumatic forms of alopecia; however, the exact etiology has not been proven in the majority of cases.[1] This chapter will focus mainly on the causes of alopecia that are most often treated by hair restoration in black women: FPHL, traction alopecia, and central centrifugal cicatricial alopecia (CCCA). In the majority of cases, a tetrad of therapeutic options for these patients is critical for success and combines medical therapy, cosmetic camouflage, surgical correction, and patient education on hair grooming. Hair restoration, a popular procedure performed primarily in men, has shown to be a viable option for hair loss in women.[3] Although the surgical technique of hair restoration is similar in men and in women, there are special considerations for women of color that will be discussed.

FEMALE PATTERN HAIR LOSS

(FPHL), also known as androgenetic alopecia (AGA), is the most common form of alopecia in women (Fig. 30-1). The true incidence varies from 6% to 25% of women before the age of 50.[4] The incidence of frontoparietal hair loss has been reported to be 13% in premenopausal women compared with 37% in postmenopausal women.[4]

The emotional and psychological reaction to hair loss in women is far greater than in men.[5–7] A study of 58 women with FPHL demonstrated negative self-esteem in 75% of the cases and social problems in 50%.[8] The quality of life in women with hair loss was as low as with psoriasis patients. Although there are no published clinical studies involving the impact of hair loss in women of color, similar quality-of-life issues may be present and, in some cases, even more severe.

The age at onset for FPHL peaks in the 20s and 40s, perimenopausally, or at times of hormonal change.[9] AGA is caused by the susceptibility of hair follicles to miniaturize in the presence of androgens.[9] There is limited data on the genetics of this type of hair loss, but proposed theories include autosomal dominance with incomplete penetrance and polygenic inheritance.[9] FPHL is a nonscarring type of alopecia and clinically appears as diffuse thinning over the frontoparietal scalp with preservation of the frontal hairline. The Ludwig pattern of hair loss is used to stage the extent of disease in patients with FPHL, with stage 1 consisting of mild hair loss and stage 3 consisting of extensive hair loss.[10]

Histologically, FPHL is characterized by follicular miniaturization, a decreased anagen-to-telogen ratio, and a decreased follicular density in long-standing cases.[9] Perifollicular inflammation and dermal fibrosis may be observed and are associated with a potentially worse prognosis.[9]

The most common treatment for FPHL is topical minoxidil 2% solution twice daily. Minoxidil is a potassium channel opener and vasodilator, but its mechanism of action on hair growth is unknown. In a 32-week clinical study in 550 women, the minoxidil-treated women had significantly higher hair counts than the women who received placebo.[11,12] In another 32-week study, hair weight was the primary end point. The average hair weight increased by 42.5% in the minoxidil group as compared with 1.9% in the placebo group.[13] Another study compared the use of minoxidil 2% solution with minoxidil 5% in the treatment of FPHL for 48 weeks. In this study, the use of minoxidil 5% was superior to minoxidil 2% using nonvellus hair counts and investigator and patient assessments of hair growth. An increased occurrence of side

Table 30-1

Causes of alopecia in black women

Nonscarring
Chemical alopecia
Traction alopecia
Androgenetic alopecia
Trichorrhexis nodosa
Telogen effluvium
Alopecia areata
Seborrheic dermatitis
Scarring
Central centrifugal cicatricial alopecia
Acne keloidalis
Folliculitis decalvans
Discoid lupus erythematosus
Secondary causes
Sarcoidosis

From Callender VD, McMichael AJ, Cohen GF. Medical and surgical therapies for alopecias in black women. *Dermatol Ther* 2004;17:164–176.

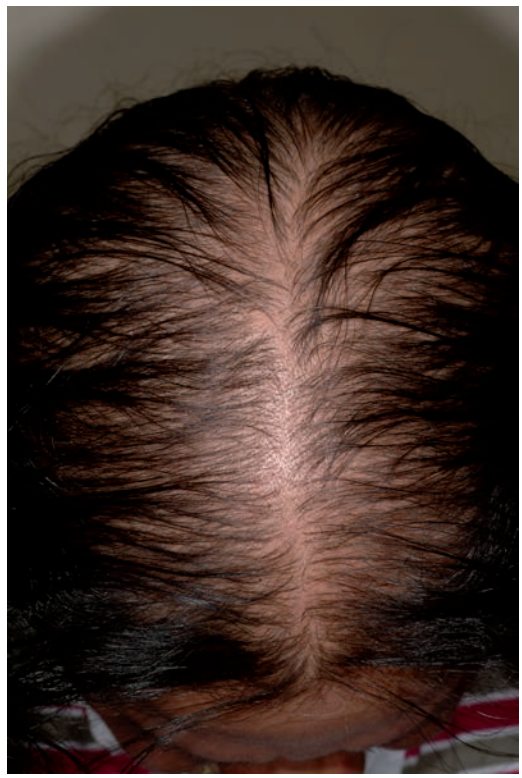

Figure 30-1 Female pattern hair loss (also known as androgenetic alopecia) is the most common form of alopecia in women.

effects, such as pruritus, local irritation, and hypertrichosis, was also observed in those using minoxidil 5% when compared with the minoxidil 2% and placebo groups.[14] Topical minoxidil solution is applied twice daily to the scalp; topical minoxidil 2% in petrolatum (rather than the solution) can be used in black female patients with natural hairstyles or thermally straightened hair.[1] Other treatments for FPHL include oral antiandrogens, such as spironolactone, cyproterone, and oral contraceptives. These are used mainly in premenopausal women. Oral finasteride has also been used as treatment for patients with FPHL, particularly in Europe, with some success.[15]

Women with Ludwig stages 1 and 2 are excellent candidates for hair transplantation, especially when combined with minoxidil.[16] Those patients with Ludwig stage 3 are generally not considered for surgical correction of their hair loss because of insufficient hair density in the donor area of the scalp.[17] Some authors report that all patients with FPHL are candidates as long as the goal of increased density is realistic and there is sufficient donor area to perform one to three hair transplant sessions of 800 to 1,200 grafts each.[3]

TRACTION ALOPECIA

Traction alopecia is a common form of hair loss in black women (Fig. 30-2). This form of traumatic alopecia has been associated with long term use of ponytails,[18] hair rollers,[19] tight braids,[20–22] and hair weaves.[22] The etiology

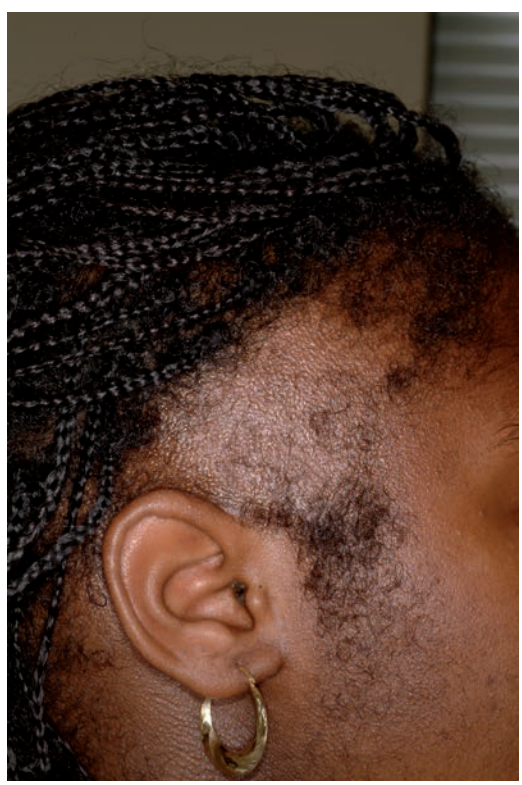

Figure 30-2 Traction alopecia is a common form of hair loss in black women.

of traction alopecia is thought to be secondary to chronic tension or pulling of the hair, leading to a mechanical loosening of the hairs from the hair follicle. A perifolliculitis occurs, and eventually a permanent alopecia develops.[23] Clinically, there is a symmetrical loss of hair in the temporal areas, anterior and superior to the ears, which, in severe cases, extends along the frontal and occipital hairlines (ophiasis pattern). Characteristically, vellus hairs are usually spared, and broken hairs are seen scattered within the areas of hair loss.[24]

Histologically, in the early stages of traction alopecia, the most prominent finding is increased number of terminal catagen and/or telogen hairs.[25] If the telogen hairs are increased in number, this is referred to as fibrous "streamers".[25] In the end stage of traction alopecia, there is a marked decrease in the total number of follicles and terminal follicles with retention of vellus hairs.[25] There are also fibrous tracts found at the sites of former follicles, normal dermal collagen, intact sebaceous glands, and no significant inflammation.[25]

Traction alopecia can be prevented if diagnosed early.[1,26] Discontinuance of any hairstyle that produces tension on the hair is the most important step in the treatment of traction alopecia. Medical management includes topical and oral antibiotics, topical and intralesional corticosteroids, and topical minoxidil.[1,26] Surgical correction with hair transplantation by punch grafting and/or flap rotation[24] and minigrafting, micrografting, and follicular-unit transplantation (FUT) has been reported to be successful.[1,27]

CENTRAL CENTRIFUGAL CICATRICIAL ALOPECIA

CCCA is an inflammatory scarring form of alopecia that is commonly seen in black women (Fig. 30-3). It has been referred to as hot-comb alopecia,[28] chemical alopecia,[21] pseudopelade,[29] chemically induced cosmetic alopecia,[30] follicular degeneration syndrome,[31] and, more recently, CCCA.[32] The North American Hair Research Society–sponsored workshop on cicatricial alopecia has further classified CCCA and other forms of cicatricial alopecias based on their clinical and pathologic findings.[33] This classification system was developed to guide the clinician and researcher on treatment monitoring as well as to facilitate clinical trials on epidemiology, pathophysiology, and therapeutic effectiveness in patients with scarring alopecia.

Although the etiology of CCCA remains unclear, the association of hot combs or chemical relaxers may contribute to CCCA in black women, and the end result is permanent destruction of the hair follicles. The course of CCCA is progressive and can be divided into early (inflammatory) and late (scarring) stages of disease. Initially, the scalp may appear normal clinically, may exhibit circular patches of broken short hairs (author's personal observation), or may exhibit partial hair loss involving the crown and/or vertex measuring only a few centimeters in diameter.[34] The affected area gradually increases in size centrifugally. At any stage of the disease, patients may experience pruritus and/or tenderness of the scalp. Erythema, scaling, and occasional pustules may also be noted clinically. Characteristically, late disease presents with lack of follicular ostia and irreversible alopecia.[35]

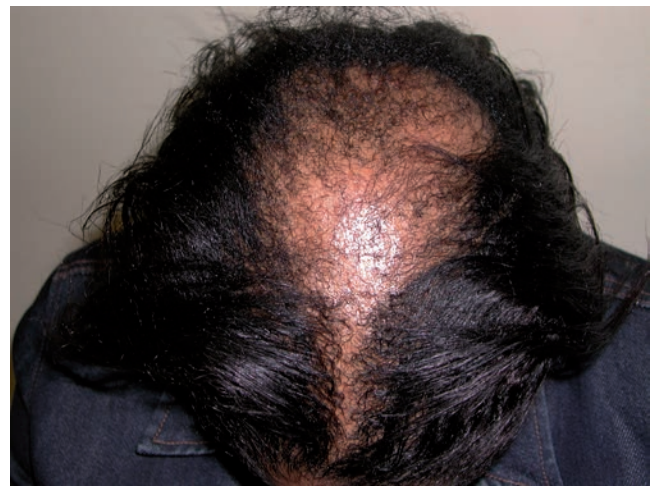

Figure 30-3 Central centrifugal cicatricial alopecia (CCCA) is an inflammatory scarring of alopecia that is commonly seen in black women.

Histologically, CCCA is characterized by premature desquamation of the inner root sheath, a decrease in the number of follicular units, and replacement of follicular units with fibrous tissue.[34] There may be various levels of inflammation, ranging from sparse to extreme perifollicular lymphohistiocytic infiltrates.[34] In cases of early CCCA, premature desquamation of the inner root sheath may be the only histologic finding.[34]

The main treatment goal in cicatrizing alopecias is to arrest the scarring process, decrease follicular inflammation, and halt further irreversible destruction.[35] Treatment options for CCCA should be tailored to the severity of disease, and it usually begins with aggressive anti-inflammatory agents. These agents include high-potency topical corticosteroids, corticosteroid-based shampoos, and oral antimicrobial agents, such as doxycycline. Intralesional corticosteroid therapy with triamcinolone acetonide (2.5 mg/mL—5 mg/mL) performed every 4 to 6 weeks is also an integral component of treating CCCA and should target lesional and perilesional areas of hair loss.[1] This serves to suppress dermal inflammation and prevent further progression of disease.[1] Alteration of the hair-grooming practices should be discussed with all patients with CCCA to minimize cutaneous inflammation and hair breakage. Suggestions include longer duration between chemical relaxer applications, natural hairstyling, avoidance of excess heat to the scalp, and limited use of styling gels, sprays, and

pomades.[1,36] Hair transplantation should be considered after 6 months or longer of medical therapy and when the inflammatory component of the disease is stable.[1,27]

HAIR TRANSPLANTATION

Hair restoration has gone through many changes over the last decade. New techniques and surgical advancements in hair transplantation have emerged, and the numbers of patients seeking this cosmetic procedure are increasing. The International Society of Hair Restoration Surgery Practice Census found that an estimated 168,155 hair-transplant procedures were performed worldwide in 2005; of these, 87,987 were performed in the United States.[37] Although this survey identified only 11% of the hair-restoration patients as women, an increasing number of female patients—white and black—are presenting to the hair-transplant surgeon to correct their hair loss.

Dr. Norman Orentreich, one of the earliest pioneers in hair transplantation, developed the punch graft technique in the late 1950s.[38] This procedure, which was performed mainly in male patients with AGA, used round punch grafts (4 mm in size with 10–25 hair follicles per graft) from the occipital scalp (donor area). These grafts were then transplanted to the anterior hairline and vertex scalp (recipient area). In 1995, Bernstein et al. reported that FUT was the preferred method in the treatment of androgenetic alopecia.[39] This procedure produced a more naturally appearing aesthetic result of the anterior hairline as compared with the punch grafting technique.[40] FUT is based on Headington's observation that hair naturally grows in discrete bundles in the scalp, called follicular units, and consists of one to four hairs surrounded by a fine adventitial sheath.[41] This revolutionary change in technique allowed more patients the benefit of a natural-looking hairline.

There are limited data on hair transplantation in blacks. Pierce noted that historically, hair transplantation for hair loss in the black population was not considered as a treatment option by patients or cosmetic surgeons for various socioeconomic and technique-specific reasons.[42] With an understanding of the racial differences in hair morphology, careful patient selection, and meticulous surgical planning, hair transplantation can be a successful cosmetic procedure to correct hair loss in black women.

DIFFERENCES IN HAIR CHARACTERISTICS RELATIVE TO HAIR TRANSPLANTATION

There are racial differences and therapeutic challenges that must be addressed when performing hair-transplant surgery in black patients (Table 30-2), and understanding these differences allows greater success in this population.[27] There are clear differences in the hair morphology among racial groups.[43,44] The hair structure of black hair is tightly coiled, helical or spiraled, elliptical, and flattened in cross-section, and the hair follicle is curved (Fig. 30-4). This curved hair follicle provides a challenge in donor-strip harvesting and graft preparation, two key steps in hair-transplant surgery. Transection of the hair follicle may occur even with the most skilled hair-transplant surgeon or technician, and a decreased survival rate of the transplanted hair may result. In contrast, Caucasian hair is straight, wavy or helical, round or oval in cross-section, and the hair follicle is straight. Asian hair is straight, round in cross-section with a greater diameter than the other two groups, and the hair follicle is straight.

Hair-density differences exist between these groups as well. Blacks have the lowest hair density as compared with Caucasians and Asians,[40,45] but have the highest hair groupings (three) as compared with the other two racial groups (two).[40] This decrease in hair density can affect the results of a hair-transplantation procedure. For example, if a 10-cm strip is removed from the donor area of the scalp for a FUT procedure, 600 grafts can be produced in the black patient compared with 1,000 grafts for the Caucasian or Asian patient.[46] Although these differences in hair characteristics exist, patients with darker skin types are heterogenous and may exhibit characteristics of all three hair types.[26,27]

Although blacks have significantly lower hair density than Caucasians and Asians, patients of color with dark curly hair have an advantage that offers better coverage of the area of hair loss.[40] In the recipient area, the curly nature of black hair camouflages any remaining areas of hair loss and obscures the graft insertion. This allows grafted hair to be less noticeable, which provides an excellent cosmetic result. In addition, patients with dark skin and dark hair have less skin/hair contrast; the dark skin fills in any gaps between individual hairs.[40,42] These advantages of dark curly hair provide an illusion of density that contributes to the overall aesthetic outcome in patients of color.[42]

CONTRAINDICATIONS FOR HAIR TRANSPLANTATION

The contraindications for hair restoration are similar in blacks and whites. These include significant mental disease, systemic disease and unrealistic expectations.[42] However, it is well known that patients with darker skin types (Africans, African Americans, Hispanics, and Asians) have a higher incidence of hypertrophic scarring and keloid formation, a major concern in performing any cosmetic or dermatologic procedure. Clinically, keloidal scars differ from hypertrophic scarring in that they grow beyond the original border of cutaneous injury. Historically, blacks were initially discouraged from hair-transplant surgery because of this untoward adverse event,[42] but over the years, this myth has been dispelled. Scalp keloids

Table 30-2

Racial differences in hair morphology and hair density

	Blacks (African, African American, Afro-Caribbean)	Caucasians	Asians (Japanese, Chinese, Koreans, Filipinos, Indians)
Hair structure	Tightly coiled, helical, or spiraled	Straight, wavy, or helical	Straight
Cross-section	Elliptical, flattened	Round or oval	Round, greater diameter
Hair follicle	Curved	Straight	Straight
Follicular units/mm^2	0.6	1	1 (0.7 Chinese)
Average density hairs/mm^2	1.6	2	1.7 (1.4 Chinese)
Predominant hair grouping	Three	Two	Two (two Asian)
Hair density (mean) number of follicles/4 mm^2	21.4	35.5	No Data
Terminal follicles	18.4	30.4	No Data
Anagen hairs	17.3	28.8	No Data

Data from Bernstein RM. The aesthetics of follicular transplantation. *Dermatol Surg* 1997;23(9):785–799; Sperling LC. Hair density in African Americans. *Arch Dermatol* 1999;135:656–658; Oresajo CO, Pillai S, Richards GM. Structure and function of skin and hair in pigmented races. In: Halder R ed. *Dermatology and Dermatological Therapy of Pigmented Skins.* Boca Raton: Taylor & Francis;2006:3–15.

Figure 30-4 4 mm punch round graft from a black woman. *Note:* The hair structure of black hair is tightly coiled, helical or spiraled, elliptical, and flattened in cross-section, and the hair follicle is curved.

following hair-transplant surgery are uncommon.[1,27] However, extensive keloid formation following hair transplantation has been reported in the literature. Brown et al. described a black male patient with no previous history of keloids who developed multiple keloidal scars involving the donor and recipient areas several months after the procedure.[47]

A detailed history and physical exam for keloids should be obtained preoperatively. If present, the surgery must not be done or should be approached with caution, using a test session of transplanting a few grafts first and waiting before proceeding with a full hair-transplantation procedure.[48]

Acne keloidalis (AK) is a chronic idiopathic scalp condition most often seen in black men and occasionally in black women (Fig. 30-5A).[23,49–51] The incidence varies, ranging from 0.45% to 13.7% in blacks.[52–54] Clinically, AK presents with multiple flesh-colored, erythematous, or hyperpigmented follicular papules and pustules on the occipital scalp. In some cases, the eruption extends to the nape of the neck or vertex of the scalp. Keloidal plaques and a scarring alopecia occur in end-stage disease. The

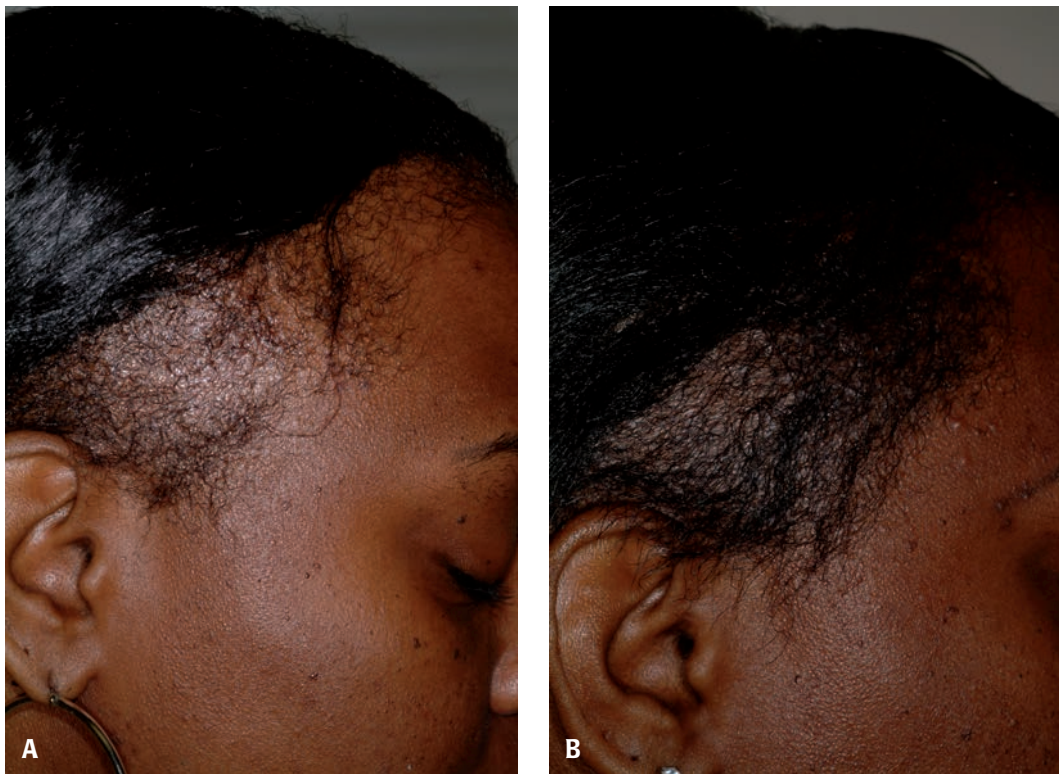

Figure 30-5 Baseline African American female with traction alopecia **(A)**. Post hair transplantation of the affected area. Note marked increase in hair density **(B)**.

exact etiology is unknown, but it is a form of primary scarring alopecia.[55] Treatment of AK includes topical and oral antibiotics, topical corticosteroids,[50] intralesional corticosteroid,[56,57] cryosurgery,[57] excision,[58,59] and laser surgery.[60] Because of the inflammatory nature of this disease, potential for scarring, and the location of AK, strip harvesting of healthy donor tissue for hair transplantation from this area would be impossible.

SURGICAL TECHNIQUE

There are several racial differences that must be considered in hair restoration in black women. As mentioned previously, the curved follicle and hair that is characteristically seen in this population can provide a surgical challenge during donor harvesting and graft preparation. It is important to remember that not all patients of color have curly hair, and straight hair that is commonly seen in Asian or Caucasian hair may be present. Therefore, special attention and close inspection of the hair morphology must be done in each patient to assess their true hair characteristics before hair-transplant surgery.

Donor harvesting

Lidocaine with epinephrine is the most commonly employed local anesthetic in hair transplant surgery.[61] Tumescence with a saline solution infiltrated into the tissue before dissection helps to obtain maximum skin turgor, which is necessary to facilitate excision of the donor strip and straightening of the curved hairs. A horizontal ellipse of donor tissue is excised by using a single No. 10 or No. 15 blade. The size of the ellipse is based on the number of follicular units or follicular hair groupings needed to cover the recipient site and will vary depending on the hair density of the patient. Excision of the donor strip allows for optimization of donor hair used for hair transplantation and limits the scarring of the posterior scalp. By ensuring that the width of the excision is less than 1 cm, the resultant scar is kept thin (1–3 mm). Some authors recommend curving the blade[46] in patients with curly hair to avoid transection. A multibladed knife is not recommended in patients with curly hair because the risk of follicle transection is greater. Undermining of the tissue surrounding the wound margins allows for better closure and less tension on the wound. Wound tension may contribute to the development of hypertrophic scarring and keloid formation. The wound is either sutured

or stapled closed and removed in 10 to 14 days; a running suture technique for closure with blue monofilament 3-0 suture in patients with dark hair will prove satisfactory results. This blue-suture material assists in the visibility of sutures when removing them after surgery.

Graft preparation

Well-trained technicians who understand the hair morphology of black hair are extremely important during this crucial stage of hair transplantation, which requires meticulous dissection of tissue to produce the size of grafts needed for the procedure. Preparation of the grafts should be done under stereomicroscopic guidance with backlighting that improves visibility while dissecting. A bendable Personna blade (DermaBlade) in the creation of follicular unit and multifollicular unit grafts can be used in patients with curved hair follicles to minimize transection of the hair follicle. This technique allows the technician to bend the blade to match the exact curvature of each individual hair. (Fig. 30-5B).

Recipient site

Instrumentation used for hair transplantation in patients with darker skin types focuses on the natural curvature of the hair and hair follicle (Table 30-3). The curly hair and hair follicle require the formation of larger grafts and larger recipient sites for placement. The surgeon's preferred technique will determine whether to use fine blades, needles, or punches when creating recipient sites. However when using surgical instruments that create larger sites and produce incisions greater than 1.5 mm (Table 30-3), curly hair is better accommodated. Nokor needles and flat blades are used primarily when performing follicular-unit and multifollicular-unit grafting in patients with FPHL and traction alopecia, whereas punches are generally used for test sessions and hair transplantation in patients with CCCA.

Special considerations in patients with central centrifugal cicatricial alopecia

There are special considerations and varying techniques used in transplanting hair into scar tissue. Although aggressive medical management to decrease inflammation in patients with CCCA is performed, graft survival is still a major concern in these patients because of limited blood supply. It has been reported that graft survival rates in nonscarred areas is 90% to 95% compared with an estimated 50% to 70% in scarred areas[7,17]. Although graft viability in scar tissue is often a concern, hair survival can be obtained as long as specific factors and techniques are followed.[27,62,63]

During the initial consultation, it is important to educate the patient with CCCA on the possibility of disease recurrence, decreased hair survival rate, and the importance of altering traumatic hair-grooming practices after hair transplantation.[27,62] A test session is often used to assess the true success of a full procedure in patients with a history of keloids[42,48] and in patients with all forms of cicatricial alopecia, including CCCA.[27] This involves transplanting four to six 4-mm round grafts from the occipital scalp (donor area) into 3.5-mm recipient sites, usually involving the vertex scalp. A scalp biopsy of the recipient area is performed to evaluate whether the inflammatory process has been stabilized. Larger grafts rather than follicular units should be used during the test session. Topical and intralesional corticosteroid therapies should be continued and the transplanted area observed for 4 to 6 months to monitor for graft survival.

The addition of 2% or 5% minoxidil therapy for 1 week preoperatively and 5 weeks postoperatively to increase blood flow to the recipient scarred area has been reported to improve graft survival;[63] however, no controlled clinical studies exist.

A hair-transplant session can later be performed if the scalp biopsy taken during the test session reveals no inflammation and the test area demonstrates successful growth. Larger grafts, rather than follicular units, are recommended in patients with CCCA. Multiple sessions are usually required, using a smaller number of grafts for each session. Longer periods between sessions (9–12 months) should also be implemented.

Table 30-3

Surgical instrumentation for performing hair restoration in blacks

Donor harvesting
Single-bladed scalpel
Curved No. 10 or 15 blade
3-0 or 4-0 Prolene (blue) suture
Loupe magnification
Graft preparation
Stereomicroscope
Fiberoptic box light (backlighting)
DermaBlade Personna blade
Recipient site
18-gauge Nokor needle (1.79 mm)
16 gauge Nokor needle (2.30 mm)
Spearpoint 90 blade (1.5 mm)
Spearpoint 91 blade (2.0 mm)
2- to 4-mm punches
Loupe magnification

COMPLICATIONS

The tendency to develop keloids, hypertrophic scars, and postinflammatory hyperpigmentation in darker-skinned

individuals following cutaneous injury is a common concern for the cosmetic surgeon. The most common site for keloidal or hypertrophic scarring postoperatively is in the donor area and may occur in patients with no previous history. Preventive topical corticosteroid therapy immediately after surgery has been found to be effective.[27] A topical midpotency corticosteroid ointment combined with an antibiotic ointment (Bacitracin) is applied twice daily to the donor site immediately after the procedure for 2 weeks. After the sutures are removed at day 14, the application of a high-potency topical corticosteroid to the wound site for 2 weeks is recommended.

If a hypertrophic scar or keloid develops in the donor area postoperatively, immediate treatment with intralesional triamcinolone, 20 to 30 mg/mL, is performed every 2 to 4 weeks until the scar flattens.[27]

POSTOPERATIVE COUNSELING

Ethnic hair-grooming practices and hairstyling should be discussed with each patient in detail to ensure a successful hair-transplant procedure. Many women of color not only wash and condition their hair weekly, they also perform other hair-grooming practices that must be understood by the surgeon. These include use of an array of hair-grooming products, chemical hair straightening (relaxing), thermal hair straightening (hot combing), hair coloring, and hair braiding.[1] These are usually performed at the hair salon by a nonmedical professional. After a hair-transplantation procedure, patients should be instructed to gently wash their hair and to refrain from any chemical hair treatments that could potentially cause cutaneous irritation or injury to the scalp. Many patients will simply wear a wig to avoid excessive hairstyling and hair grooming during the postoperative period.

SUMMARY

Hair restoration, a procedure once offered only to men, is a safe and long-term corrective therapeutic option in women with hair loss who have not responded to medical intervention. This procedure has the potential to produce the most dramatic improvement with minimal complications in women who suffer with both nonscarring and scarring forms of alopecia. Special considerations for hair restoration in patients of African descent with curly hair include knowledge of the current hair-grooming practices, concomitant medical treatment, test sessions in scarring alopecia, selection of appropriate instrumentation for donor harvesting and recipient site creation, and the prevention of keloidal scarring. Hair-transplant surgery offers a high level of patient satisfaction, and concerns of lower density and risks of keloidal scarring should not prevent the cosmetic surgeon from performing this highly successful procedure in appropriately selected patients.

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31

Hair Transplantation for Men

Marc R. Avram

The goal of hair transplantation is to establish an aesthetically appropriate frontal hairline to frame the face. From the 1960s into the late 1990s, ten to twenty-five 3- to 4-mm hair grafts were the mainstay of hair transplantation, despite the fact that hair naturally grows in the scalp in bundles of 1 to 4 hair follicles. The 10 to 25 hair grafts looked unnatural because they *were* unnatural. Today, surgeons and their surgical assistants meticulously harvest the natural 1–4 hair-follicular groupings from donor hair and implant them in the recipient region. This technique consistently creates natural-appearing hair (Fig. 31-1A,B). Contemporary hair transplantation requires a highly skilled transplant team. A skilled team is created by having enthusiastic, dedicated members train more than 6 to 12 months to develop skills necessary to create grafts and place them in recipient sites. The surgeon and team work together to accurately and efficiently harvest the donor hair, create a large number of natural 1–4 grafts, create recipient sites, and place the grafts into these sites. This chapter will provide an overview of appropriate candidate selection, the role of medication with surgery, donor harvesting techniques, graft creation, hairline design, and graft placement for consistently natural transplanted hair in men. Hair transplantation procedures are indeed performed in men of darker racial ethnic groups, including Asians, Hispanics, Africans, and African Americans. Techniques are similar for Asians, Hispanics, and Caucasians. However, the unique morphological features of Afrocentric hair require special considerations for hair transplantation, as discussed in this chapter and in Chapter 30.

THE CONSULT

Male pattern hair loss is an *involuntary* change in a man's appearance. It affects 50% of men by age 50.[1] The involuntary change in physical appearance is a source of stress for many men. Unfortunately, many believe there is nothing that can be done to halt or reverse their hair loss. In fact, the vast majority of men could halt or reverse their hair loss via safe medical and/or surgical options. A consultation for male pattern hair loss is vital to create the appropriate treatment plan for each individual.

MEDICAL THERAPY

The introduction of minoxidil and finasteride as effective treatment options for hair loss have provided physicians with new tools to treat hair loss[2,3] (Table 31-1). Both medications are more effective for patients with earlier stages of hair loss and are an excellent treatment option for patients losing hair but who are not candidates for surgery. For patients who are candidates for surgery, continuing medical treatment will often help increase the density of transplanted hair by slowing down the rate of loss of existing hair and increasing the caliber of existing and transplanted hair. In addition, these medications may help reduce a postsurgical telogen effluvium and maintain donor density.[4]

There are a variety of supplements and products advertised on the Internet and television that purport to stop and reverse male pattern hair loss. The majority are herbal and vitamin supplements. Good nutrition is important for hair growth. The vast majority of men receive more-than-adequate nutrition for normal hair growth, and supplements are not needed. The problem is a genetic, not a nutritional, one. Some men, in their zeal to treat their hair loss, take megadoses of vitamins that have a counterproductive effect and promote further hair loss. Minoxidil and finasteride are the only two medications that have demonstrated through studies to have a consistently positive impact on male pattern hair loss.

SURGERY

A hair transplant is an outpatient procedure performed under local anesthesia. The average procedure takes 3 to 4 hours. The majority of the time is used to create an average of 1,000 to 1,500 1–4 hair grafts, produce recipient sites, and place the grafts. Patients resume normal activities immediately, with a restriction on heavy exercise for 3 to 7 days after surgery. If there is pain after the procedure, it occurs during

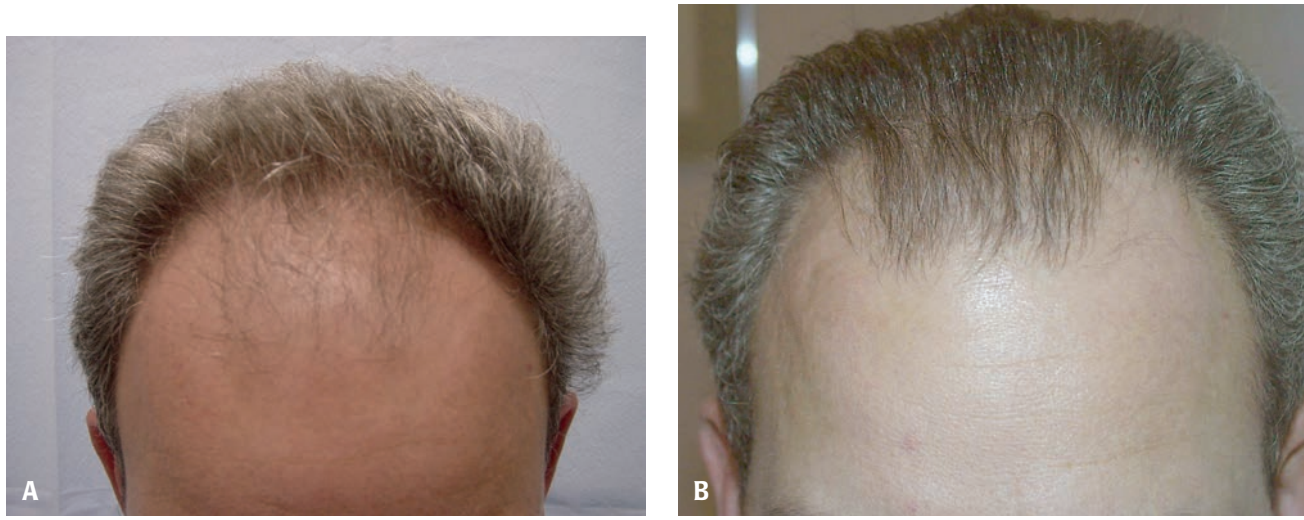

Figure 31-1 Before hair transplant **(A)** and after 800 1–3 hair grafts **(B)**.

the day of the procedure, and a mild pain medication is adequate for relief. The day after the procedure, patients should feel no discomfort. Typically, the only physical evidence of the procedure is the perifollicular crusting that remains 6 to 8 days and in some patients edema in the forehead for 2 to 3 days. Most patients return to work 2 to 3 days after the procedure without any negative cosmetic impact.

All patients undergoing hair transplantation should expect natural-appearing transplanted hair. During the consult, realistic expectations need to be created for short- and long-term density from a hair transplant. All skin types and hair colors are candidates for surgery. The physical exam includes evaluating the donor density and caliber of the hair follicle which will help determine the expected density from the procedure. Patients with below-average donor density and fine-caliber hair will have natural but thin transplanted hair. Those with above-average density with wide-caliber hair follicles can expect greater perceived density. The density of transplanted hair will be affected by the rate of hair loss and/or postsurgery telogen effluvium. Patients with a lot of remaining hair but rapid loss of hair may even have less hair 12 months after surgery. The extent and rate of hair loss varies from person to person. During the consult, the surgeon must emphasize

Table 31-1

FDA-approved medical therapy: comparison of the only two FDA approved medications for male pattern hair loss

	Finasteride	Minoxidil
Mechanism of action	5-alpha reductase type II inhibitor Blocks the conversion of testosterone to dihydrotestosterone	Unknown
Key to success	Emphasize maintenance over regrowth of hair Compliance for at least 6–8 months to see a benefit	Emphasize maintenance over regrowth of hair Compliance 6–8 months to see a benefit
Side effects	2% of men experience sexual dysfunction. Reversible within days if discontinued. No allergic reactions, blood monitoring, or drug interactions. Women should never handle or take medication.	Dryness and pruritus of the scalp. Rare allergic reaction.
Clinical onset of action	6–8 months	6–8 months
Dose	1 mg once daily with or without food	2–4 drops 1–2 times daily to frontal and vertex of scalp

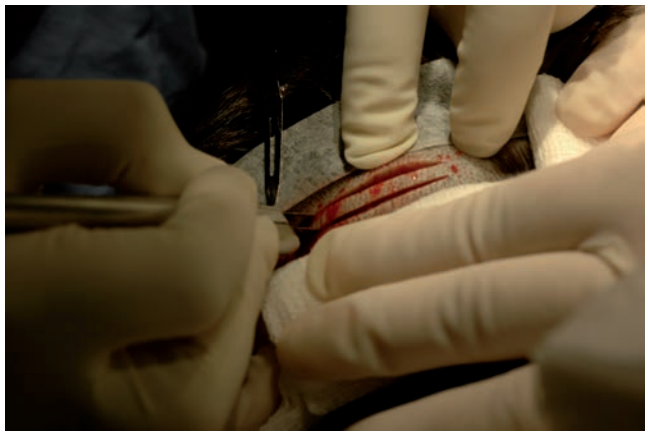

Figure 31-2 Donor ellipse harvesting.

the ongoing nature of hair loss with or without surgery. Despite recent 5-year studies confirming the long-term benefit from these medications, it is vital that surgeons still apply the same criteria for candidate selection and hairline design in patients with successful medical treatment.

Patients should be aware of a permanent scar in the donor region from the harvesting of hair for the transplant. For the majority of patients, the scar does not create any physical or cosmetic concern. Some patients that may shave their hair or wear it closely cropped to the scalp should be aware the scar will be visible before the procedure is performed. Explaining the ongoing loss of hair with or without transplantation, role of medications, permanent donor scar, realistic density based on hair caliber, and long-term hair loss will help create realistic expectations for patients. If a patient does not have a realistic expectation for what a transplant can and cannot achieve in the short and long term, the surgery should not be performed.

DONOR REGION

The limiting factor in hair transplantation is the amount of hair available in the donor scalp of patients. From the 1960s into the 1990s, steel punches measuring from 3 to 4 mm in diameter were used to harvest donor tissue from the posterior scalp. This resulted in extensive scarring over the posterior scalp and an inefficient use of valuable donor hair. In the mid-1990s, multibladed knives were popularized as an easy method to obtain elliptical strips that were easily dissected into smaller follicular units.[5] Although efficient for creating grafts, the transection rate of follicles was higher because of the multiple blades through the tissue. The clinical significance in the yield of transected hair is unclear, but minimizing trauma to hair follicles is a goal of all hair-transplant surgery teams. The single-blade donor ellipse does reduce transection of follicles and has become the most popular method for donor harvesting (Fig. 31-2).

The donor region is trimmed with a moustache trimmer. The patient is placed in the prone position and the area anesthetized with 1% lidocaine with 1:200,000 epinephrine. Saline is added to the donor region. The saline helps with hemostasis and through increased turgor reduces the transection of hair follicles. The donor ellipse is created using No. 10 blades on a surgical handle with 0.8- to 1.0-cm spacers between the blades. The length of the donor strip is determined by the number of grafts required for the surgery. The average patient has 60 to 85 follicular groupings per cm^2.[6] For example, a donor strip 12 to 14 cm long and 1 cm wide will create approximately 800 to 1,200 grafts.

Recently, the idea of harvesting donor hair using 1- to 1.3-mm punches has been advocated to minimize a visible scar in the donor region.[7] Follicular unit extraction does leave less visible scarring for most patients. Despite this, follicular unit extraction has a limited role in hair transplantation. Its chief advantages are for patients with shaved hair or closely cropped hair and patients with severely depleted donor hair from multiple previous hair transplants. The disadvantages of this method include (a) less hair harvested for each session, resulting in less density from each procedure; (b) a higher transection rate of hair than with elliptical donor harvesting; and (c) longer operative time (Table 31-2).

Table 31-2
Advantages and disadvantages of donor harvesting techniques

	Ellipse	Follicular unit extraction
Minimal transection of donor hair	Yes	No
Number of 1–4 grafts safely harvested per procedure	1,500–2,000	200–400
Time to harvest donor hair	15–20 minutes	1–2 hours
Visible donor scar with hair length >1 cm long	No	No
Visible donor scar with hair <0.5 cm long	Yes	Likely not
Overall percentage of cases used	>95%	<5%

Figure 31-3 A 1–4 hair-follicular grouping in saline.

GRAFT SIZE

Hair naturally grows in bundles of 1–4 hair units. In nature, hair is randomly, yet evenly, distributed throughout the scalp. In traditional methods of hair transplantation, plugs contained 15 to 25 hairs per graft. They were placed into 3- to 4-mm recipient punch sites and grew 6 months after surgery. This technique produced the "pluggy" unnatural appearance of transplanted hair because, our eyes are used to seeing thousands of 1–4 hair bundles of hair on the scalp. Transplanting unnaturally large bundles of 15–25 hair together inevitably resulted in their "pluggy" appearance. The exclusive use of 1–4 hair grafts allows for consistently natural-appearing transplanted hair for men. Terms such as *follicular units* and *micrografts* have been used to describe these grafts.[8,9] Today, surgical teams carefully separate 500 to 2,000 natural bundles of hair from the donor strip (Fig. 31-3). The 1–4 hair grafts are produced by a variety of methods. Cutting instruments include no. 11 and no. 15 blades and no. 10 prep blades. Good lighting, comfortable chairs, and well-designed instruments are prerequisites to produce thousands of high-quality grafts (Fig. 31-4). Some surgeons believe microscopic dissection of 1–4 hair grafts from donor tissue is essential for the highest-quality grafts.[10] Data regarding microscopically dissected donor tissue and subsequent yield of transplanted hair are still inconclusive. What is not debated is the need to create intact, minimally traumatized, follicular groupings and place the transplanted hair as efficiently and quickly as possible into the recipient sites to optimize the survival of hair and produce the greatest density possible.

HAIRLINE DESIGN AND RECIPIENT SITE CREATION FOR MEN

The hairline is what defines the cosmetic success of a hair transplant. As with hair-graft creation, the trend in hairline design has been toward mimicking as closely as possible what occurs in nature. The goal of a hairline is to frame the face in an undetectable manner. Hairlines do not exist, but a natural transition zone of gradually increasing density from skin to terminal hair–bearing skin occurs. This ill-defined "feathering zone" is created by randomly placing, in an irregular pattern, one to three hair grafts along the newly created hairline.[11] The level at which the hairline is created varies from individual to individual. It is important for a surgeon to look at each patient in a global, 360-degree view before deciding where to place the hairline. Androgenetic alopecia is progressive, but transplanted hair will grow long term. Therefore, when viewing patients, surgeons must assume all patients will progress to complete hair loss with only transplanted hair remaining. This assumption allows transplanted hair to look equally natural 1 year and 20 years after surgery. Hard-and-fast rules of how many centimeters a hairline should be placed above the glabella are generally not followed, but the shape of a patient's forehead and level of temporal hairline recession will determine the ideal aesthetic placement of grafts to produce a natural frontal hairline.

The posterior hairline should mimic the natural semicircle that expands as hair loss progresses in the vertex of the scalp. It should, as with the frontal hairline, appear to be designed anticipating ongoing hair loss in the future. To avoid future aesthetic complications, the posterior hairline should be placed on the same plane as the frontal hairline. This will avoid "chasing" the ever-expanding ring of hair loss on the vertex of the scalp with valuable donor grafts. Recipient sites should mimic the natural 30- to 45-degree angle of hair growth on the scalp. There are a variety of needles that are used to make sites large enough to place the 1–4 hair-follicle grafts. Some of the most popular needles to make sites include no. 18 and no. 19 needles and CAG needles. When making recipient sites, surgeons must be careful not to transect existing hair follicles. Magnification for making recipient sites has recently been advocated

Figure 31-4 Surgical assistant producing 1–4 hair grafts.

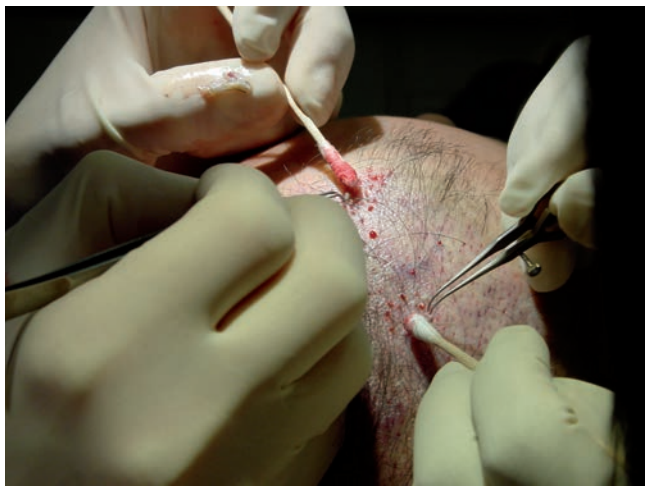

Figure 31-5 Placement of grafts using microvascular forceps.

to limit any loss of existing hair during surgery.[12] The key to success is to create recipient sites in a random, highly irregular pattern with 10 to 30 sites per cm^2, depending on the density of existing hair on the scalp.

GRAFT PLACEMENT AND POSTOPERATIVE COURSE

The grafts are placed by two to three surgical assistants using microvascular forceps (Fig. 31-5 and Fig. 31-6). The forceps pick up the 1–4 hair grafts by their perifollicular tissue, avoiding trauma to the hair follicles. Regular surgical forceps will not work. The placement of grafts into recipient sites is often the most challenging part of the procedure for novice and experienced hair-transplant teams. The chief challenges are hemostasis and "popping" of grafts from sites after they are placed. Hemostasis is achieved via dermal infiltration of 1:100,000 epinephrine 5 to 10 minutes before placing the grafts. The "popping" of grafts is unpredictable from patient to patient. "Popping" of grafts is overcome by placing light pressure over a paced graft and holding it for 10 to 20 seconds with a moist, saline-soaked, cotton-tip applicator before placing the next graft.

Once all the grafts are placed, a dressing is placed overnight. The dressing helps protect the grafts from any unintended trauma as they heal overnight. All patients are given a mild pain medication, which the majority of patients take the afternoon of surgery. The next day, the dressing is removed, and patients may shower but are told not to pick or rub off the perifollicular crusting that occurs around some grafts and lasts for 6 to 8 days. Patients may resume regular activities immediately, light exercise 3 to 4 days postoperatively and full exercise 7 days after surgery once the donor sutures are removed. The transplanted hair does not begin to grow for 3 to 6 months after the surgery and does not achieve its full cosmetic impact for 9 to 12 months (Fig. 31-7A,B and Fig. 31-8A,B).

HAIR TRANSPLANTATION FOR MEN OF AFRICAN ANCESTRY

The hair transplant process is essentially a *peg-in-a-hole* surgery. Straight hairs are nursed into small recipient site holes. Of all global racial ethnic groups, only the tightly coiled hair of individuals of African ancestry make the peg-in-a-hole metaphor difficult to implement. There are some differences in hair transplantation that are unique to the coarse. First, the overall hair density is substantially less than other ethnic groups (1.3 hairs/mm^2 for Africans, 1.6 hairs/mm^2 for Asians, and 2.1 hairs/mm^2 for Caucasians), so that the overall supply of the donor hairs is less for Afrocentric hair. Second, the grouping of hair follicles in the follicular unit is higher in Afrocentric hair. For instance, there are more three hair follicular units in individuals of African ancestry than in other racial ethnic groups. The higher number of hairs per follicular unit and the lower density means that the number of follicular units per square mm is substantially more disproportional than with other racial groups. The implications of this are such that Africans or African Americans do not have enough hair to produce adequate cover for extensive balding, but as the hair "wants" to mat together, the value of each hair is higher than the straight hair of, for example, Asians. Thirdly, the Afrocentric hair shaft curls in the fatty dermis, and once the follicular unit is severed from its fibrous attachment, the curly nature of the follicles tends to dominate its shape outside the body. These follicular units have a wide splay in their natural home in the deep dermis, and the splay becomes even wider when they are

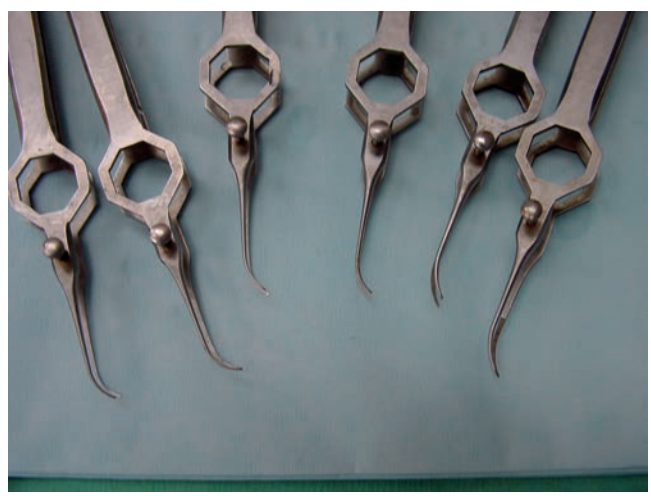

Figure 31-6 Microvascular forceps for planting grafts.

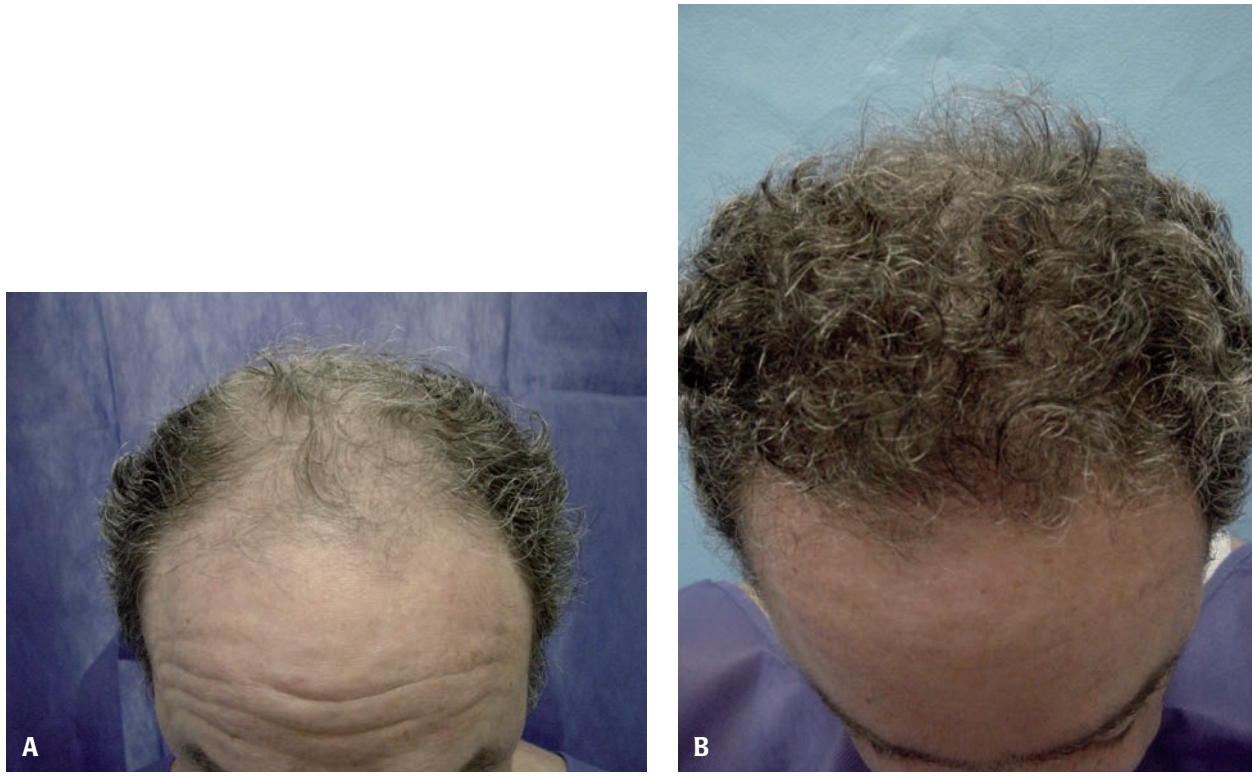

Figure 31-7 Before hair transplant **(A)** and after 1,000 1–4 hair grafts **(B)**.

out of the body. Making the hair graft behave according to the above peg-in-a-hole metaphor requires a very experienced technician who must know how to coerce the graft into the hole in the recipient site. It is not uncommon that recipient sites may have to be slightly larger to accommodate the larger bulk of the coarse hair and its corkscrew shape outside of the body. Less dense packing is also advisable for Afrocentric hair because the supply and the numbers of available grafts are more limited. Still, in experienced hands, follicular unit transplants can be performed to the exact same quality as those that better fit the peg-in-a-hole metaphor. Despite inherent difficulties in the transplantation process of Afrocentric hair, excellent results can indeed be achieved. So if there is a problem with African hair, it is not in the quality arena [13,14] (Fig. 31-9). Keloids and hypertrophic scars can indeed occur at the donor site, requiring treatment with intralesional and or topical steroids (see Chapter 34).

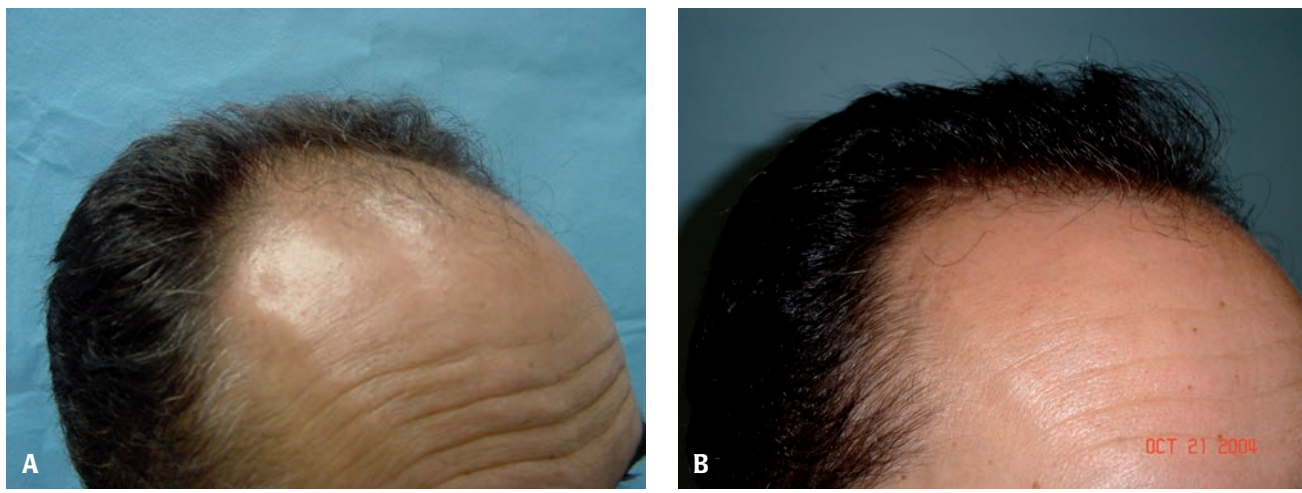

Figure 31-8 Before hair transplant **(A)** and after 1,450 1–3 hair grafts **(B)**.

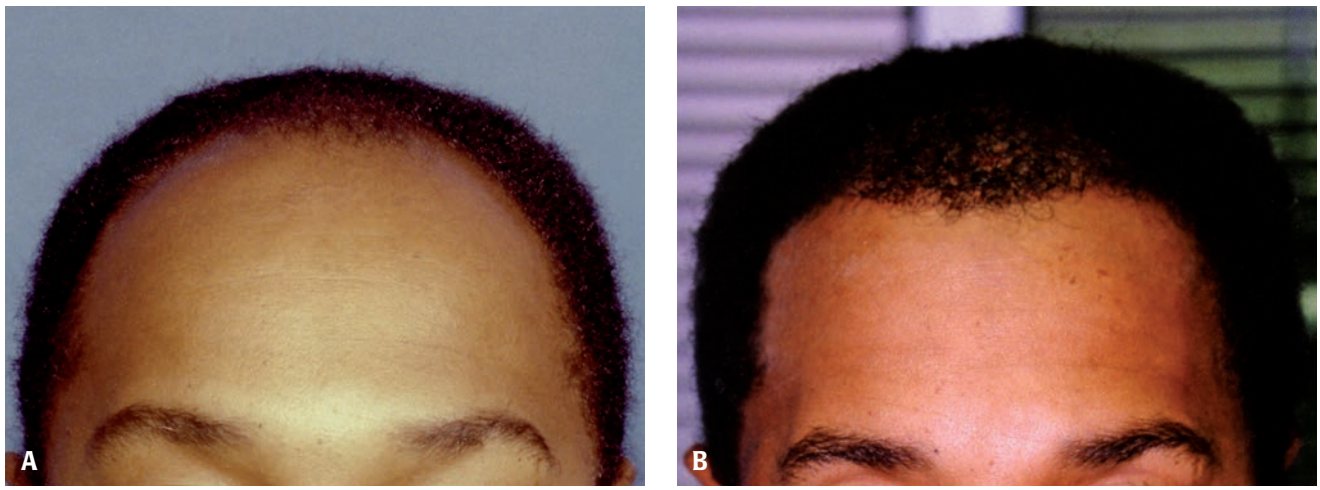

Figure 31-9 Before hair transplant **(A)** and after hair transplant in African American patient **(B)**. (Courtesy of William Rassman, MD.)

THE FUTURE

The public image of hair transplantation remains the "corn row" and plug. Hundreds of thousands of patients have benefited from the revolutionary changes in technique and are in the position of voluntarily—not involuntarily—informing friends or the public of their surgery. The next leap will be cloning hair follicles. In the early 21st century, the claims on Web sites regarding cloning hair are far more optimistic than the actual scientific progress. The amount of research in the area should allow hair to be cloned in the next several years. Future refinements with lasers and robotics will also allow an even more efficient procedure for patients and physicians.

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32

Laser Hair Removal in Darker Racial Ethnic Groups

Teresa Soriano, David Beynet, and Dafnis C. Carranza

Laser-assisted hair removal (LHR) is a commonly performed cosmetic procedure today. Initially, LHR was reserved for patients with lighter skin types (Fitzpatrick I–III) because of the increased incidence of adverse effects in patients with darker skin. Over the last decade, with the advent of lasers with longer wavelengths, longer pulse durations, and improved cooling mechanisms, LHR can be safely performed in all skin types, including Fitzpatrick types IV to VI. It has the ability to significantly reduce the number of hairs and their rate of growth while maintaining a low incidence of side effects.[1–3]

LHR is of special importance in ethnic skin types for several reasons. Darker-skinned patients often have darker, coarser, and thus more noticeable hair than lighter-skinned patients. This may lead to increased cosmetic concern of unwanted hair in darker-skinned patients. In addition, certain diseases that are more prevalent in patients of color—such as hirsutism, pseudofolliculitis barbae, and acne keloidalis—can be improved with laser therapy.[4]

LASER CHOICES

The mechanism of LHR is based on the theory of selective photothermolysis. In selective photothermolysis, heat is released by a target chromophore, which has absorbed photons from the laser. This heat destroys neighboring structures, causing permanent damage.[5] In LHR, the target chromophore is melanin, which is primarily found in the hair bulb and hair shaft. After photon absorption, heat is released by the hair shaft and hair bulb, causing permanent thermal destruction of the surrounding follicular structures.

The higher concentration of melanin in the epidermis of darker skin types presents a challenge in LHR treatment of this population compared with lighter skin types. There are two unwanted outcomes. The first is that less photons ultimately reach their intended site, the follicular structures, which results in decreased efficacy. The second is that there is increased heating of the epidermis.[6] This can lead to side effects, such as hyperpigmentation, hypopigmentation, blistering, and scarring.

The melanin absorption spectrum ranges from approximately 300 to 1,200 nm, with absorption decreasing as wavelength increases. Follicular structures are located to a depth of 2 to 4 mm within the dermis. The ideal laser thus should have a wavelength that can provide adequate photon absorption by melanin, as well as penetration into the dermis. Wavelengths between 600 and 1100 nm are capable of this.[7]

In addition to wavelength, pulse duration is an important consideration in LHR. Relatively long pulse durations are necessary. Long pulse duration results in slow heating of the follicular unit and greater diffusion of heat from the hair shaft and bulb during the pulse. This allows for destruction of the entire follicular unit, not only the pigmented components.[8]

There has been a marked increase in the number of lasers for LHR since the first lasers were approved in 1996.[9] LHR has primarily been done with the following light sources: the ruby laser (694 nm), the alexandrite laser (755 nm), the diode laser (810 nm), the neodymium:yttruium-aluminum-garnet laser (Nd:YAG) (1,064 nm), intense pulsed light (IPL), and IPL with radiofrequency (IPL/RF) (Table 32-1). The ruby laser is the most selective for melanin absorption but has short penetration depth and a higher incidence of side effects. The Nd:YAG laser has the deepest penetration but the least specificity for absorption by melanin.[8] This may result in decreased efficacy; however, it lends itself to fewer adverse effects. The alexandrite and the diode lasers have benefits of both of these extremes. IPL works by using noncoherent light with wavelengths ranging from 515 to 1,200 nm. By using different cutoff filters, treatment parameters can be adjusted to allow safer treatment for patients with different skin types. In addition, devices combining radiofrequency with an intense pulsed light have been used for LHR. It has been proposed that lower fluences can achieve hair reduction in these devices, thus making IPL/RF a safe alternative of LHR for darker-skinned patients.[10]

Table 32-1
Lasers and light sources for hair removal

Ruby laser (694 nm)
Alexandrite laser (755 nm)
Diode laser (810 nm)
Neodymium:yttrium-aluminum-garnet laser (Nd:YAG) (1,064 nm)
Intense pulsed light (IPL)
IPL with radiofrequency (IPL/RF)

Table 32-2
Optimal lasers for darker racial ethnic groups

Types	Features
Diode laser (810 nm)	Longer wavelength, Longer pulse duration, Optimal cooling FDA approved for darker skin types
Neodymium:yttrium-aluminum-garnet laser (Nd:YAG) (1,064 nm)	

In ethnic skin, the safest lasers are those with longer wavelengths, longer pulse durations, and optimal cooling devices. The longer wavelength diode and Nd:YAG are the preferred devices to safely perform LHR in ethnic skin. (Table 32-2) (Figs. 32-1 and 32-2).[3,11] The increased wavelength allows for decreased epidermal melanin absorption and increased penetration depth. The long pulse duration causes slower heating and results in a lower incidence of dyspigmentation. Between the two laser systems, the longer-wavelength 1,064-nm Nd:YAG laser is generally safer, particularly for very dark skin types, however, the diode laser may be more effective because of greater melanin absorption.[9] A mean hair reduction ranging from 58% to 62% on facial sites and 66% to 69% on nonfacial sites has been reported after three treatments with the long-pulsed Nd:YAG compared with 74% to 84% hair reduction with the diode laser 6 months after the final laser treatment.[8] Both long-pulsed Nd:YAG and diode devices are FDA approved for LHR in darker skin types.

Efficient cooling devices provide added benefit for LHR, especially in ethnic skin. Cooling devices function to cool the epidermis and prevent laser-induced thermal damage. Epidermal thermal damage can result in dyspigmentation, scarring, and blistering, especially in darker skin types. Cooling devices also have the added benefit of

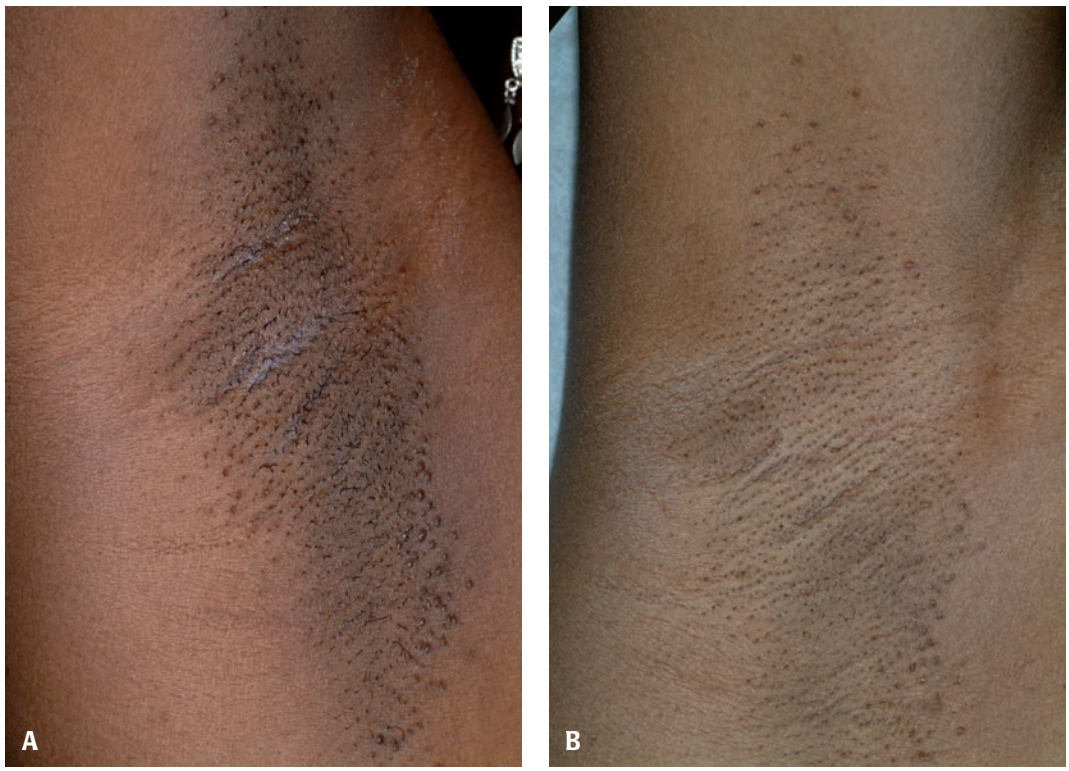

Figure 32-1 Axillary hair, skin type V: baseline **(A)**, after five long-pulsed 1064 nm Nd:YAG treatments **(B)**. (Courtesy of Pearl E. Grimes, MD.)

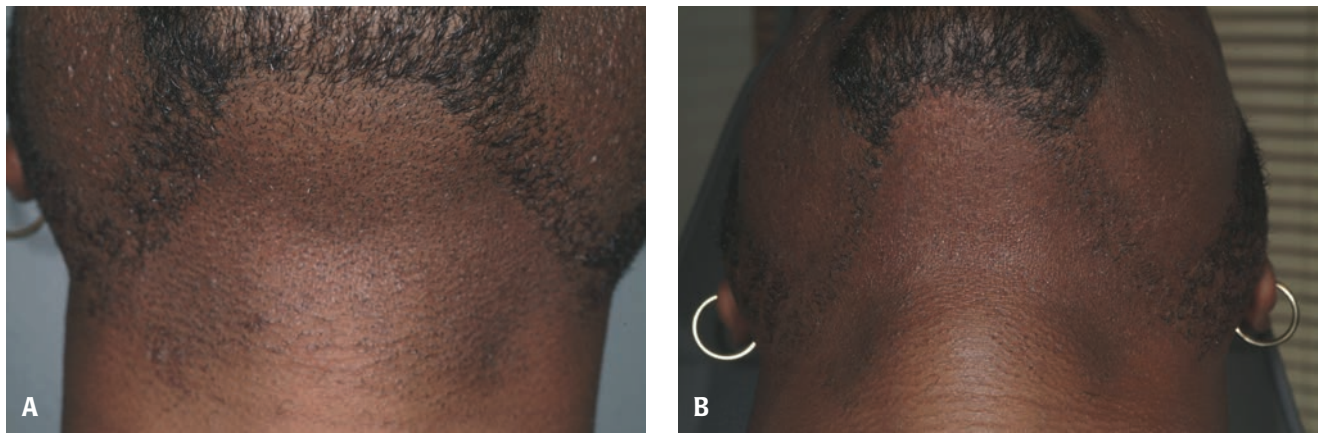

Figure 32-2 Unwanted facial hair, skin type V: baseline **(A)**, after four long-pulsed 1064 nm Nd:YAG treatments **(B)**. (Courtesy of Pearl E. Grimes, MD.)

decreasing pain associated with the procedure. Current cooling devices use both evaporative and conductive mechanisms. These tend to provide more efficient epidermal cooling than older techniques of using ice or water-based gel. Dynamic cooling devices function by using a cryogen spray immediately before the laser pulse, which evaporates and instantaneously cools the epidermis.[12] Conductive cooling devices include cooled sapphire laser windows, which cool the epidermis by conductive heat transfer. Conductive devices also lead to dermal compression, which has two benefits: It brings follicular structures closer to the area of maximal dermal laser penetration, and it compresses blood vessels, thereby decreasing the concentration of the hemoglobin.[6]

PRACTICAL ASPECTS

The ideal patient for laser-assisted hair removal is one with dark hair and light skin. Gray or light hair absorbs insufficient energy to cause permanent follicular destruction with current hair-removal systems. Darker skin carries a higher risk of epidermal melanin absorption, which can potentially lead to adverse side effects. Performing test spots, initiating treatments at lower fluences, and accepting the likelihood that the patient may require an increased number of treatments compared with lighter-skinned patients are all especially important for LHR in ethnic skin.

Patients should be instructed to avoid suntanning, self-tanning products, plucking, and waxing for at least 2 weeks before treatments. Plucking and waxing removes the hair shaft, leaving the laser energy without a target, thus potentially making treatment less effective. Regular shaving or trimming of hair before and in between laser treatments is acceptable. The use of 2% to 4% hydroquinone cream for 2 to 4 weeks before treatment may reduce the incidence of posttreatment hyperpigmention.[2]

Test spots should be done in a representative area that closely resembles the treated area. For example, the posterior auricular or submental area is commonly used as a test spot for LHR of the upper lip. Patients should be seen approximately 2 weeks after the test spot and evaluated for side effects. If no pigmentary change is noted, a full treatment can be done at that visit.

Some level of discomfort is expected during the procedure. A topical anesthetic, such as eutectic mixture of local anesthetics (EMLA, lidocaine 2.5% and prilocaine 2.5%) or topical lidocaine (LMX, 4% or 5%) can help decrease pain. A recent study showed no statistical significance between EMLA and LMX (5%) for pain control in laser hair removal.[13] EMLA has been associated with rare cases of methemoglobinemia in selected patient populations.[14] The amount of topical anesthesia applied should be limited to the recommended quantities, as toxicity may result from increased systemic absorption. The use of compounded high-dosage topical lidocaine preparations over large body surface areas can also have serious and life-threatening toxicities. In addition to preoperative topical anesthesia, the use of ice packs or air-cooling devices peri- and postoperatively can provide some additional pain relief.

Before laser treatments, the hair should be shaved or clipped to skin level. All makeup should be removed. Everyone in the room should wear proper eye protection. Fluence and pulse duration is determined based on test-spot parameters. With lasers that use contact cooling, care should be taken to ensure that the handpiece is in direct contact with the skin. This allows for maximum benefit of the cooling tips. In addition, burned debris that may accumulate on the tips of some devices should be cleaned to avoid suboptimal contact cooling. When treating the upper lip, some have advocated covering the teeth with a gauze pad to protect the enamel.[15]

Perifollicular erythema and edema lasting several hours after treatment typically occurs immediately after

treatment.[6] Icing the area immediately after the treatment may reduce this erythema and discomfort. A topical steroid can be applied for prolonged irritation, erythema, and edema. Careful sun avoidance and the regular use of a broad-spectrum sunscreen are recommended during laser treatments.

COMPLICATIONS AND CONTRAINDICATIONS

The most common complications of laser hair removal include hyperpigmentation, hypopigmentation, blistering, and scarring (Table 32-3). Thermal damage after unwanted partial epidermal absorption of laser energy accounts for these adverse reactions. Darker ethnic skin and tanned skin are at higher risk for adverse events because of the increased epidermal melanin that acts as a competitive chromophore for melanin in the hair follicle. Some perifollicular erythema and edema for several hours are expected responses immediately after LHR treatments. However, if more severe epidermal injury occurs, long-lasting side effects may result. Blistering, scabbing, and persistent erythema may lead to hypopigmentation, hyperpigmentation, and scarring. Studies have demonstrated that the longer wavelength lasers with appropriate cooling devices are safer for darker skin types.[16] In a study from the United Kingdom of 109 patients with skin types IV to VI, the highest incidence of side effects was seen in patients with darker skin treated with the long-pulsed ruby laser. The overall incidence of blistering and dyspigmentation was 9.4% with the Nd:YAG laser and 29.9% with the ruby laser.[16] Hyperpigmentation often resolves with time and can be treated with bleaching agents and topical retinoids. Hypopigmentation is often also transient, but may be permanent because of thermally induced destruction of melanocytes (Figs. 32-3 and 32-4).

A phenomenon termed *hair induction* has been reported in which patients develop terminal hairs in areas not present before laser and IPL treatment.[17] It has been seen most commonly after laser hair removal of the face and neck of women of Mediterranean ancestry with darker skin types.[18] This may suggest a greater tendency of hair-follicle transformation from vellus to terminal hair in this population. In a retrospective Greek study, hair induction occurred after at least three treatments and on an average of 7 months after the first treatment. Most of the increased hair growth developed at the edges of the treated areas. Some have advocated that continuation of laser treatment in these cases results in decreased hair growth.[18] Stopping treatments, re-evaluating to rule out an underlying endocrine abnormality, and resuming laser treatment to small test areas to evaluate response is recommended. If hair reduction is noted after multiple laser treatments to the test areas, then one may proceed cautiously to treat the entire face and neck.

Table 32-3
Complications of laser hair removal

Blistering
Scabbing/crusting
Persistent erythema
Hyperpigmentation
Hypopigmentation
Scarring

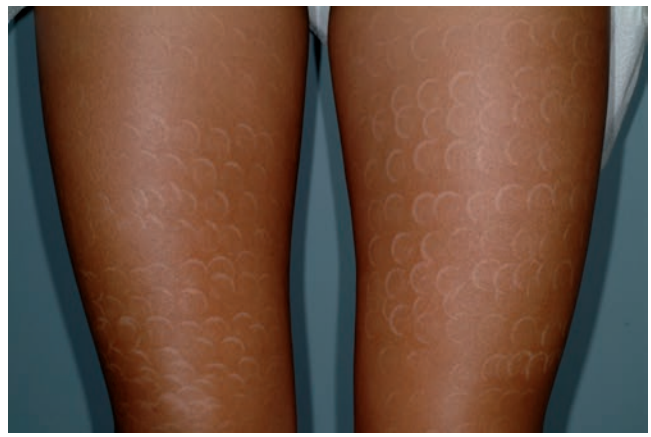

Figure 32-3 Long-term hypopigmentation following laser hair removal treatment of the lower extremities with alexandrite laser. (Courtesy of Pearl E. Grimes, MD.)

Acneform reactions have been reported to occur after laser hair removal.[19] The exact mechanism for the formation of acneform lesions is unknown. A possible explanation may be related to secondary follicular inflammation and blockage to the sebaceous gland following disruption of the pilosebaceous unit. The perioperative use of soothing creams and topical steroids may also be a contributing factor in certain cases. In a prospective multicenter study in the United Kingdom, 26 out of 411 patients (6%) developed acneform reactions following LHR.[19] The reactions tend to be mild, with a mean duration of 9.6 days. History of polycystic ovarian disease and number of prior treatments did not seem to affect the incidence of acneform reactions. It occurred most frequently on the face in young women with skin type V undergoing long pulsed Nd:YAG laser treatment.

There are few contraindications for laser hair removal. Photosensitizing medication is considered a relative contraindication. LHR is generally contraindicated for approximately 6 months after oral isotretinoin therapy because of the potential for delayed wound healing and increased risk of scarring associated with oral retinoids. Although there

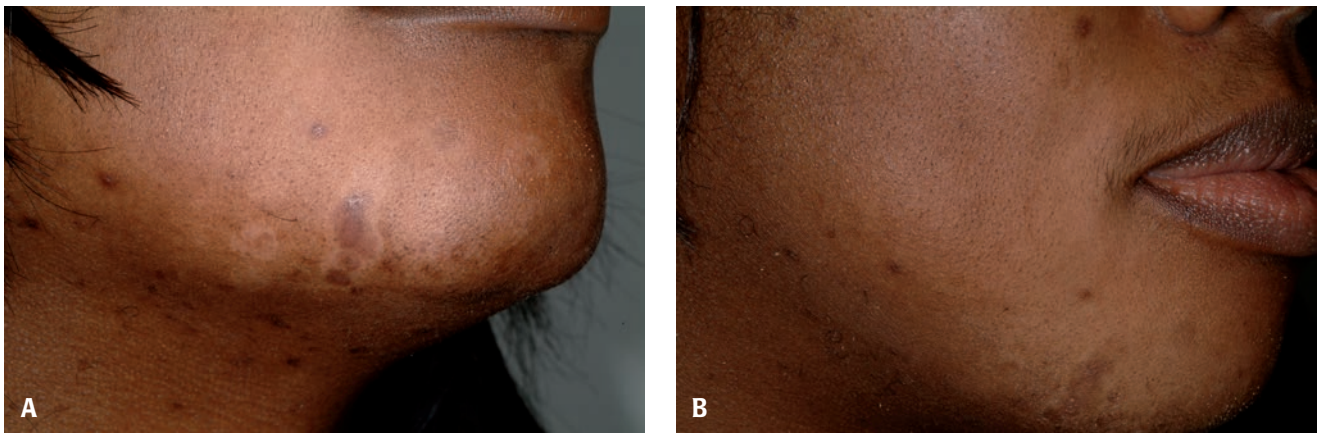

Figure 32-4 Transient hypopigmentation following blistering after laser hair removal of the perioral area with long-pulsed Nd:YAG treatments **(A)**, with clearing after 2 weeks, without treatment **(B)**. (Courtesy of Pearl E. Grimes, MD.)

are no large clinical studies demonstrating an increased incidence of laser hair removal associated adverse effects on individuals who are on or have recently been on isotretinoin, there have been isolated reports of bullae and keloid formation after LHR in patients on isotretinoin.[20,21] Individuals with a history of keloids or hypertrophic scars should also be treated cautiously. Lastly, patients with a history of herpetic infections, especially if they erupt in or around the treatment area, should have prophylactic treatment with an antiviral agent.[1]

SPECIFIC CLINICAL APPLICATIONS

Pseudofolliculitis barbae

Pseudofolliculitis barbae (PFB) is a chronic inflammatory disease caused by tightly curled hairs that re-enter the skin approximately 1 to 2 mm from the respective follicular orifices. It is most common in the beard and neck area of men but may occur in other shaved areas. Papules and pustules develop at the site of re-entry and may lead to hyperpigmentation and keloidal scarring. Although PFB may be seen in patients of any ethnic background, it is more common in patients of African descent, with the prevalence approaching 80% in certain populations.[4] Allowing the hair to grow out typically improves the condition, however, individuals often find this socially or cosmetically unacceptable. LHR has become an effective treatment option for PFB. With removal of the hair, improvement of the lesions and subsequent postinflammatory dyspigmentation can be achieved (Fig. 32-5).

LHR, particularly using the long-pulsed diode and YAG lasers, can safely and effectively improve pseudofolliculitis barbae.[22,23] In a side-by-side study using a long-pulsed Nd:YAG laser on 37 patients (skin types IV–VI) with PFB, Ross et al.[22] reported a decreased mean papule count on the treated side compared with the untreated side (1 versus 6.95) at 90 days posttreatment. Similarly, another study of 20 patients with skin types V to VI had significant reduction of lesions and hair growth 3 months after two treatments with a long-pulsed Nd:YAG laser.[24] Side effects included transient dyspigmentation, itching, and erythema. A study using the 810-nm diode laser demonstrated a greater than 50% improvement in signs of PFB after three treatments.[25] However, in very dark-skinned patients, blistering and crusting with subsequent dyspigmentation was observed. Epidermal damage in very dark-skinned patients can be decreased by reducing the total energies delivered.

Acne keloidalis nuchae

Acne keloidalis nuchae is a chronic inflammatory disease in which patients develop papules, pustules, and keloidal scarring in the posterior neck and scalp region, usually following a chronic folliculitis. It is commonly seen in men of African descent. Although its exact etiology is not characterized, shaved or short haircuts, pseudofolliculitis, low-grade bacterial infection, and chronic irritation from shirt collars have been proposed as possible contributing factors. Histologically, early lesions demonstrate a perifollicular infiltrate in the upper portion of the hair follicle, whereas older lesions display a granulomatous infiltrate around broken hair fragments and scarring.

Treatment of acne keloidalis nuchae can be challenging. Therapies have included topical and oral antibiotics, retinoids, intralesional steroid injections, and surgical and laser excision. LHR has been used as an adjunctive therapy with some anecdotal benefit for the papular and pustular lesion, however, it has no known effect on already-formed keloids. In two patients with recalcitrant papules, Shah[26] reported a 90% to 95% clearance after

Figure 32-5 Marked improvement of pseudofolliculitis barbae, skin type V at baseline **(A)** after seven long-pulsed 1,064 nm Nd:YAG treatments **(B)**. (Courtesy of Pearl E. Grimes, MD.)

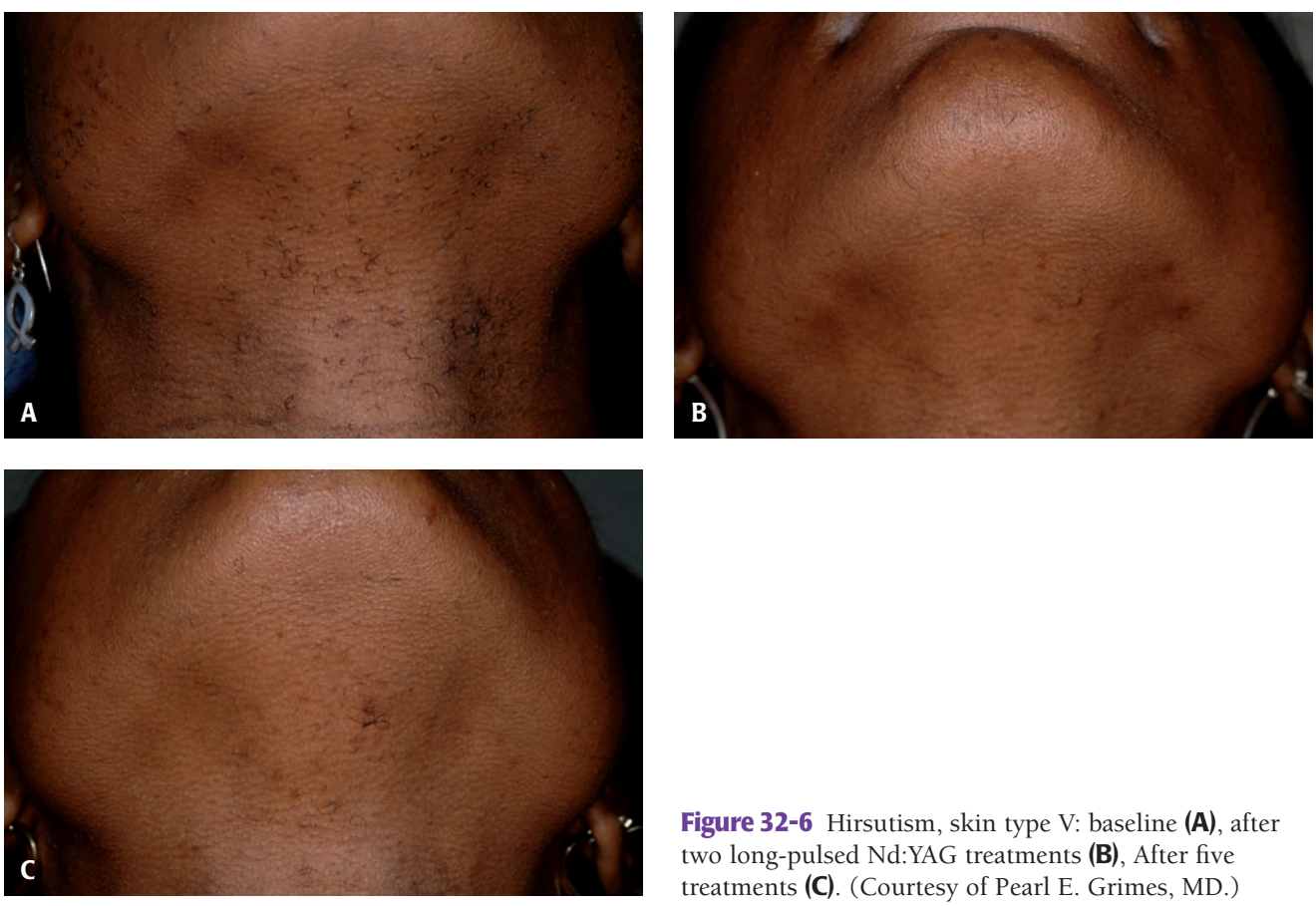

Figure 32-6 Hirsutism, skin type V: baseline **(A)**, after two long-pulsed Nd:YAG treatments **(B)**, After five treatments **(C)**. (Courtesy of Pearl E. Grimes, MD.)

four diode laser treatment sessions at 4- to 6-week intervals used in conjunction with a daily retinoid and topical steroid cream. The patients had regrowth of thinner hair and no recurrent papules or pigmentary changes at 6 month follow-up.

Hypertrichosis and hirsutism

Hypertrichosis is an increased amount of hair in a normal physiologic pattern. Hirsutism is defined as excessive male pattern hair growth in women. A wide range of etiologies, including repeated trauma, genodermatoses, endocrine diseases, and medications can lead to increased hair growth. Hirsutism is more common in certain ethnicities, such as women of Middle Eastern descent, and may be considered a normal variant. Regardless of the cause, hirsutism and hypertrichosis can result in significant psychological morbidity in women.[27] LHR is an effective and safe treatment option (Fig. 32-6). In a study by Levy et al.,[28] 29 women with hypertrichosis (skin types I–VI) were treated with a long-pulsed Nd:YAG laser. The average reduction in hair counts after three treatments at 1-month intervals was 46% at 9 months after treatment. No significant complications were observed. Unlike traditional treatments to remove hair, such as waxing, plucking, shaving, and depilatory creams, LHR can offer long-lasting hair removal.

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PART

9

Tumors

33

The Pathogenesis of Keloids

Heather Woolery–Lloyd

Darker racial ethnic groups have unique wound-healing characteristics to be considered when performing cosmetic procedures. The main concern with surgical procedures in patients with skin of color is the occurrence of keloids and hypertrophic scars. Keloids and hypertrophic scars are most common in darker racial ethnic groups and are most prevalent in African American, Hispanic, and Asian populations (Fig. 33-1 and Fig. 33-2). Statistics on the incidence of keloids in specific populations vary greatly; however, an incidence of 4.5% to 16% has been reported in black and Hispanic populations. Keloids are least common in Caucasians and albinos.[1]

Patients with keloids usually present in the second or third decade. There is an equal risk between women and men. Although most keloids occur sporadically, familial cases have been described. These cases appear to have an autosomal dominant pattern with incomplete penetrance and variable expression.[2]

Commonly affected sites for keloids include earlobes, shoulders, upper back, and chest. Postsurgically, they appear to be most common in areas of highest tension. Unlike hypertrophic scars, keloids rarely regress spontaneously. Once excised, they tend to recur. Common symptoms include pruritus and tenderness at the site of the keloid. These symptoms are most severe in new scars and tend to diminish with time.

Histopathology of keloidal tissue reveals a thickened dermis consisting of hypereosinophilic, hyalinized collagen (Fig. 33-3). Few adnexal structures or elastic fibers are observed. Hypertrophic scars are more cellular than keloids, and hyalinized collagen is less prominent (Fig. 33-4).[3]

The mechanism behind keloid formation has not yet been elucidated; however, abnormal fibroblast metabolism and enhanced response to growth factors have been suggested. Other theories include aberrant apoptosis and abnormal epidermal-dermal interaction during wound healing. In this chapter, the many proposed mechanisms behind keloid formation will be explored. (Table 33-1).

There has been much discussion on the relationship between keloids and hypertrophic scars. Older studies often grouped these two entities and studied them together. More recently, an effort has been made to study these scars separately as two distinct disease entities. Keloid pathogenesis will be the main focus of this chapter to maximize clarity of the discussion.

ALTERED GROWTH FACTORS/CYTOKINES

Transforming growth factor beta

Transforming growth factor beta (TGF-beta) has been closely implicated in scar formation. Its role in keloid biology has been extensively studied, and it has been found to be profibrotic in wound healing. There are three isoforms of TGF-beta: TGF-beta1, TGF-beta2, and TGF-beta3. Of the three isoforms, TGF-beta1 is most abundant in all tissues and in wound fluid. In vitro studies demonstrate that TGF-beta1 and TGF-beta2 are profibrotic isoforms and promote scar formation.[4] Interestingly, some studies suggest TGF-beta3 may have the opposite effect and may, in fact, reduce scar formation.[5] Other data suggests that the ratio between TGF-beta3 and TGF-beta1 most affects scar formation.[6]

During wound healing, TGF-beta is first released by degranulating platelets. Other major cells involved in

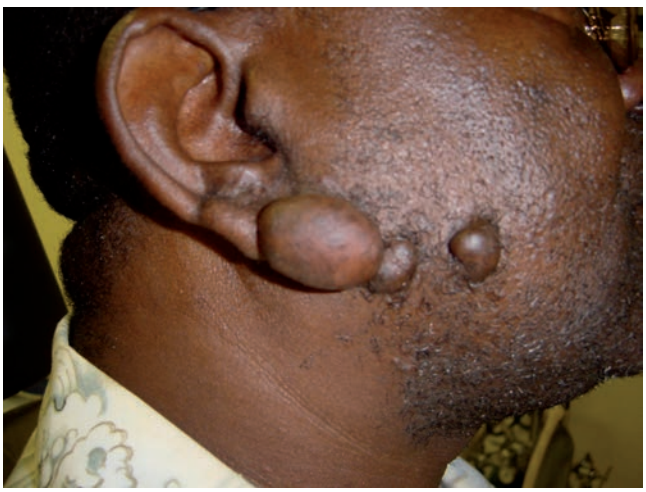

Figure 33-1 Keloidal lesion of the ear.

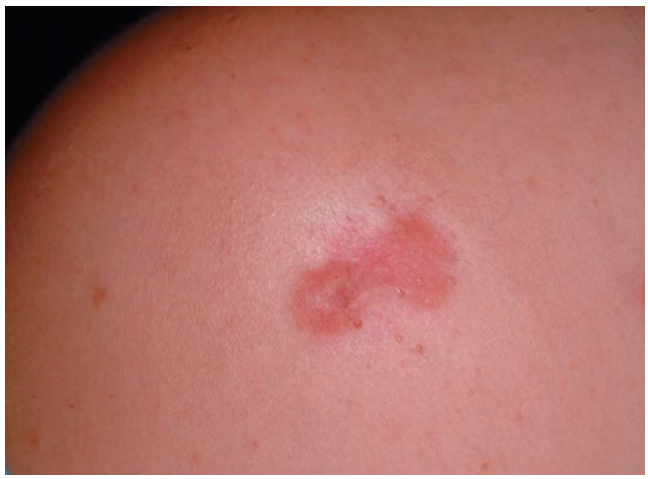

Figure 33-2 Hypertrophic scar of the back.

wound healing that secrete TGF-beta include lymphocytes, macrophages, endothelial cells, epithelial cells, and fibroblasts. Once released, TGF-beta is involved in chemotaxis, angiogenesis, and extracellular matrix formation. It also stimulates dermal fibroblast proliferation and migration.[4]

Because of its clearly profibrotic role in wound healing, TGF-beta has been extensively studied in keloid formation. In vitro studies have shown that TGF-beta1 stimulates synthesis of keloid-derived fibroblasts more than it stimulates normal fibroblasts. TGF-beta also increases collagen synthesis in keloid fibroblasts more than in normal fibroblasts. These results suggest that keloid fibroblasts may have increased sensitivity to the effects of TGF-beta compared with normal fibroblasts.[7]

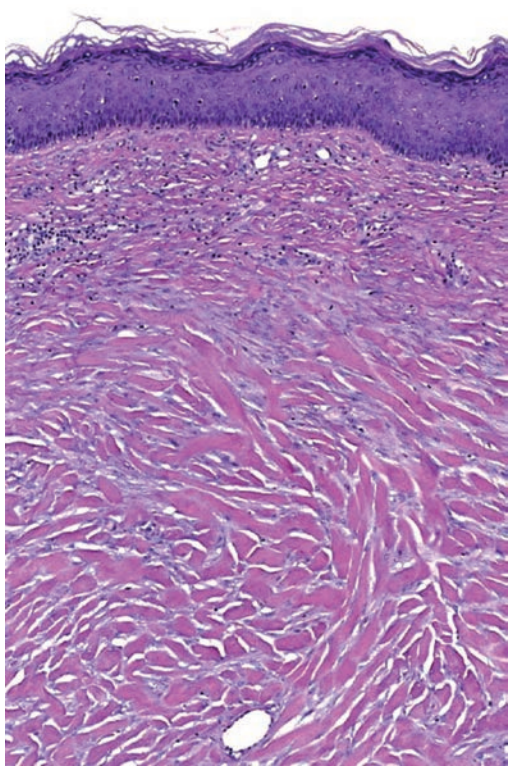

Figure 33-3 Hematoxylin, eosin stain of a keloid. Thickened dermis with hypereosinophilic and hyalinized collagen. (Courtesy of Pearl E. Grimes, MD and Jag Bhawan, MD)

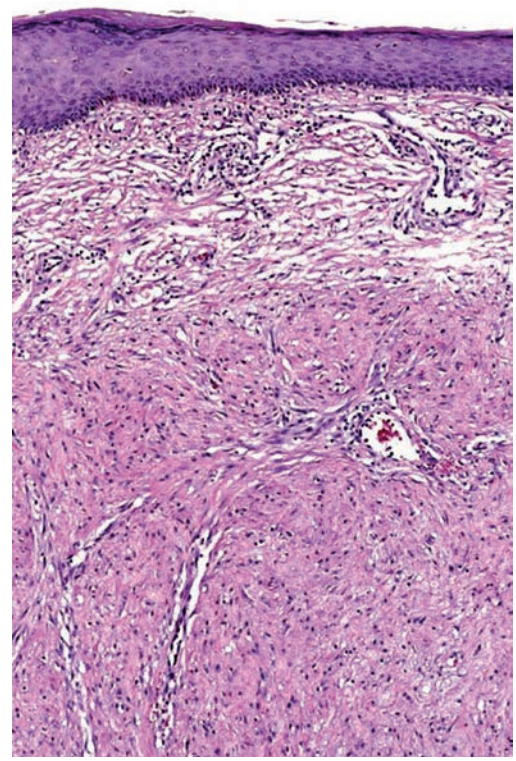

Figure 33-4 Hematoxylin, eosin stain of a hypertrophic scar. Note greater cellularity compared with keloid, and hyalinized collagen is less prominent. (Courtesy of Pearl E. Grimes, MD and Jag Bhawan, MD)

In addition to increased fibroblast and collagen synthesis, TGF-beta may also inhibit collagen degradation. Matrix metalloproteinases (MMPs) and plasminogen activator are the two main enzymes involved in breakdown of the extracellular matrix. Plasminogen activator is inhibited by plasminogen activator inhibitor 1 (PAI-1). MMP is inhibited by tissue inhibitor of metalloproteinase-1 (TIMP). TGF-beta up-regulates both PAI-1 and TIMP and, thus, may inhibit collagen degradation.[8,9]

Most studies clearly demonstrate the profibrotic role that TGF-beta plays in wound healing. Accordingly, multiple studies have examined the effect of anti-TGF antibodies on wound healing. Not unexpectedly, inhibition of TGF-beta with anti-TGF-beta antibodies in animal studies reduces scar formation.[5,10]

One study specifically examined the temporal effect of TGF-beta1, 2, and 3 on wound healing. In this study, anti-TGF-beta1, 2, and 3 were applied to rabbit ear wounds at different periods in wound healing. Anti-TGF-beta actually delayed wound healing when applied early to the wounds. Additionally, anti-TGF-beta applied early did not improve

the scar compared with untreated controls. This implies that TGF-beta is important and necessary for optimal wound healing in the first week after injury. However, anti-TGF-beta applied 1 week or more after injury resulted in reduced scar hypertrophy. Thus, early in wound healing, TGF-beta is necessary for optimal healing. However, after 1 week, the presence of TGF-beta may contribute to hypertrophic scar formation.[11]

TGF-beta clearly appears to be involved in abnormal scar formation; however, it does not appear to be the sole causative agent in keloids and hypertrophic scars. In fact, plasma levels of TGF-beta are no different in patients with keloids and controls. Additionally, common polymorphisms of the TGF-beta 1 gene are not associated with a risk of keloid disease.[12] Although it appears that TGF-beta is important in understanding keloid biology, it does not appear to be the sole factor in keloid pathogenesis.

Platelet-derived growth factor

Platelet-derived growth factor (PDGF) is another profibrotic growth factor that has been implicated in keloid pathogenesis. In wound healing, PDGF acts both as a chemoattractant and as a mitogen for fibroblasts. Interestingly, in fetal (nonscarring) wounds, this growth factor disappears quickly. In scarring wounds there is prolonged expression of PDGF.[13] Keloid fibroblasts also appear to be more responsive to PDGF's profibrotic effects than normal fibroblasts. The enhanced PDGF response of keloid fibroblasts may be influenced by increased levels of PDGF alpha receptors on keloid fibroblasts.[14]

Connective tissue–derived growth factor

Connective tissue–derived growth factor (CTGF) is another tissue growth factor that has been implicated in

Table 33-1

Research and theories in keloid biology

Area of research	Role and significance in keloid biology	
TGF-beta	Profibrotic	• Increases collagen production • Inhibits collagen degradation • Causes hypertrophic scars in animal studies
PDGF	Profibrotic	• Enhanced PDGF response in keloid fibroblasts
CTGF	Profibrotic	• Up-regulated in hypertrophic scars
IL-6	Profibrotic	• Enhanced expression in keloid fibroblasts • Increased production seen in peripheral blood mononuclear cells of keloid patients
IFN	Antifibrotic	• Suppresses collagen synthesis • Used with varied success as a keloid therapy
Apoptosis	Altered	• Multiple studies demonstrate increased and decreased apoptosis • Clearly altered in keloids
TNF	Antifibrotic	• Keloid fibroblasts less sensitive to the inhibitory effects of TNF on collagen synthesis
Epidermal-dermal interaction	Significant	• Keratinocyte paracrine function appears to regulate fibroblasts
Sebum	Profibrotic	• Sebum induces an immune reaction in susceptible patients resulting in keloids
Hypoxia	Profibrotic	• Tissue hypoxia stimulates excessive collagen production
Tension	Profibrotic	• Stress tension on fibroblasts induces excessive collagen production

CTGF, connective tissue–derived growth factor; IFN, interferon; IL-6, interleukin-6; PDGF, platelet-derived growth factor; TGF-beta, transforming growth factor beta; TNF, tumor necrosis factor.

fibroproliferative disorders.[15] CTGF is important for skeletal development, angiogenesis, cell adhesion, and cell migration.[16] CTGF is also a downstream mediator of TGF-beta activity and is secreted by fibroblasts after activation by TGF-beta.[17] In one study, CTGF expression was up-regulated in hypertrophic scar fibroblasts at baseline and after TGF-beta stimulation. In this study, a trend toward increased CTGF expression was also seen in keloid fibroblasts; however, this increased expression did not reach statistical significance.[18] CTGF represents yet another growth factor, which may play a role in keloids and hypertrophic scars.

Interleukin-6

Cytokines such as interleukin-6, interferon-gamma, and interferon-alpha have all been implicated in fibrosis and keloids. Interleukin-6 (IL-6) is a profibrotic cytokine that stimulates monocyte chemotaxis.[19,20] Wounding stimulates IL-6 production. Elevated IL-6 persists in adult wounds but disappears in the fetus.[19] Interestingly, addition of IL-6 to fetal wounds results in early scarring.[19]

Enhanced expression of IL-6 has been demonstrated in keloid fibroblasts.[21] Increased IL-6 production has also been demonstrated in peripheral blood mononuclear cells of keloid patients.[22] In another study examining the effect of electron-beam radiation on keloids, researchers found the IL-6 pathway was primarily involved in the electron-beam irradiation response.[23] Thus, it appears that IL-6 may not only be important in keloid pathogenesis but may also play a crucial role in the mechanism behind certain keloid therapies.

Interferon

Interferons have been studied in keloids because of their antifibrotic activity. Interferons (IFN)-alpha, -beta, and -gamma suppress collagen synthesis.[24] Interestingly, decreased IFN-alpha and IFN-gamma production has been demonstrated in peripheral blood mononuclear cells of keloid patients.[22]

Intralesional IFN-gamma and IFN-alpha2b have both been evaluated as keloid therapies. A few studies have demonstrated decreased size of keloids after IFN-gamma injections.[25,26] Other studies have shown that monotherapy of keloids with intralesional IFN-alpha2b is not effective.[27–29] Intralesional IFN-alpha2b postexcision has been found to have minimal to no efficacy.[30,31] Although in vitro studies of interferon suggest that it may be a novel treatment for keloids, clinically, interferon does not appear to be a highly efficacious treatment alternative. (See Chapter 34)

Apoptosis

Increased apoptosis

There are varied reports on the role of apoptosis in keloids. Caspase plays an important role in apoptosis and has been studied in keloids. The caspase family is a group of proapoptotic proteases, which cleave proteins at aspartic acid residues. The sequential activation of one caspase by another leads to a mounting cascade of proteolytic activity and eventual cell death. One study examined the expression of activated caspase-9 and caspase-3 in keloid fibroblasts. Immunohistochemistry showed that fibroblasts positive for activated caspase-9 or caspase-3 was greater in keloid tissues than in normal scar tissues.[32] Another study examined caspase-3 staining in surgically resected normal scars and in hypertrophic or keloid scars. This study found that caspase-3 staining was significantly higher in the hypertrophic scar/keloid group. The authors suggested that there is increased cell death and reduced cell survival in hypertrophic scars and keloids.[33]

Decreased apoptosis

In contrast, other studies suggest that keloids and keloid fibroblasts may have lower rates of apoptosis than normal fibroblasts. Researchers have demonstrated resistance of keloid-derived fibroblasts to both ceramide-induced apoptosis and Fas-mediated apoptosis.[34,35] Keloid fibroblasts also appear to exhibit decreased expression of apoptosis-related genes compared with normal scars.[36]

p53 is a tumor suppressor gene. Expression of p53 results in either cell cycle arrest or apoptosis.[37] Focal mutations in p53 have been demonstrated in patients with keloids. These mutations may result in increased cell proliferation and decreased cell death in patients with keloids.[38]

The role of apoptosis in common keloid treatments has also been examined. Following stimulation by hydrocortisone, gamma-interferon, and hypoxia, keloid fibroblasts display enhanced apoptosis compared with normal fibroblasts.[39] This data suggests that apoptosis may, in fact, be decreased in keloids, and treatment with intralesional steroids or interferon may enhance or normalize apoptosis. This could be one mechanism to explain the improvement of keloids that is observed clinically with these treatments.

Tumor necrosis factor and apoptosis

The tumor necrosis factor (TNF) superfamily includes both the TNF ligand and the TNF receptor family. TNF can activate both cell-survival and cell-death mechanisms. This complex group of transmembrane proteins is an important regulator of homeostasis. Keloid fibroblasts are less responsive to the inhibitory effects of TNF-alpha on collagen synthesis.[40] Additionally, compared with normal fibroblasts, keloid fibroblasts showed decreased expression of apoptosis-associated genes when exposed to TNF-alpha.[41] TNF may represent yet another cytokine important in understanding keloid biology.

It appears that apoptosis does play a role in keloid pathogenesis, however, the research on apoptosis in keloids is varied. One can conclude that there is aberrant apoptosis in keloids. This role of apoptosis in keloids needs to be further elucidated.

EPIDERMAL-DERMAL INTERACTION

Recent research suggests that dermal scarring may be regulated by factors produced by the epidermis. Paracrine activity of the epidermis may play an important role in keloid formation. Specifically, the role of keratinocytes in keloid formation has been examined.

A unique two-chamber coculture technique has been used to observe the effect of keratinocytes on fibroblasts.[42,43] A pivotal study revealed that keloid-derived keratinocytes cocultured with normal dermal fibroblasts resulted in increased proliferation of those normal fibroblasts.[43] This increased proliferation was significantly greater than the proliferation seen in normal fibroblasts cocultured with normal keratinocyte. Additionally, when keloid keratinocytes were cocultured with keloid fibroblasts, an even greater proliferation rate of these fibroblasts was observed.

Using the same technique, normal keratinocytes were cocultured with keloid fibroblasts. When normal keratinocytes were cocultured with keloid fibroblasts, the keloid fibroblasts behaved more biologically normal than when cocultured with keloid keratinocytes.[43]

Interestingly, the keloid keratinocyte/normal fibroblast group demonstrated a higher proliferation rate than the normal keratinocyte/keloid fibroblast group. This observation suggests that the paracrine activity of the keratinocyte may have a greater influence on fibroblast proliferation than the keloid fibroblast alone.[43]

The investigators then looked at the effect of keloid keratinocytes on collagen production and used scanning electron microscopy to evaluate the collagen morphology. Keloid keratinocytes cocultured with normal fibroblasts caused increased production of insoluble collagen I and III.[44] Additionally, keloid keratinocytes caused the normal fibroblasts to secrete collagen in a pattern similar to keloid tissue.[44]

Thus, it appears that the keratinocyte may play a greater role in keloid pathogenesis than previously believed. Further studies of the epidermal-dermal interaction in keloids may be the key to a greater understanding of keloid biology and pathogenesis.

SEBUM AUTOIMMUNE HYPOTHESIS

One hypothesis to explain the pathogenesis of keloids is the sebum hypothesis. This theory asserts that keloids are due to an immune reaction to sebum exposure after an injury in the skin. There are a few clinical characteristics of keloids that help to support this theory.[45]

First, keloids are seen most frequently after puberty when sebaceous glands are most active. The incidence of keloids diminishes in the later decades of life as sebum production declines. Additionally, after puberty, keloids can frequently be "activated" from older wounds incurred during childhood. This phenomenon is sometimes seen in earlobe keloids and keloids at vaccination sites.

Humans are the only known animals to develop true keloids and are also the only animals with sebaceous glands. Volar skin lacks sebaceous glands, and, interestingly, keloids are rarely described on the palms and soles.

Keloids are quite common on the chest and back and often have a clearly seborrheic distribution. In fact, one of the most severe manifestations of keloids is the spontaneous keloidal plaque seen in young adults on the sternum, chest, and upper back. In these extreme keloid cases, patients often cannot identify a specific injury to the skin other than acne. Frequently, in these cases, open comedones can be observed within the keloids.

One study examined the immune reaction to sebum in 22 volunteers. In this controlled study, 11 keloid formers and 11 nonkeloid formers were injected intradermally with 0.1 cc of sterile liquid paraffin and vernix caseosa from neonates. In this study, there was a greater reaction in the keloid formers, but this difference was not statistically significant. Based on these findings, the authors concluded that sebum may not be an important factor in keloid pathogensis.[46]

The role of sebum in keloids is interesting, but further studies are necessary to establish if there is, in fact, a true relationship.

HYPOXIA HYPOTHESIS

In wound healing, the formation of granulation tissue is associated with significant microvascular regeneration. Transmission electron microscopy of keloids demonstrates that most microvessels of keloids and hypertrophic scars are occluded because of excessive endothelial cells.[47] Some investigators have suggested that this microvascular occlusion leads to hypoxia in keloid tissue.[48] Measurable tissue hypoxia has been demonstrated in keloid and hypertrophic scars compared with normal skin.[49] The hypoxia theory asserts that hypoxia may stimulate excessive collagen production, resulting in the keloid nodules seen clinically.

TENSION HYPOTHESIS

The tension hypothesis asserts that keloids are caused and exacerbated by tension in wounds. This theory is supported by the clinical observation that keloids and keloid recurrence are most common in areas of highest tension on the body. One large study examined recurrence rates after excision and radiation. The highest recurrence rates were on the chest wall, scapular, and suprapubic regions.[50] The lowest recurrence rates were in the areas of lowest tension, such as the neck, earlobes, and lower limbs.[50]

In vitro studies have also examined the effects of tension on healing. In a novel fibroblast-populated collagen lattice isometric tension model, investigators found that

mechanical strain up-regulates matrix remodeling genes and down-regulates apoptosis.[51] In another study, application of biaxial strain on fibroblasts cultured on flexible silicone demonstrated that the type of strain caused different patterns of gene regulation. These results suggest mechanical stimuli may lead to a fibroblast phenotype characterized by induced connective tissue synthesis and inhibition of matrix degradation.[52]

SUMMARY

In summary, the theories behind keloid formation are varied and diverse. To date, most recent research has concentrated on TGF-beta, apoptosis, and epidermal-dermal interaction. Despite all of the research on keloids, a true understanding of keloid biology remains a mystery. Further research is necessary to elucidate keloid pathogenesis as this may provide a target for treatment of this disfiguring dermatological condition.

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34

Medical and Surgical Therapies for Keloids

A. Paul Kelly

Keloids are medically benign but often psychologically malignant proliferative growths of dermal collagen that usually result from an excessive response to skin trauma in predisposed individuals.[1,2] There are, however, spontaneous keloids that develop without a history of trauma. Keloids grow beyond the boundaries of the original wound by invading clinically normal skin. This is in contradiction to hypertrophic scars, which remain within those boundaries and usually regress spontaneously in 1 to 2 years. After several years of growth, keloids usually remain stable; however, some will gradually enlarge, with almost complete central clearing over the lifetime of the patient (Fig. 34-1).

The etiopathogenesis of keloids is unknown (see Chapter 33). However, blacks form keloids more often than whites, and albinos do not develop keloids. Also, the author has treated two patients who developed vitiligo, and some of the vitiliginous lesions were overlying a keloid. The keloids in the vitiliginous areas resolved, whereas the keloids covered by the patient's normal-colored skin did not improve. Enlargement can be predicted if any part of the keloid has an erythematous border (Fig 34-2). Unfortunately, there are no animal models to study these growths.

There is no single therapeutic modality that is best for all keloids. The recurrence rate for surgical excision is greater than 50% when used as a monotherapy. Thus, medical, physical, or radiologic adjuncts are needed. Location, size, depth, age of patient, past response to treatment, and a family history of keloids determine the type of therapy prescribed.

INTRALESIONAL STEROIDS

Intralesional steroids are usually the treatment of choice. Intralesional cortisone improves keloids by inhibiting alpha 2-macroglobulin, which inhibits collagenase in keloids. An increase in collagenase then increases collagen degradation.[1,3,4] Triamcinolone (10–40 mg/mL) is injected every 2 to 3 weeks with a 27- to 30-gauge needle on a small bore Luer-Lock syringe. Larger needles, when injected into hard keloids, often become clogged with keloid tissue. The papillary dermis is the target because that is where collagenase is produced. If there is no regression of the keloid after four injections or if the keloid no longer responds to further injections, surgery is recommended.

In addition, intralesional steroids are commonly used as an adjunct treatment in patients undergoing excision of lesions. Triamcinolone acetonide 40 mg/cc is injected into the postoperative sites every 2 to 3 weeks for a total of four injections, starting 1 week after the sutures are removed (Fig. 34-3A,B). If the site of keloid removal starts to enlarge later on, intralesional triamcinolone is restarted. Patients should be forewarned that the injection sites may become hypopigmented and stay that way for 3 to 6 months. A mixture of equal parts of 40 mg/cc of triamcinolone acetonide and 2% Xylocaine can be used to anesthetize the operative site. The steroid slows wound healing, so sutures should remain in for 10 to 20 days, especially on the earlobes.

INTRALESIONAL INTERFERON

Intralesional interferon has been reported to be effective in improving the appearance of keloids.[5–7] Berman and Flores[5] reported an 18.7% recurrence rate when injecting 1 million units of interferon alpha-2b per linear centimeter in the postoperative site immediately after surgery and 1 to 2 weeks later. The recurrence rate with excision alone was 51%. If the excision site is long, the patient should be premedicated with acetaminophen to help prevent the flu-like symptoms caused by the interferon. Another limiting factor with interferon is its high cost. Interferon alpha and gamma inhibit type I and III collagen synthesis. Other potential mechanisms of action include reduced production of transforming growth factor beta and increased levels of collagenase activity.[6]

IMIQUIMOD THERAPY

Imiquimod is a topical therapeutic agent that acts as an immune-response modulator by inducing interferon-α, tumor necrosis factor-α, and interleukin-1, -6, and -8.

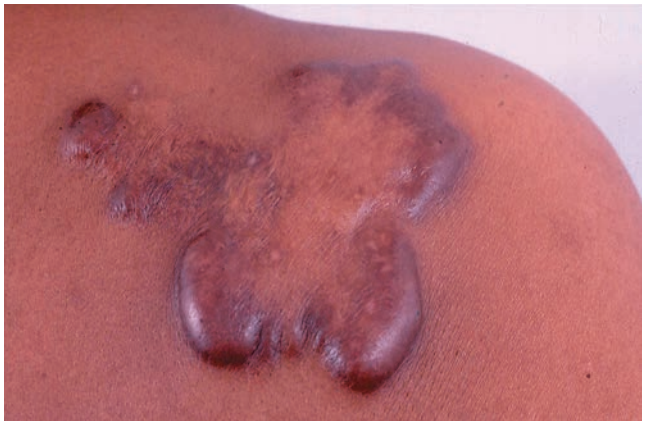

Figure 34-1 Central clearing of Keloid.

Berman and Kaufman[8] evaluated the effects of postoperative imiquimod 5% on the recurrence of excised keloids. Imiquimod cream was applied to the postoperative site daily for 8 weeks, starting immediately after surgery. Those who experienced marked irritation had to discontinue the medication for 3 to 7 days and then resume therapy. Patients with large excisions, wounds under tension, or wounds closed with flaps or grafts are advised not to use imiquimod for 4 to 6 weeks after excision because the postoperative site may splay or dehisce. Approximately half of the patients treated with imiquimod developed hyperpigmentation. Berman and Kaufman[8] also demonstrated that postoperative imiquimod cream reduced recurrence of keloids. The expression of genes associated with apoptosis is significantly altered in keloidal tissue treated with imiquimod.

5-FLUOROURACIL THERAPY

Intralesional 5-fluorouracil (5-FU) can also be used for treatment of hypertrophic scars and keloids. 5-FU is an antimetabolite that blocks DNA synthesis by blocking thymidylate synthetase. It decreases collagen synthesis in proliferating fibroblasts. It can be used alone or in conjunction with triamcinolone.[9] Better results are achieved when used in combination with triamcinolone. The standard dosage is 5-FU 50 mg/mL, 0.9 mL, and 0.1 mL of triamcinolone acetonide 10 mg/mL. Lesions are injected 1 to 3 times a week for 10 to 12 weeks.

OTHER THERAPIES

The use of pentoxifylline (Trental) 400 mg three times a day has been suggested as a useful antifibrotic agent but had limited success in preventing recurrence of excised keloids.[10] A recent publication provides a rationale for postoperative use of tacrolimus in the prevention of postexcision keloid recurrence.[11] It was demonstrated that *gli*-1 protein is highly expressed in keloidal tissues but not in scar or normal-skin fibroblast. During the course of a clinical trial, it was noted that a patient on topical tacrolimus noted clearing of a keloid after treatment, and *gli*-1 has been shown to be a target of tacrolimus.

An old and somewhat abandoned adjuvant therapy to prevent postexcision recurrence is the use of methotrexate, 15 to 20 mg every 4 days, starting 1 week before surgery and continuing for 3 to 4 months. Postoperative use of colchicine is another old and somewhat successful therapy.

ADJUNCT MEDICAL THERAPIES

Pressure garments, starting 1 week after suture removal, combined with a topical class-1 steroid helps prevent recurrence (Fig. 34-4). Silicone gel sheeting, flurandrenolide tape, or Curad Scar Therapy cosmetic pad used postoperatively, starting 1 week after suture removal, will also help prevent recurrence.

EXCISIONAL SURGERY

Surgical methods differ according to the size and location of lesions. Excisional surgery as a monotherapy is usually not recommended because the likelihood of recurrence is greater than 50%. The best results are achieved when excision is combined with other modalities.[1] The first rule of keloid excision is withholding elective cosmetic surgery from known keloid formers (those with only earlobe lesions should not be considered keloid formers). All surgical wounds should be closed with as little tension as possible, incisions should not cross joint spaces, midchest incisions should be avoided, and excisions should follow

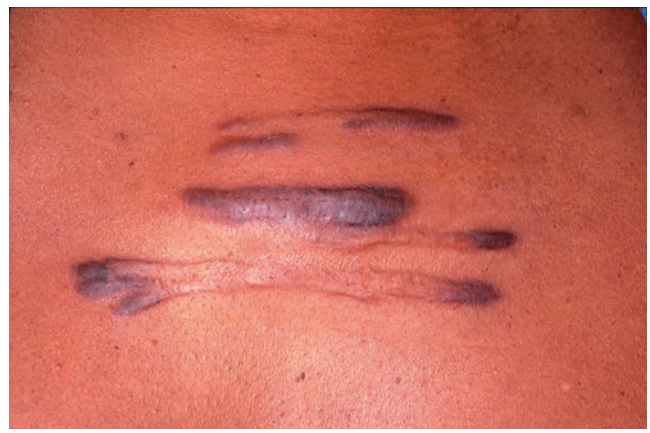

Figure 34-2 Keloid with erythematous border.

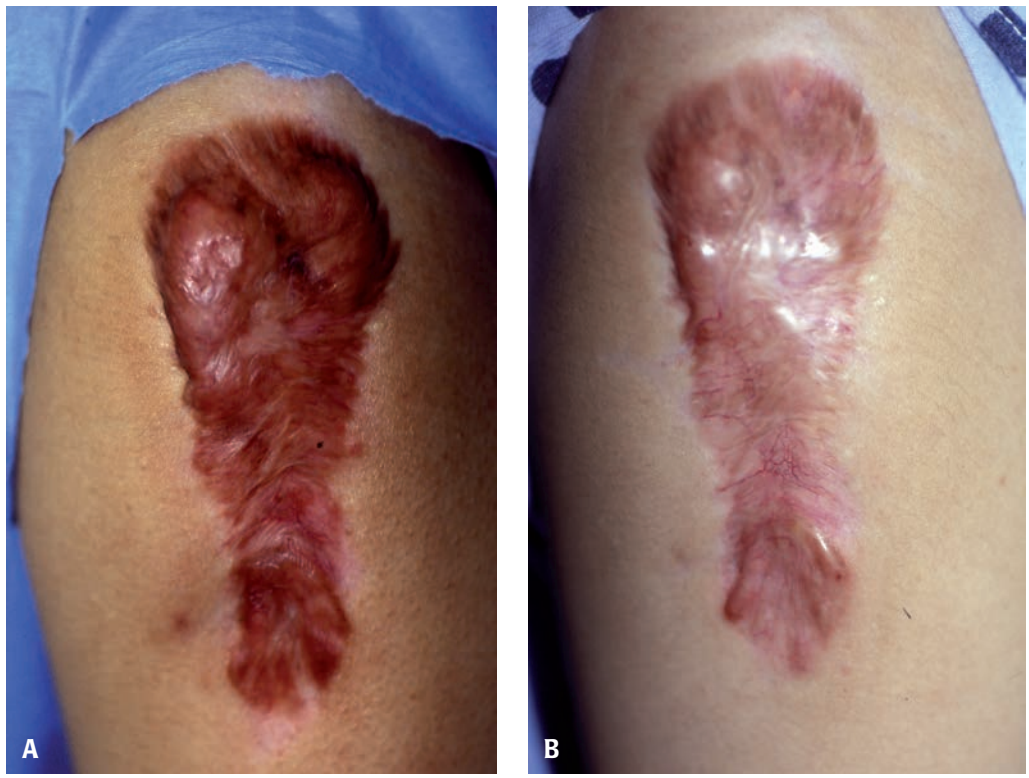

Figure 34-3 **A:** Keloid, left shoulder. **B:** Same keloid 8 weeks after triamcinolone (40 mg/mL) injection every 2 weeks and topical clobetasol cream daily.

Figure 34-4 Pressure garment for face, trunk, and arms.

the skin creases. During the history section of the examination, the patient should be asked if he/she has a family history of keloids, or if the keloid developed secondary to a chemical or thermal burn or surgical procedure. Also, ascertain if the operative site is infected. If any of these answers is yes, the patients will have a greater risk of keloid recurrence.

The patient should be informed that the risk for postexcision recurrence is approximately 50% if surgery is used as a monotherapy. For keloids with narrow bases (less than 1–2 cm), a simple elliptical excision followed by undermining the base and closing with interrupted sutures will suffice.

For posterior pedunculated earlobe keloids, shaving followed by pressure hemostasis is a simple and efficient method. Once the postoperative site heals, daily use of a pressure earring with a silicone backing helps prevent keloid recurrence.

For large nonpedunculated earlobe keloids and keloids with wide bases on other parts of the body, removal is more complex. First, a tonguelike incision approximately one fifth the size of the lesion is made from one border onto the part of the keloid with the smoothest and flattest-looking surface. The remaining part of the keloid is then excised, and the tongue of keloid tissue is used like a flap to close the postoperative site (Figs. 34-5, 34-6, and 34-7). In some cases, when the skin of the keloid is not smooth, a tissue expander

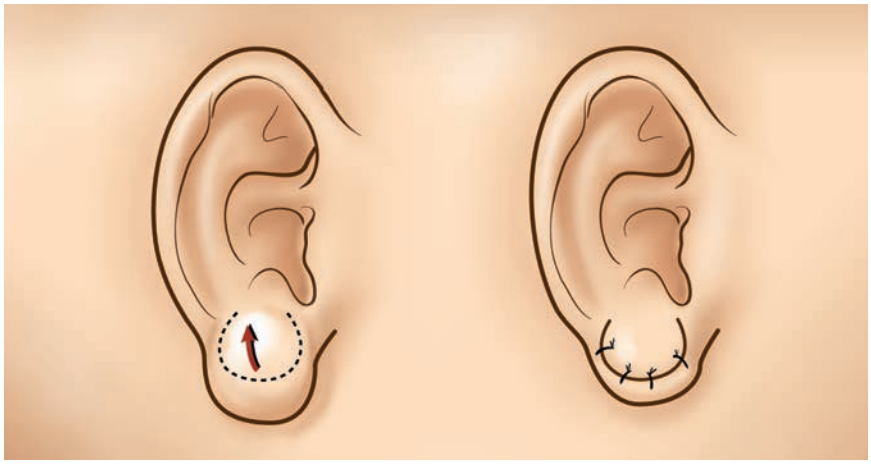

Figure 34-5 Drawing to illustrate keloid surgery using some of the overlying skin as an autograph.

may be inserted so the keloid can be excised and closed primarily several months later.

CRYOSURGERY

Cryosurgery can be used alone or in conjunction with intralesional steroids. When used alone, two 15- to 20-second freeze-thaw cycles are used at each visit every 3 weeks. Freezing more than 20 seconds may produce hypopigmentation, which lasts longer than a year; freezing less than 20 seconds may cause hyperpigmentation, which may last 6 to 12 weeks. Freezing can also cause mild edema of the tissue, enabling easier intralesional triamcinolone injections.

In a double-blind study, Layton et al.[12] compared the efficacy of intralesional triamcinolone and cryosurgery in the treatment of acne keloids. Data demonstrated an 85% improvement in flattening when treated early and in particular vascular lesions. Treatment with intralesional

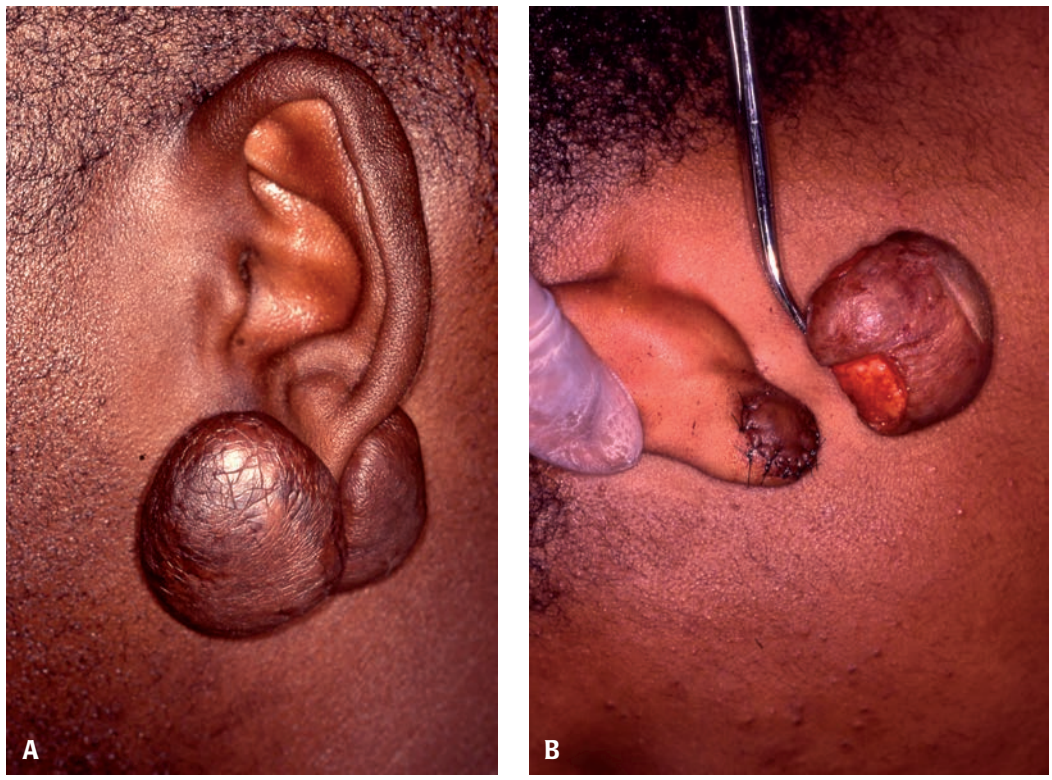

Figure 34-6 **A:** Keloids of right anterior and posterior lobe. **B:** Posterior keloid removed 4 weeks after anterior lobe keloid removal.

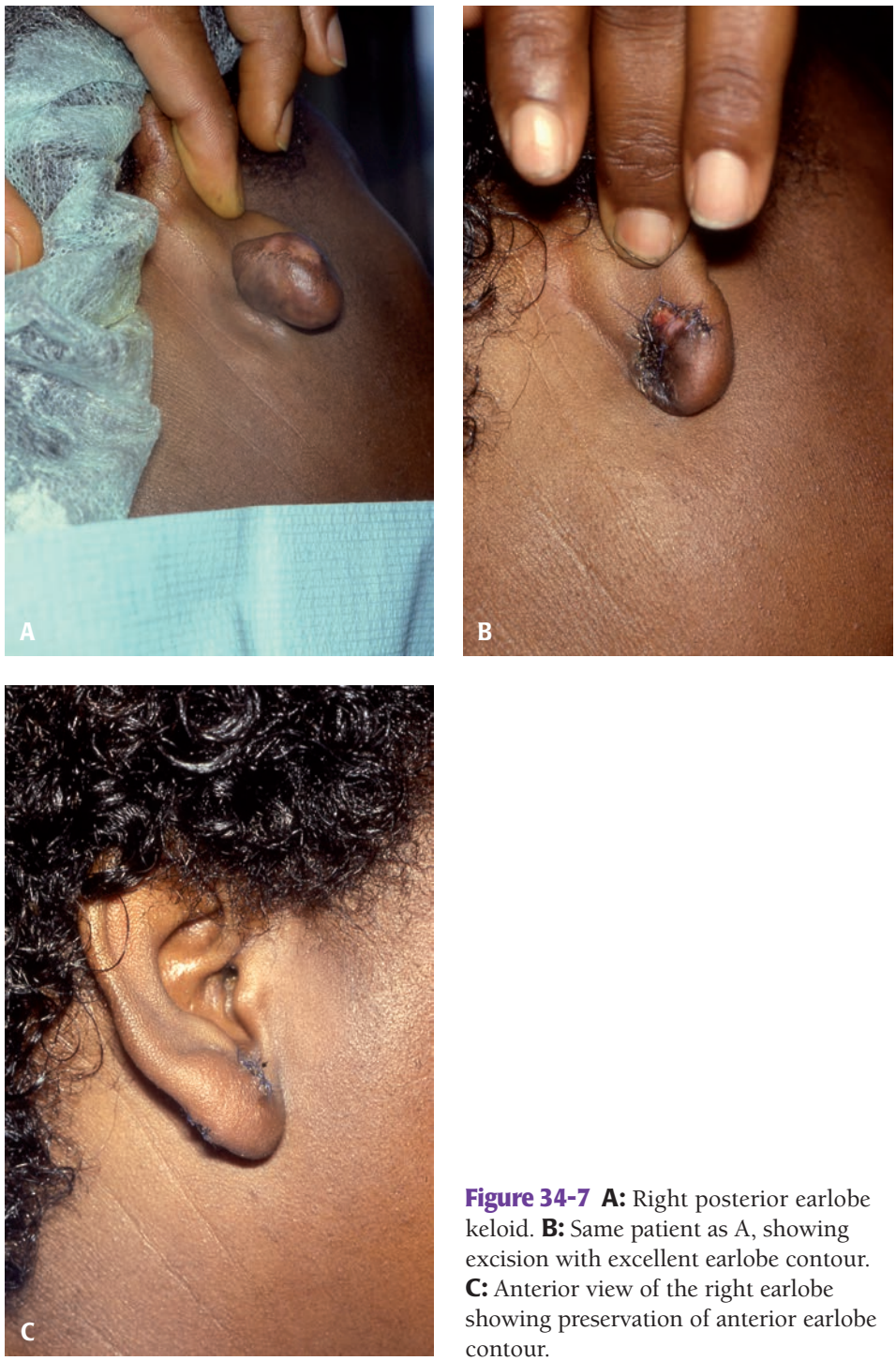

Figure 34-7 **A:** Right posterior earlobe keloid. **B:** Same patient as A, showing excision with excellent earlobe contour. **C:** Anterior view of the right earlobe showing preservation of anterior earlobe contour.

triamcinolone was also beneficial, but the response to cryosurgery was significantly better in early vascular lesions.[12]

LASER SURGERY

There seems to be a laser for each dermatosis, but the jury is still out on laser success for keloid therapy. Laser treatment of keloidal scars includes argon, CO_2, Nd:YAG laser, and 585-nm flashlamp-pumped pulsed-dye laser.[13,14] Favorable preliminary findings were reported using argon lasers. However, subsequent studies failed to confirm these results.[15] The carbon dioxide laser can be used to soften and flatten large lesions, but when used as monotherapy, the recurrence rate is often more than 70%.[16,17] Sherman and Rosenfield[14] reported improvement in 16 out of 17 patients treated with Nd:YAG 1,064-nm laser. The study, however, was lacking

Table 34-1
Therapeutic alternatives

Surgical	Medical-injectable	Medical	Physical	Medical-topical
Excision with 1-degree closure	IL steroids	Imiquimod	Pressure earrings	Steroids
Excision with second-intention healing	IL bleomycin	Verapamil	Pressure garments	Flurandrenolide tape
Excision with grafting	IL 5-FU	Colchicine	UVA-1	Silicone gel
Cryosurgery	Interferon alfa-2b	D-penicillamine		Curad scar therapy
Laser surgery		Tacrolimus		

5-FU, 5-fluorouracil; IL, interleukin; UVA, ultraviolet A.

in outcome definitions and adequate follow-up. The 585-nm flashlamp-pumped pulsed-dye laser has had some success in treating sternotomy scars.[18] Therapy was more successful if intralesional triamcinolone was used in conjunction with a pulsed-dye laser every 3 weeks.

A comparison study evaluated the clinical response of keloidal and hypertrophic scars after treatment with intralesional corticosteroid alone or combined with 5-FU, 5-FU alone, and the 585-nm flashlamp-pumped pulsed-dye laser. Significant clinical improvement was noted in all treated segments; however, no significant difference in treatment outcome versus method of treatment was observed.[19]

A recent study assessed the efficacy of a combination treatment of triamcinolone, 5-FU, and pulsed-dye laser for treatment of keloids and hypertrophic scars in a 12-week study of 69 patients. Patients were randomly assigned to one of three arms: triamcinolone alone; triamcinolone and 5-FU; or the triple-combination therapy. Overall efficacy was best in the triamcinolone + 5-FU group and the triple-combination groups. However, the triple combination of triamcinolone, 5-FU, and pulsed-dye laser was more acceptable to patients.[20]

RADIATION

Radiation therapy as a monotherapeutic modality for keloid removal is not very effective unless large doses of radiation are used; however, large doses may result in squamous cell carcinoma at the treated sites 15 or more years later (Fig. 34-7). Radiation is more successful when given within the first 2 weeks after excision, when the fibroblasts are proliferating. The usual doses are 300 rads (3Gy) five times a day or 500 rads (5Gy) three times every other day, starting immediately after surgery. Postoperative interstitial radiotherapy with iridium 192 has lowered the keloid recurrence rate by 20% to 30%[5]. Ragoowansi et al.[21] found that extralesional excision of keloid followed by early postoperative single fraction radiotherapy is both simple and effective in preventing recurrence of excision sites in high-risk keloids that have failed prior treatment.

CONCLUSION

Keloids are medically benign but often psychologically and socially malignant fibrous growths that result from an abnormal connective tissue response in predisposed individuals. They occur more often in blacks than whites, with the incidence in Asians and Hispanics falling between the two extremes. They may be pruritic and painful and occur most often on the earlobes, chest, upper back, and shoulders. They pose a tremendous challenge to the treating physician because of the high incidence of recurrence. The multiplicity of therapeutic modalities illustrates that there is not one that is universally efficacious (Table 34-1). Surgery as a monotherapy usually has a high recurrence rate; however, when used in conjunction with some medical, physical, or radiation therapy, the recurrence rate is lower. All patients undergoing keloid excision should be advised that postoperation compliance is the most important part of surgical therapy.

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35

Cosmetic Aspects of Common Benign Tumors

Doris M. Hexsel and Mariana Soirefmann

Benign tumors are frequent in all skin types. The diagnosis of benign skin tumors may need careful dermatologic exam; patient history and familial history; physical exam, including gross visualization; dermoscopy; and biopsy to confirm it is truly benign and to rule out malignancies.

Benign tumors are mainly located on the face, interfering with the appearance not only by fact of the lesions themselves but also because some are numerous.

All benign skin tumors may affect darker racial ethnic groups, but some are more frequent. This chapter will discuss the diagnosis and treatment of the most frequently benign skin tumors, including dermatosis papulosa nigra, dermatofibromas, acrochordons (skin tags), syringomas, trichoepitheliomas, and sebaceous hyperplasia.

DERMATOSIS PAPULOSA NIGRA

General features

Dermatosis papulosa nigra (DPN) is a pigmented eruption of the face and neck caused by a nevoid development defect of the pilosebaceous follicles, with histology resembling seborrhoeic keratosis.[1,2] The condition occurs almost exclusively in darker racial ethnic groups and is more frequent in women than in men.[3,4]

DPN is probably genetically determined.[1] It begins to appear in adolescence or early adulthood and progresses with age.[3,5] Incidence in darker racial ethnic groups rises from about 5% in the first decade to more than 40% by the third decade.[1] It has been estimated that lesions of DPN occur in about 50% of dark-skinned patients.[3] Dunwell and Rose studied 1,000 Afro-Caribbean patients and found DPN a notable common diagnoses.[6] Babapour et al. reported a case of DPN in a 3-year-old dark-skinned boy.[7] Grimes et al. studied 82 dark-skinned patients and reported predominance in women of almost 2:1. Fifty-four percent of these patients reported that other members of their families were also affected.[8] Some authors believe DPN to be a variant of seborrheic keratosis, whereas others consider both lesions as variants of epidermal nevus with delayed onset. A few regard DPN as a variant of acrochordon.[3]

Individual lesions are black or dark brown, flattened or cupuliform papules 1 to 5 mm in diameter[1,3] and can be elevated from 1 to 3 mm above the skin.[4] Older lesions can become very long and pedunculated or filiform. Growth rate and size usually slow during the fifth or sixth decade.[4] They are more common on the face and neck, especially on the upper cheek area, although they may form on almost any area of the body. Any one individual can have hundreds, even thousands, of these lesions.[1,4] DPNs are benign epidermal tumors that do not spontaneously regress.[3] There have been no reports of malignant degeneration, and the lesions are not associated with any systemic diseases or syndromes.[3,4] They are usually free of pain and itching, although these can develop if the lesions become large and are irritated by friction from clothing. Although lesions may hang over the eyelids and obstruct vision, most patients are more concerned with the cosmetic effects of the lesions than with health effects.[4] The epidermis occasionally has a gently lobulated configuration, similar to that seen in a fibroepithelial polyp. The keratinocytes are basaloid, and horned pseudocysts may be present, resembling seborrheic keratosis.[3]

The clinical differential diagnosis of DPN is relatively small, as these lesions have a classic appearance. Lesions that might be considered in the differential diagnosis include multiple seborrheic keratoses or verrucae, fibroepithelial polyps, syringomas, and trichoepitheliomas. Multiple pigmented melanocytic nevi might rarely be mistaken for DPN.[3]

Treatment

DPNs can cause significant cosmetic and functional impairment when they occur in a frequent location, such as head and neck area. Multiple methods of treatment—including surgery, cryosurgery, curettage, and superficial chemical peeling—have been reported in the literature (Table 35-1).[3] However, it is important to inform the patient that any treatment is likely to cause more cosmetic disturbance than the lesions themselves.[5]

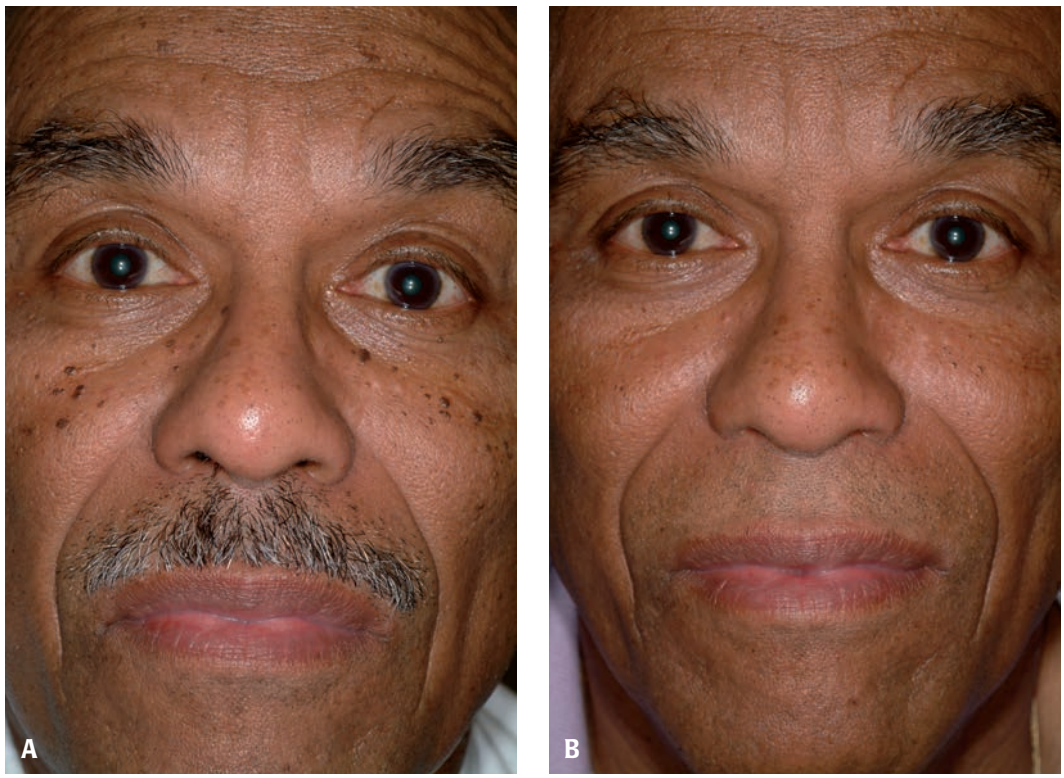

Figure 35-1 **A:** Dermatosis papulosa nigra: baseline. **B:** Dermatosis papulosa nigra after epilation of multiple lesions. (Courtesy of Pearl E. Grimes, MD.)

Treatment is usually surgical. Electrodesiccation and curettage is a common and accepted technique for removing DPN lesions[5] (Fig. 35-1A,B and Fig. 35-2A,B). Electrodesiccation is also routinely performed for destruction of benign skin lesions, including DPN.[9] Results are normally successful when the procedure is done by an experienced practitioner and follow-up care is given.[4] Kauh et al. reported success on the use of curettage with a small, sharp curette without anesthesia. There was little bleeding and no postoperative scarring or significant pigmentary change in several hundred patients, mostly African Americans, who were followed for 10 years.[10] Moreover, electrofulguration is ideal for very superficial benign lesions, such as DPN. This procedure carbonizes the surface of the lesion, protecting deeper tissue from additional fulguration, so healing is rapid and scarring rare.[11] Chemical peeling using alpha hydroxyl acids will soften and flatten these lesions and does seem to prevent some new lesions. Daily use of lactic acid or other alpha hydroxyl acid–containing lotion or creams is also useful.[3] Cryosurgery results in variable pigmentation and is not considered the treatment of choice for DPN.[3]

Complications

Some degree of hypopigmentation or hyperpigmentation can be expected from surgical procedures. Postinflammatory hyperpigmentation may occur in dark-skinned patients, and it is more frequent than hypopigmentation changes in such patients. Cryosurgery should be undertaken with caution because of the potential for hypopigmentation in black skin,[4] as the melanocytes are very sensitive to this surgical treatment modality. Electrodesiccation is successful, but may also result in hyperpigmentation.[3]

DERMATOFIBROMAS

General features

Dermatofibroma (DF) (also called *benign fibrous histiocytoma, sclerosing hemangioma,* or *histiocytoma cutis*) is a benign dermal and often superficial subcutaneous proliferation of oval cells resembling histiocytes and spindle-shaped cells resembling fibroblasts and myofibroblasts.[12] The etiology of DF is unknown, but recent cytogenetic studies demonstrating clonality favor these lesions being neoplastic.[12] The previous theory that DF is a dermal response to injury, such as an insect bite, trauma, or vaccination, has been challenged.[12] DF is the most frequent fibrohistiocytic skin tumor. Occurrence is more frequent in women than men, and it appears most often in middle age.[13] Child et al., in a study of prevalence of skin disease in a dark-skinned population in southeast London, showed that dermatofibroma is sufficiently common in this population. It was the ninth (2.7%) dermatological diagnostic

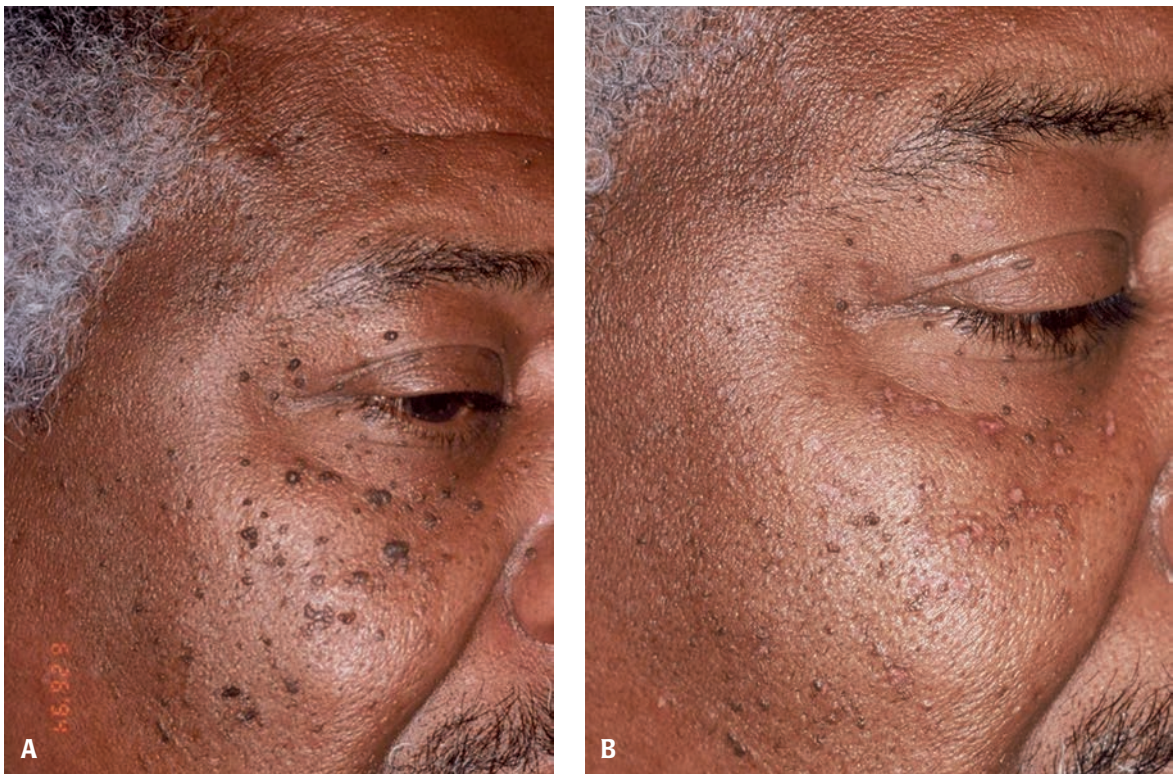

Figure 35-2 **A:** Dematosis papulosa nigra: baseline. **B:** Dermatosis papulosa nigra after epilation and iris scissor excision of multiple facial lesions. (Courtesy of Pearl E. Grimes, MD.)

most common in 274 consecutive dark-skinned patients.[14] Another more recent article that revised the more common cutaneous alterations of ethnic skin did not cite dermatofibroma as a frequent dermatosis in darker racial ethnic groups, neither in Asian or Hispanic racial groups.[15]

DFs usually appear in adults as a single or multiple firm pigmented papules or nodules that grow slowly and can develop anywhere in the body surface, with predilection for the lower limbs. Their size ranges from a few millimeters to 2 cm, and their color varies from light brown to dark brown, yellow-red, brown-red, or black. They are commonly asymptomatic and rarely can be associated with mild symptoms on palpation. Lateral compression frequently causes dimpling of the skin (Fitzpatrick's sign), although it is not pathognomic.[16] A number of clinicopathological variants of DF have been described. Cellular DFs are larger lesions, more commonly found in men and on the limbs, and represent less than 5% of all DFs. Aneurismal DFs are rapidly growing lesions that mimic a vascular tumor. Atypical DFs are more common in young men, with a predilection for lower limbs. Epithelioid DFs resembles a nonulcerated pyogenic granuloma and present on the lower limbs of young women.[12] Atrophic DF occurs more in women, on the upper trunk, and represent approximately 2% of all DFs.[17] Occasionally, DF is associated with immature follicular structures, which may be confused with basal cell carcinoma.[18]

Dermoscopy can assist in the recognition of DF, mainly to differentiate the DF diagnosis with the diagnosis of melanocytic diseases. There seem to be three standards of DF: (a) isolated pigment network, (b) peripheral pigment network with dark brown globules and dots or with scale crust in the central area, and (c) peripheral pigment network with a central white area.[16]

Treatment

DFs can be treated with surgical excision, cryosurgery, and intralesional injection of corticoid with variable results. All these therapeutic modalities are related with scars and dyschromias, which are more evident in dark-skinned patients. Wang and Lee reported that pulsed-dye laser is a safe and effective treatment of these lesions.[19]

Complications

Cellular, aneurysmal, and atypical variants should be completely removed because of the risk of local recurrence and distant metastases.[12]

ACROCHORDONS (SKIN TAGS)

General features

Acrochordons or skin tags (ST) (also called soft warts) are a common benign, cosmetically disfiguring lesion composed

of loose fibrous tissue and occurring mainly on the neck and major flexures as a small soft pedunculated protrusion. They are frequently found together with seborrhoeic keratoses.[1] These lesions are very common, particularly in women at the menopause or later.[1] They are derived from ectoderm and mesoderm and represent a hyperplastic epidermis.[20] STs are found in 25% of all people and increase in number with age.[20] Obesity is a predisposing factor.[18,20] Multiple lesions may appear in the latter trimesters of pregnancy, and as they often resolve postdelivery, it has been suggested that they are probably due to hormonal factors.[21] Multiple acrochordons can be found as part of syndromes, such as Birt-Hogg-Dubé syndrome[22] (fibrofolliculomas, trichodiscomas, and acrochordons) and Bannayan-Riley-Ruvalcaba syndrome[23] (macrocephaly, genital lentiginosis, intestinal polyposis, vascular malformations, lipomatosis, speckled lentiginosis of the penis or vulva, facial verrucae-like or acanthosis nigranslike lesions, and multiple acrochordons). Acrochordons can also be a manifestation of diabetes[24] and diseases associated with atherosclerosis.[25]

The lesions are usually attached to the skin by a thin stalk (pedunculated) but also can be sessile.[1,20] They vary in size and are about 2 mm in diameter on average. They are round, soft, and inelastic. The color may be unchanged (skin colored), but they are frequently hyperpigmented.[1] The most common site is on the sides of the neck, where they may be mixed with typical small sessile seborrhoeic keratoses. When more profuse, they can extend onto the face or down to the back and chest. Similar lesions may be found in and around the axillae and groins.[1,20] Lesions are usually found on the flexural aspects of the body,[26] usually points of chronic trauma.[18]

Melanocytic proliferation and naevus cells are not usually seen, and the majority of such lesions probably come within the seborrhoeic keratosis spectrum. However, some STs may be the last remnants of a pre-existing melanocytic naevus.[1]

The clinical differential diagnosis of ST is relatively small. Lesions that might be considered include wart, nevus, neurofibroma, and seborrheic keratosis.[18]

Treatment

STs pose no malignant threat in adults, but treatment is appropriate for cosmesis or because of irritation.[20] Various treatment modalities have been advocated, such as excision and hemostasis, electrosurgery, chemical cautery, or cryosurgery,[18,26] but recurrences are common,[20] and new lesions may appear. Both electro- and cryosurgery with liquid nitrogen are effective,[1] but there is a risk of secondary bacterial infections.[26] Chemical cautery requires multiple sessions and is associated with cosmetic defects.[26] Simple electrocautery scissor excision at the base of the stalk is sufficient in most of the cases.[20] Electrofulguration is ideal for ST, because healing is rapid and scarring is rare.[11] All these procedures can be performed with or without local anesthesia.[2]

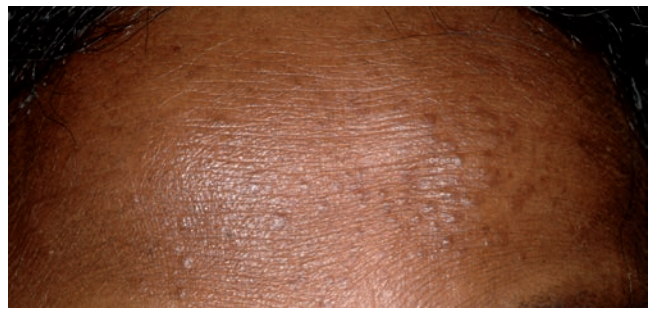

Figure 35-3 Multiple eruptive papules of the forehead consistent with syringomas. (Courtesy of Pearl E. Grimes, MD.)

Mukhtar[26] proposed a method using tissue forceps as a simple and effective instrument for treating STs in the outpatient setting. Five patients with 37 STs were included in the study. The body of the tag was grasped and pulled out gently with a DeBakey's forceps and the base of the pedicle was clamped with a Kocher's forceps for 10 to 15 seconds. None of the patients reported a negative cosmetic effect or recurrence at the site (4 weeks follow-up). Pathologic evaluation is unnecessary unless STs are present in childhood, because they may be the initial presentation of nevoid basal cell carcinoma syndrome.[27]

Complications

All treatments described above should be performed with care in darker racial ethnic groups because of the risks of hyper- or hypopigmentation.

SYRINGOMA

General features

Syringoma (also called *syringoma hidradenoma eruptions, syringocystadenoma,* or *syringocystoma*) is a benign tumor of the skin appendage that is usually multiple and has characteristic histopathologic features.[28] Histochemically, it is a tumor of the eccrine sweat duct. Often it appears at puberty, and lesions continue to develop during adult life but may occur at any age from adolescence onward.[28] There are four clinical variants: localized, familial, associated with Down syndrome, and a generalized form that encompasses multiple and eruptive syringomas.[29] The localized form presents with firm papules and skin colored to yellow on the periorbital region[30] (Fig. 35-3). Familial syringomas affect both sexes equally with a pattern of autosomal inheritance. The incidence of familial syringomas is possibly underestimated.[31] Syringomas are present in patients with Down's syndrome more often than expected.[31] Although Horenstein et al.[32] reported a higher incidence of eruptive syringomas in African Americans, and Sacoor and Medley[33] reported four cases of eruptive syringoma in dark-skinned South African children, these

Table 35-1
Treatment of benign tumors

Tumor	Treatment modality
Dermatosis papulosa nigra	Electrodesiccation Curettage Epilation Iris scissor excision Cryotherapy Superficial chemical peeling
Dermatofibroma	Surgical excision Cryotherapy Intralesional corticosteroid Pulsed-dye laser
Skin tags (acrochordons)	Surgical excision Hemostasis Electrosurgery Chemical cautery Cryosurgery
Syringoma	Intralesional electrodesiccation Electrodesiccation and curettage CO_2 laser and trichloroacetic acid Dermabrasion Q-switched alexandrite laser Iris scissor excision
Trichoepithelioma	Imiquimod Tretinoin Primary excision Dermabrasion Ablative resurfacing Electrocautery
Sebaceous hyperplasia	Isotretinoin Shave excision Trichloroacetic acid (TCA) Bichloroacetic acid (BCA) chemical peeling Electrodesiccation Laser therapy Photodynamic therapy

lesions present mostly in adolescents[31] and tend to be more prevalent in women and whites.[29] Eruptive syringomas have a chronic and persistent course.[33]

The lesions of syringoma are individual skin-colored or yellowish papules with flat-topped or rounded surfaces that vary in size from 1 to 5 mm (usually <3 mm). In general, they are multiple tumors and tend to have a bilateral symmetric distribution.[28] They occur most commonly, on the eyelids and cheeks, but may occur at axillae, abdomen, vulva, scalp, hands, or moustache area.[34] Occasionally, generalized eruptive syringomas develop in a more widespread distribution (eruptive hidradenoma of Darier and Jaquet).[35] The lesions often arise in large numbers and successive crops on the anterior neck, chest, and abdomen.[36] Powell et al. reported a young dark-skinned man with multiple, eruptive, asymptomatic syringomas on his buttocks.[29] The preferential localization of lesions on the ventral area of the body can be explained because this area has more eccrine glands than the dorsal half.[35] Usually, syringoma is asymptomatic, but when located on vulva it can cause pruritus, mainly during menstruation and pregnancy.[37]

A characteristic feature of syringoma is the tail-like strand of cells extending into the stroma, resembling a comma.[28] Syringomas located on the eyelids are typical, histopathologic studies are necessary only if there is diagnostic doubt. Syringoma can be confused with trichoepithelioma when located on the face, but are usually smaller, less superficial, and disposed to the eyelids and cheeks rather than the nasolabial creases. Lesions on eyelids can be mistaken as xanthelasma (but these have an orange characteristic color) or as milium cysts. Those erupting on the trunk may be mistaken for disseminated granuloma annulare.[28]

Treatment

The reason for treatment is cosmetic; the aim is to treat the lesion with minimal scarring to produce an acceptable cosmetic result.[38] Usual treatments aim to remove or flatten the papule produced by each syringoma. All modalities of therapy are ablative and will produce scarring to some degree. There are no studies comparing treatment modalities nor guidelines to follow. Case reports and little series of cases therapies include intralesional electrodesiccation, which consists in the use of a fine electrode into the lesion with the aim of localizing the effect and minimizing the scarring;[39] electrodesiccation and curettage;[40] CO_2 laser and trichloroacetic acid,[40] with good to excellent results; dermabrasion;[40] and temporary tattooing followed by Q-switched alexandrite laser.[41] Surgical excision using iris scissors may also be considered, as it can give cosmetic results.

Complications

All therapeutic modalities may result in cosmetically acceptable scars, and patients should be aware of this. Darker racial ethnic groups may have focal areas of hyperpigmentation that usually clear in 2 to 3 months.[39]

TRICHOEPITHELIOMA

General features

Trichoepithelioma (TE) is a benign cutaneous tumor that originates from hair follicles and occurs either in multiple

(autosomal dominant) or solitary (sporadic) lesions.[42–46] It is characterized as a hamartoma of the hair germ composed of immature islands of basaloid cells with focal, primitive follicular differentiation and induction of a cellular stroma.[28] TE is derived from trichogenic epithelium and differentiates toward hair germ, bulb, and infundibulum.[43] It appears predominantly in young adults, and it is most commonly found on the face.[28] Child et al. reviewed the spectrum of skin disease occurring in 461 dark-skinned patients in southeast London and did not find TE as a frequent dermatosis.[14]

Three distinctive forms of TE are recognized, namely solitary, multiple, and desmoplastic.[35] The lesions commonly appear as sporadic solitary lesions or, more rarely, as multiple lesions that are often dominantly inherited.[44]

TE can be confused with basal cell carcinoma, sebaceous hyperplasia, syringoma, and hidrocystoma. The "adenoma sebaceum" of tuberous sclerosis, lesions of which are truly angiofibromas, can also present with many skin-colored papules on the central part of the face. Biopsy is usually required to distinguish TE from basal cell carcinoma. History of a long-standing lesion with little change may be suggestive, but this same history is often obtained with basal cell carcinoma.[43]

Treatment

TEs can cause significant cosmetic and functional impairment when they occur in the head and neck area. Multiple methods of treatment—including plastic surgery, dermabrasion, cryosurgery, and laser surgery—have been reported in the literature. The current treatment of multiple TE is surgical and includes excision, electrocautery, and ablative resurfacing.[45–49] However, Urquhart and Weston used topical imiquimod three times a week for this condition.[47] The patient progressively increased the frequency of application to twice daily and added topical tretinoin gel once daily to her regimen for more resistant lesions. After 3 years of treatment, the patient experienced approximately 80% clearing of lesions without scarring. The advantages of using this nonsurgical treatment are that there is no scarring, it is painless, and there is no need for other invasive procedures, such as injection of local anesthetic.[47] There is a report that documents a case of multiple TEs treated successfully with the argon laser from the face and scalp. The benefits of the argon laser in treatment of multiple TEs include eradication of the lesions without apparent recurrence, restriction of spread of solitary TE into adjacent tumors, and prevention of obstruction of the periorbital region and auditory canal. The treatment may be accomplished as a simple outpatient procedure under local anesthesia with minimal pain or disability.[48]

Complications

Unfortunately, all the treatments described above should be performed with care in darker racial ethnic groups because of the risks of hyper- or hypopigmentation.

SEBACEOUS HYPERPLASIA

General features

Sebaceous hyperplasia (SH) is a benign condition characterized by the proliferation of the sebaceous gland. It is probably the most common of all pilosebaceous tumors and also the one of least significance.[43] Intrinsic and extrinsic aging (photoaging) are causative factors in SH. Reduced androgen levels lead a decreased cellular turnover in aged sebaceous glands of the face, resulting in glandular hyperplasia. Prolonged ultraviolet radiation has been shown to induce marked SH in hair mice. Ultraviolet A penetrates deeper into the dermis to reach the sebaceous gland and is probably the spectrum that causes the sebaceous gland hyperplasia to develop in aging facial skin.[50] SH is also associated with immunosuppressive treatment with cyclosporine in transplant patients,[51] and patients receiving hemodialysis are at increased risk. Although these lesions are common in darker racial ethnic groups, there is no relationship between skin type and the appearance of SH.[52]

SH consists of soft, yellow, dome-shaped papules, some of which are centrally umbilicated. These lesions are commonly found on the forehead, cheeks, lower eyelid, and nose.[52–55] SH also can occur on the vulva.[53] SH is most common in middle-aged and elderly persons. These lesions occur after the age of 30 years in 25% of the population and gradually become more numerous.[2] SH can also occur during the neonatal period by sebaceous hyperactivity caused by androgenic stimulation. In this case, treatment is not necessary because the condition disappears in some weeks.[54] In patients with rare familial forms, SH begins during puberty[55] and has a tendency to worsen with age.

Dermatoscopy of SH shows aggregated white or yellow nodules at the center of the lesion that correspond to hyperplastic sebaceous glands. Sometimes the ostium of these glands is visible as a small crater. The yellowish nodules are surrounded by "cross vessels" that can be defined as a group of orderly winding, scarcely branching, and not arborizing vessels that may extend toward the center but never cross it.[56]

The sebaceous lobules show a proper maturation sequence of the sebocytes with only a single rim of basaloid cells at the periphery and mature sebocytes within the central portions of the lobules.[43]

The differential diagnosis must be with early basal cell carcinomas that are characterized by a mosaic appearance; the surface of SH is generally less uniform than basal cell carcinomas.

Treatment

SH is an asymptomatic condition, but these lesions often represent a cosmetic concern to affected patients, leading them to seek treatment. Treatment options include cauterization or electrodesiccation, shave excision and excision,

oral isotretinoin, chemical peelings (bichloracetic acid or trichloroacetic acid), cryosurgery, laser therapy (argon, carbon dioxide, diode, or pulsed-dye laser) and photodynamic therapy (with combined use of 5-aminolevulinic acid [5-ALA] and visible light or lasers).[52] Previous curettage to electrosurgery may also be used. The curetted lesion may be sent to histological evaluation. Previous biopsy is recommended if there is concern that the lesion is a basal cell carcinoma.

In darker racial ethnic groups, complications of nonspecific destructive therapies include considerable risk of postoperative scarring, dyspigmentation, postinflammatory hyperpigmentation, and keloids. Peelings can be used in carefully selected patients, because different ethnicities may respond unpredictably to chemical peeling regardless of skin phenotype.[57] Oral isotretinoin is effective and must be prescribed only for patients without contraindications, but lesions often recur upon discontinuation of therapy.

Photodynamic therapy with topical 5-ALA can achieve safe and effective improvement of SH.[58,59] Alster and Tanzi reported good results from 10 patients with skin types I to IV treated with pulsed-dye laser and 5-ALA (Levulan Keratic, Dusa Pharmaceuticals) with no side effects and without recurrence during the 3 months follow-up.[59] However, Richey mentioned postinflammatory hyperpigmentation and skin discoloration in two patients with skin types IV and V after photodynamic therapy with ALA and 410-nm blue light that cleared with hydroquinone within 10 to 21 days.[60]

CONCLUSIONS

Most of the benign skin tumors that affect darker racial ethnic groups are not specific for this population. Despite the cosmetic effects, most of them do not cause functional impairment. On the other hand, all treatments reported in literature are associated with some degree of dyschromia when performed in darker racial ethnic groups. Scars and keloids also can occur when more invasive procedures are chosen. More studies are necessary to improve the knowledge and safety in treating benign tumors of darker racial ethnic groups as well as to decrease the risks of side effects.

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36

Surgical Treatment of Skin Cancers in Darker Racial Ethnic Groups

P. Kim Phillips

Skin cancer is the most common type of cancer in the United States.[1] Important risk factors associated with the development of nonmelanoma skin cancer (NMSC) and melanoma includes Fitzpatrick phototype I skin, Celtic ancestry, fair complexion, and light eyes. Hispanics, African Americans, and Asians, both having darker skin pigmentation than Caucasians, are at lower risk for developing skin cancer.[2–14] Although the incidence of NMSC and melanoma is lower in Hispanics, African Americans, and Asians, tumors in these populations tend to present in more advanced stages and carry a poorer prognosis than those in Caucasians. Skin cancers can cause significant cosmetic disfigurement. Therefore, selection of appropriate excisional modalities is essential for optimizing aesthetic outcomes.

SQUAMOUS CELL CARCINOMA

Squamous cell carcinoma (SCC) is the most common cutaneous malignancy in African Americans. SCC is an invasive epithelial malignancy exhibiting keratinocyte differentiation. When it occurs in African Americans, tumors tend to present in more advanced stages. SCC accounts for about three fourths of the mortality attributable to NMSC in African Americans.[13,14]

Numerous studies have reported that sun exposure does not appear to be an important etiologic factor in the development of SCC in African Americans, as lesions most frequently occur on non–sun-exposed skin. SCCs arising on non–sun-exposed skin tend to be more aggressive and have a greater potential to metastasize. When SCCs do arise on sun-exposed areas of pigmented skin, they are most commonly found on the "midfacial triangle," which includes the forehead, nasal tip and lip. These tumors also occur to a greater degree on the legs, especially in elderly women.

A significant predisposing factor for the development of SCC is the presence of scar tissue arising from a chronic inflammatory process such as discoid lupus erythematosus, cutaneous horns, chronic leg ulcers, or scrotal ulcers (Fig. 36-1). Further, Hubbell et al. reported that mortality was greater when the lesion arose from a chronic inflammatory process and was highest in perianal tumors.[13]

BASAL CELL CARCINOMA

Basal cell carcinoma (BCC) is the most common skin cancer in the United States, accounting for at least 75% of all NMSCs. However, more than 99% of these cases occur in whites. The rarity of this cancer in darkly pigmented skin is accounted for by the central role of ultraviolet radiation in the development of BCC[13,14]. However, other risk factors have also been reported for BCC, including prior exposure to radiation, trauma, arsenic ingestion, immunosuppression, and the basal cell nevus syndrome.

BCC typically exhibits characteristic nests or cords of small, dark-staining epithelial cells with palisading of the peripheral cells. Tumors may be pigmented or nonpigmented and arise most commonly on the face, head, and neck (Fig. 36-2). However, lesions may also occur on non–sun-exposed skin. BCCs are generally similar in histology and clinical course in both African Americans and Caucasians. Pigmented BCCs are found with increased frequency in blacks.

MALIGNANT MELANOMA

Risk factors for malignant melanoma in darker racial ethnic groups include exposure to ultraviolet light, a history of blistering sunburns, albinism, burn scars, exposure to ionizing radiations, pre-existing pigmented lesions, and history of trauma.[6–12] Interestingly, family history does not appear to be a significant risk factor in the development of melanoma in persons of color.

Individuals with pigmented skin are more likely to develop acral melanoma, both the acral lentiginous and subungual subtypes. Acral lentiginous melanoma is a very

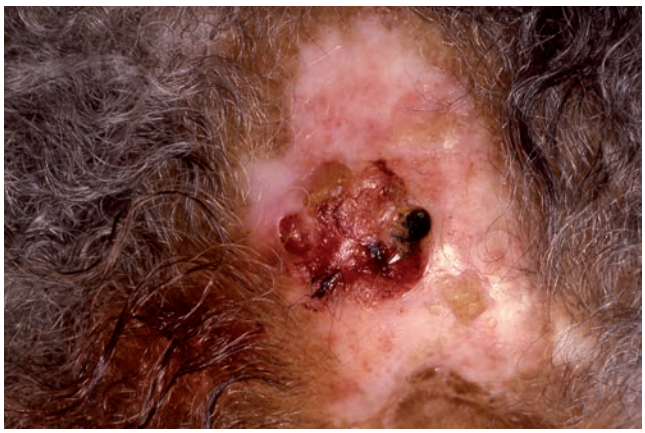

Figure 36-1 Squamous cell carcinoma of the scalp in an African American patient with discoid lupus. (Courtesy of Pearl E. Grimes, MD.)

aggressive tumor that commonly occurs on the plantar surface of the feet, palms, and digits and presents as a rapidly spreading, darkly pigmented patch (Fig. 36-3A,B). Subungual melanoma typically arises on the hand, and treatment often requires amputation. Occasionally, these tumors may be amelanotic, which often leads to a delay in the diagnosis. These lesions have a propensity to metastasize to the central nervous system, liver, lungs, bone, and lymph nodes. Prognosis in these cases is poor.

Overall, the outcome of melanoma is worse for deeply pigmented individuals when compared with white skin. According to the California Cancer Registry, melanoma was diagnosed only after metastasis to a remote site for 12% of black men, compared with only 6% of white men.

When faced with a skin cancer in darker racial ethnic groups, as in all other patient populations, the surgeon's primary focus must be: (a) complete removal of the tumor, (b) preservation of function of key anatomic structures, and (c) restoration of cosmesis. These key principles must be considered in the order presented to achieve high cure rates and prevent tumor recurrence. This chapter will focus on a discussion of common surgical techniques required to manage most cutaneous malignancies as well as reconstruction of postoperative defects to achieve acceptable aesthetic outcomes.

PRIMARY EXCISION

Chief among the surgical procedures performed on skin is the elliptical or fusiform excision. It is used for the therapeutic removal of benign and malignant lesions and is critical to properly diagnose pigmented lesions and inflammatory diseases of the skin. The elliptical excision encompasses all the fundamental elements of more advanced procedures, such as local flaps, skin grafts, and cosmetic procedures. Those elements that must be mastered include knowledge of local anatomy, cosmetic units,

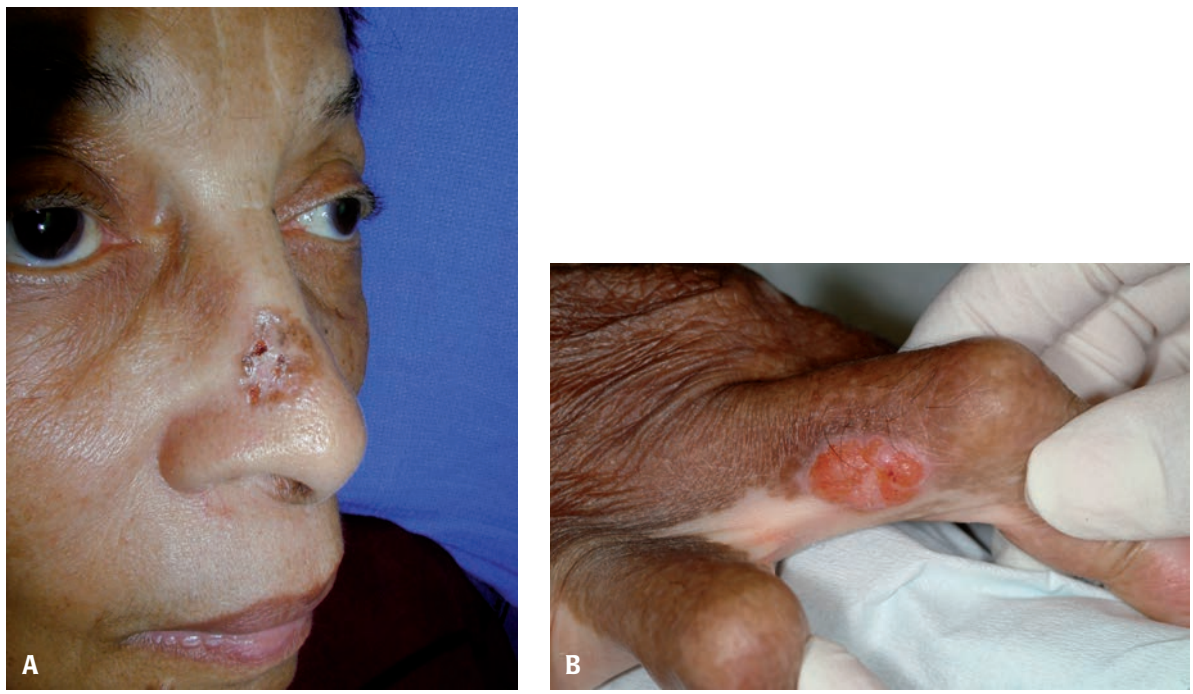

Figure 36-2 **A:** Basal cell carcinoma of the face in an African American. (Courtesy of Carl Washington, MD.) **B:** Basal squamous cell carcinoma of the finger in a 90-year-old African American male with vitiligo. (Courtesy of Pearl E. Grimes, MD.)

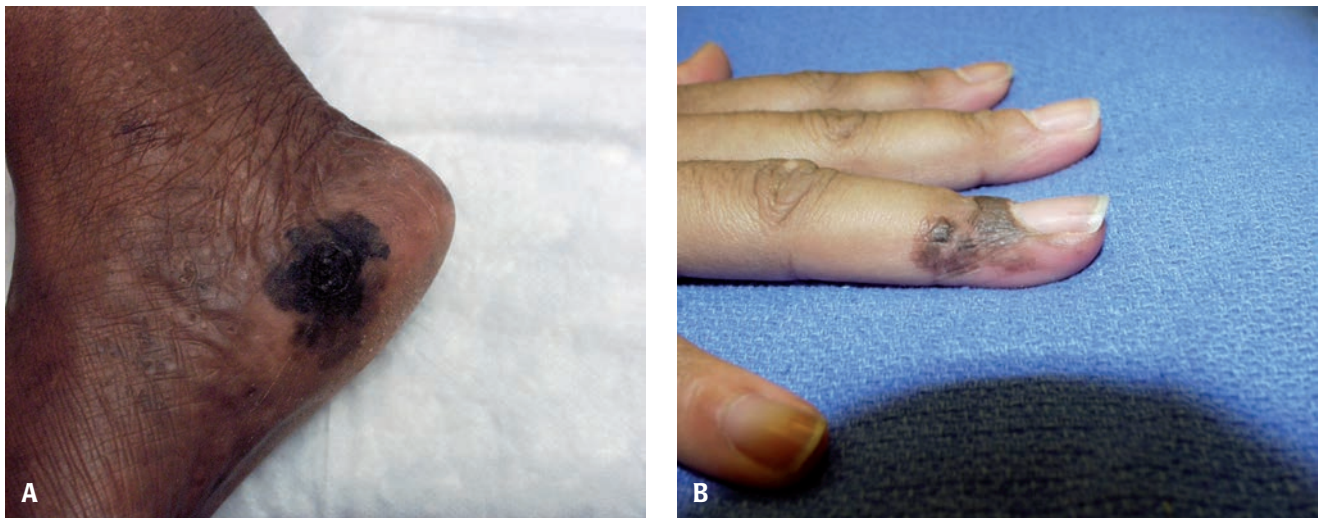

Figure 36-3 **A:** Nodular malignant melanoma of the heel. **B:** Acrolentiginous melanoma of the digit. (Courtesy of Carl Washington, MD.)

incision technique, tissue handling, and wound management. All of these elements are the foundation upon which more advanced surgical procedures are based. The goal of the elliptical excision, as with any other surgical procedure, is a cosmetically acceptable result. The scar should be hairline in width and well concealed within natural skin tension lines.

Patient evaluation

After obtaining a thorough history of present illness as well as information regarding medications, allergies, review of systems, and past medical surgical history, physical examination should be performed with the aid of appropriate lighting with the patient in a seated position. The most important aspect of the physical examination is identifying anatomic landmarks, including cosmetic units and relaxed skin tension lines. These important landmarks are used to help camouflage the surgical scar.

The importance of understanding cosmetic units is critical. Cosmetic units are regional subunits or anatomic areas defined by gradations of light and shadow that are determined by the underlying framework of soft and hard tissue. Scars limited to one cosmetic unit or at the boundary between two cosmetic units will appear less noticeable than a scar that crosses the border between two units.

One of the basic principles for cosmetic closure of surgical wounds is placement of scar in the natural skin tension lines. Proper orientation of scars makes them imperceptible. Wounds heal so well that patients have the impression that there is no scar.

Langer's lines should be familiar to all dermatologic surgeons. Tension lines may vary between patients, but they become more prominent with age. The severity of tension lines is influenced by sun exposure, cigarette smoking, and skin type. It is important, therefore, that each patient be examined closely when planning an excision. Visual inspection, palpation, and gentle manipulation are necessary to confirm the location of relaxed skin tension lines and to determine the impact of a particular repair on adjacent structures. There are many locations, such as the glabella, lateral margins of the chin, or shoulder, for which there is more than one set of relaxed skin tension lines. Patients should be encouraged to smile or make other specific facial expressions such as pursing the lips or raising the eyebrows to help clearly delineate skin tension lines.

Surgical technique

Elliptical excision

The classic elliptical or fusiform excision is based on a design that bears a length-to-width ratio of 3:1 or 4:1, with the apical angles ranging from 30 degrees to 75 degrees.[15] This design is intended to eliminate tissue redundancies or dog-ear formation at the poles of a linear closure.

When designing an ellipse, the size of the lesion—including the margins of normal skin necessary for appropriate removal—must be considered. BCCs and SCCs that are well demarcated should be excised with a minimum of 4 mm and 6 mm margins, respectively, if Mohs micrographic surgery is not performed.[16,17] Margins for invasive melanoma are based on the Breslow depth of tumor invasion. Excision depth should be extended into the subcutaneous tissue or approximation of wound edges will be impeded.

After the surgical site has been marked, anesthetized, prepped, and draped, surgical technique becomes critical. The actual performance of the incision must be smooth with the surgeon using firm, confident strokes. The point of the blade is used to make the initial cut at the apex of the ellipse, then the sharper belly of the blade is used to move along the arc. Back tension on the surrounding skin

is paramount. If assistants are not available, the surgeon can use the nondominant hand and the fifth finger of the dominant hand on the adjacent skin to apply mild tension around the surgical site. The incision should be carried down to the subcutaneous tissue on the first pass. Using toothed forceps, the specimen is grasped at one of its apices and dissected away from the surrounding normal tissue in an even plane, using either a scalpel for sharp dissection or scissors for more blunt dissection. Once the specimen has been removed, wound edges are undermined. Undermining is required to ease tissue movement, reduce tension on the wound edges, and to allow for adequate wound edge eversion.[18] Undermining must be performed carefully and meticulously. Regardless of whether sharp or blunt techniques are used, the surgeon must have a clear understanding of the local anatomy. One must avoid severing motor nerves or large vessels because of poor technique. Use of a skin hook when undermining allows lifting of the wound edge with minimal tissue damage. Skin hooks should be held perpendicular to the surface of the wound to permit maximal exposure of the wound bed. Forceps can be used to gain this exposure, but care must be taken to avoid crushing the wound edge. Undermining should be carried out along the entire wound edge, especially at the apices. Adequate undermining at the apices may prevent the formation of standing cone deformities or dog ears. To evaluate the adequacy of undermining, two skin hooks are used to approximate the wound edges.

After undermining is complete, the wound base is inspected for bleeding. Hemostasis can be achieved with electrocautery. Electrocautery is most effective in a dry field. Quickly dabbing the area with gauze or rolling a cotton-tip applicator over the area before cautery enhances its effectiveness. To decrease unnecessary tissue damage, pinpoint cautery is preferred. Excessive charring of tissue should be avoided. For larger vessels, cautery may not be sufficient, and the vessel should be ligated with 4-0 or 5-0 absorbable suture.

Once hemostasis is achieved, repair of the defect can begin. Cosmetically superior results are achieved with layered closure. This consists of the use of absorbable deep sutures, followed by placement of nonabsorbable superficial sutures. When there is little tension on the wound, closure by halves is the gold standard. The first buried or absorbable suture is placed in the center of wound. Next, each half of the remaining defect is repaired in a similar fashion. Alternatively, it may be beneficial to begin suturing at the apices of the ellipse and place sutures incrementally until the center of the ellipse is reached. The buried vertical mattress suture enhances wound eversion, resulting in an improved cosmetic result.[19] The buried suture is the foundation of the repair and will have the greatest impact on the final result. Precise placement is critical. Improperly placed sutures should be removed and repositioned as needed.

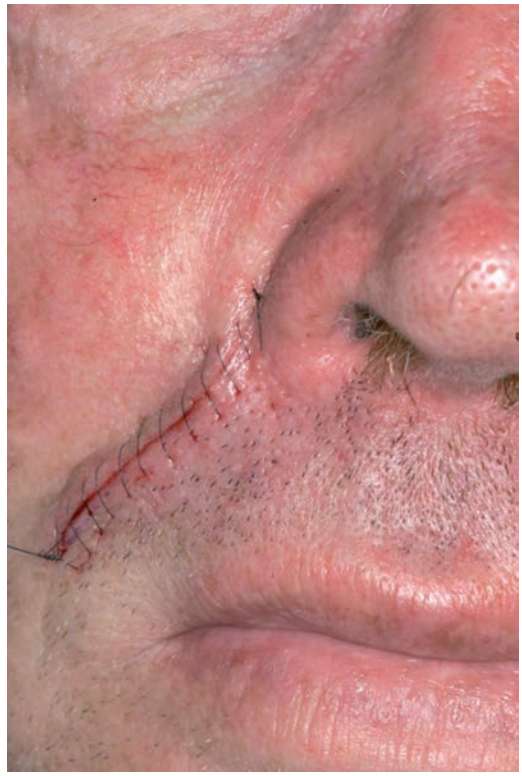

Figure 36-4 The classic elliptical excision. Wound edges are well approximated and everted.

Once the buried sutures have been placed, one can proceed with epidermal sutures. The goal of this component is epidermal approximation. Typical epidermal sutures range from 4-0 to 6-0 monofilament nonabsorbable sutures. On the lips or eyelids, absorbable suture can be used. If wound edges have been well approximated and everted with the buried vertical mattress suture, a running suture effectively achieves rapid additional wound edge approximation (Fig. 36-4). Simple interrupted sutures should be used if uneven wound edges need to be adjusted for level or if there are concerns with hemostasis. Should it become necessary to open the wound in the postoperative period to identify a source of bleeding or to place a drain, it will be possible to remove a few sutures and avoid having to remove an entire running suture. Sutures should be snug, but not so tight as to strangulate the wound edges.

Crescent excision

A variation of the standard elliptical excision, the crescent excision takes advantage of wound edges of unequal length and is designed to result in a curvilinear scar, which can be cosmetically superior to a long straight scar. The crescent excision or repair is often helpful on the cheek and around the chin (Fig. 36-5A,B). When properly designed, the arc of the crescent is oriented in the direction of the relaxed skin tension lines. These wounds must

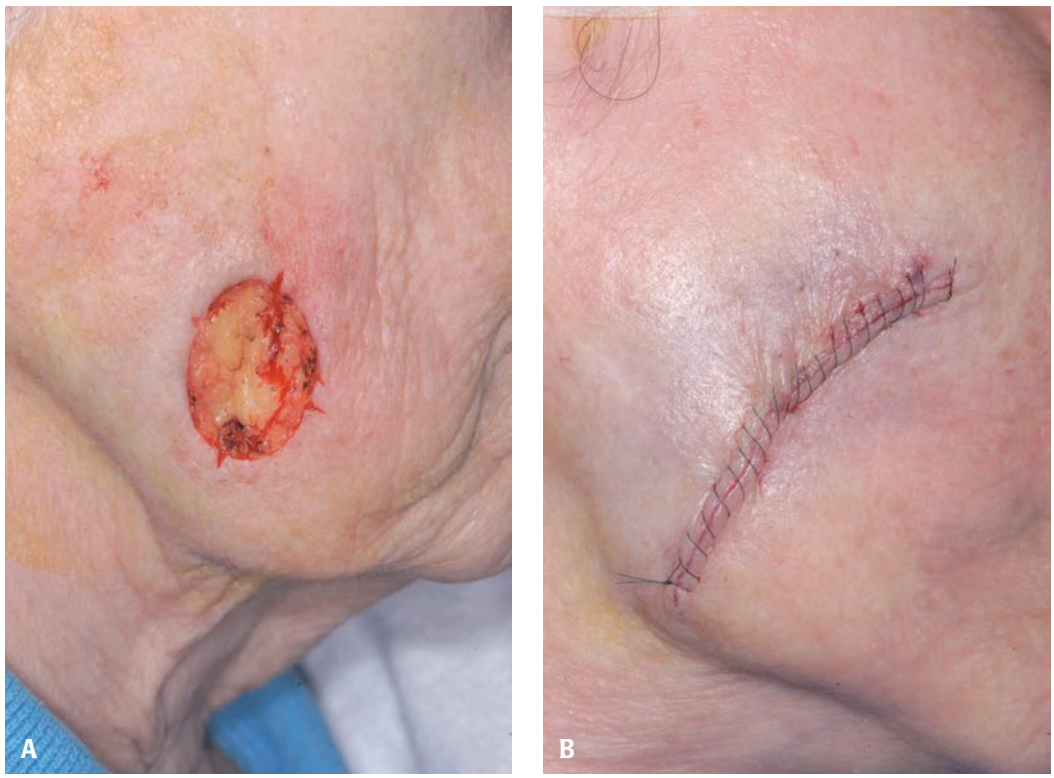

Figure 36-5 The crescent excision. **A:** Circular defect on the medial cheek following removal of a basal cell carcinoma. **B:** Final curvilinear scar hidden within the natural skin tension lines.

be closed by the rule of halves to avoid redundancies at the apices.

M-plasty

The M-plasty is a simple and effective method for reducing the length of a scar when it would otherwise impinge on nearby functionally important or cosmetic structures (Fig. 36-6A,B). An M-plasty is designed to remove excess skin from the apex of an ellipse while allowing the limbs of the repair to be well concealed. When designing an M-plasty, an M shape instead of an apical tip is drawn at approximately one fourth of the length of the ellipse. When an M-plasty is used to remove a dog ear, the M shape is formed by lifting the excess tissue with a skin hook and making incisions with 45 degrees on both sides of the standing cone. The tissue is then draped over the incision lines and the redundant triangles removed from each side. A tip stitch is used to complete the M.

S-plasty

Another variation of the ellipse is the curvilinear ellipse, S-plasty, or lazy-S repair. This repair is used to achieve superior cosmetic results when working on convex surfaces such as the jaw and extremities. Use of an S-plasty allows tension vectors to be distributed in multiple directions along the length of the scar. It also serves to elongate a scar. As healing occurs, contraction will occur over a greater length, which effectively minimizes buckling of the scar.

Complications

Dermatologic surgeons often eventually experience complications. With the elliptical excision and its variants, there are four major categories of complications: bleeding, infection, dehiscence, and scarring. If the patient is clearly informed about the possibility of complications preoperatively and postoperatively as well as how they can be managed, the impact of any complication will be minimized.

In the event of extensive bleeding during surgery, one must anticipate the possibility of postoperative bleeding. The placement of a drain at the surgical site may help prevent collection of fluid and hematoma formation. A surgeon can use a Penrose drain for this purpose. If wounds continue to bleed despite firm pressure held continuously for 20 to 30 minutes, or if there is an expanding collection of blood beneath the suture line, surgical intervention is necessary. Patients are prepped, draped, and anesthetized, and the wound is opened and irrigated. Cautery and suture ligation are used as needed to stop obvious sources of bleeding.

When bleeding is slower over the immediate postoperative period, a hematoma may develop. These become apparent to the patient as an enlarging tender or nontender

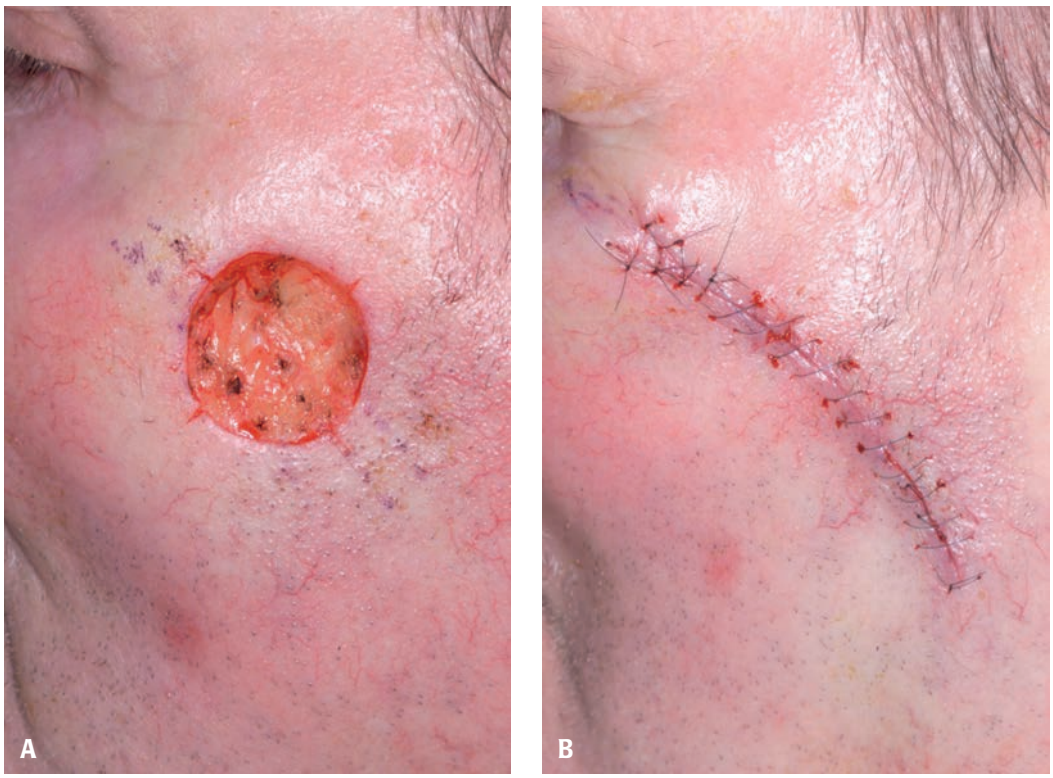

Figure 36-6 M-plasty. **A:** Defect after Mohs micrographic surgery. **B:** Scar within a single cosmetic unit after M-plasty designed at the superior pole of defect.

mass. Draining a hematoma facilitates healing, avoids the development of excess scar tissue, and prevents compromise of wound healing. After appropriate prep, draping, and injection of local anesthetic, a no. 11 blade may be used to make a small incision over the hematoma. The hematoma is then manually expressed. This resultant wound is allowed to heal by second intention.

Infection rates in office-based surgery range from 1% to 3%.[20,21] Intertriginous areas, such as the perineum and axillae, as well as the lower extremities are more susceptible to infection. Exposed cartilage, especially on the ear, is likewise at an increased risk of infection. Most superficial skin wound infections are caused by *Staphylococcus aureus,* so empiric treatment with an appropriate antibiotic is reasonable in certain cases. Using sterile technique, prepping the patient properly, and carefully handling the tissue and wound closure without tension will all decrease the chance of infection.

Patients should all be counseled that there is no such thing as scarless surgery. Surgical techniques are used to produce an optimal scar. It is always best to inform patients that there will be a scar but every effort will be made to make the scar as invisible as possible. Hypertrophic scars and keloids are thickened, raised scars. Keloids are tumors of scar tissue that extend beyond wound margins. Hypertrophic scars tend to resolve with time. Both tend to occur in areas of high tension and in patients with a personal or family history. Such scars are substantially more common following surgery in darker racial ethnic groups, in particular, African Americans.

Postsurgical wound tension has been implicated in the literature as a contributing factor in keloid formation. Closing a wound against the relaxed skin-tension lines results in a wound with twice the tension of one closed along Langer's lines and may be more likely to result in keloid formation. The loss of tissue that results from surgical excisions may also increase wound tension.

The first goal of therapy is prevention. Surgical wounds should be closed within the relaxed skin tension lines using adequate undermining and wound edge eversion to minimize tension. Healing by second intention should be considered to reduce tension. Preventative intralesional corticosteroids can be injected immediately postoperatively, then monthly thereafter if needed.

Other surgical complications more common in these groups include postinflammatory hyperpigmentation as well as hypopigmentation. These potential complications should be discussed in detail with patients before surgery. Treatment of hyperpigmentation, hypopigmentation, hypertrophic scars, and keloids are discussed in Chapters 13, 14, and 34.

ADJACENT TISSUE TRANSFER

Most operative defects in dermatologic surgery can be closed primarily or allowed to heal by second intention. Deeper or more critically located wounds often require closure via adjacent tissue transfer, local tissue rearrangement, or a flap. A flap is a moving construct of skin and subcutaneous tissue created from tissue near an existing surgical defect. Flaps retain vascularized connections to underlying tissue at the bases. Flaps provide opportunities not only to restore function by filling and closing operative wounds but also provide an opportunity to more elegantly restore natural appearance.

Historically, there have been many classification schemes for surgical flaps. Flaps have been categorized by their vascular supply, primary motion, configurations, their eponymous designations and their locations.

Patient evaluation

Proper patient selection is critical to flap success. The patient's preoperative evaluation for flap reconstruction typically consists of a well-documented medical history and an appropriate single system examination. In addition to verifying general health, the surgeon should also properly assess the patient's anatomy for suitability of a flap reconstruction. This is particularly important when assessing facial defects because minor degrees of asymmetry, particularly in the central face, are quite common. These preoperative asymmetries as well as any anticipated postoperative change should be demonstrated to the patient before initiation of the flap procedure.

When possible, flaps should be designed so that incision lines do not cross convexities with underlying bone such as the mandibular ramus, zygomatic arch or the clavicle. Hypertrophic scaring is more common in these situations.

Patients should be counseled to understand that facial flaps can be relatively complex reconstructions and that occasionally long and complicated incision lines are required for proper tissue mobilization. The undermining required for flap mobilization frequently causes bruising, swelling and some postoperative discomfort. It is important to stress that flap reconstructions may take months to mature and that surgical revisions may be necessary in some cases. It is also essential to inform patients about the possibility of postoperative numbness or paraesthesias, especially in areas such as the forehead or upper lip. Fortunately, most sensory disturbances associated with flap repairs are temporary.

Surgical techniques

Advancement flap

When an operative defect lies near a free margin, such as the vermilion border, or close to a defined facial boundary, such as the nasolabial fold, an advancement flap frequently allows for optimal closure. The advancement flap is conceptually the simplest of all flap repairs. In most cases, the tissue movement associated with these flaps is unidirectional advancement of the leading edge of the flap. In addition to moving adjacent tissue into the operative defect, advancement flaps displace redundant tissue created by the flap's primary motion tissue to locations from which they can be excised with less cosmetic impact. The ideally designed advancement flap allows for a limb of the repair to run along a free margin or within a defined facial boundary.

Unilateral/bilateral advancement flap

The classic advancement flap involves the creation of a rectangular pedicle or bilateral rectangular pedicles. As the flap is advanced, tissue redundancies develop at the pedicle base. If the ideal skin contour is to be preserved, these dog ears must be excised, which adds further complexity to the simple U-shaped scar of the traditional advancement flap.

When sufficient tissue laxity does not exist to allow for a simple unilateral advancement flap, a bilateral advancement flap may be designed such that each flap advances half as far to meet in the center of the operative defect. The standard bilateral rectangular advancement flap is most useful for eyebrow defects where the horizontal and vertical scars can be hidden adjacent to and within the brow, respectively.

A-T advancement flap

The standard A-T advancement flap can be a great improvement over the unilateral and bilateral rectangular advancement flaps in most facial locations. In the A-T repair, a linear repair of the operative wound is designed perpendicular to a free margin or to a pre-existing cosmetic junction. Instead of extending a primary linear repair across a cosmetic boundary or free margin, incisions are designed along the margin of the operative defect, a free margin, or a cosmetic boundary perpendicular to the linear repair axis. In this manner, one line of the repair is hidden in a cosmetic junction.

The A-T flap is useful for perialar defects where the top of the T can be hidden in the alar crease and the vertical limb of the T can be hidden in the nasolabial fold above the brow or on the forehead. The base of an inverted T can be hidden either just above or just below the brow or within a horizontal forehead rhytid. The vertical scar that results from this repair may be somewhat visible, but it generally fades nicely over time if the flap is not closed under tension.

As with all facial flaps, advancement flaps are most useful when the incisions of the flap can be hidden within cosmetic unit boundaries or along natural facial expression lines. Commonly used sites for advancement flaps are the nasal sidewall superior to the alar crease, the upper lateral lip superior to the vermilion border, and the supraorbital forehead lateral to the midpupillary line (Fig. 36-7).

Island pedicle flap

The island pedicle flap is a specialized advancement flap that differs from other traditional advancement flaps in

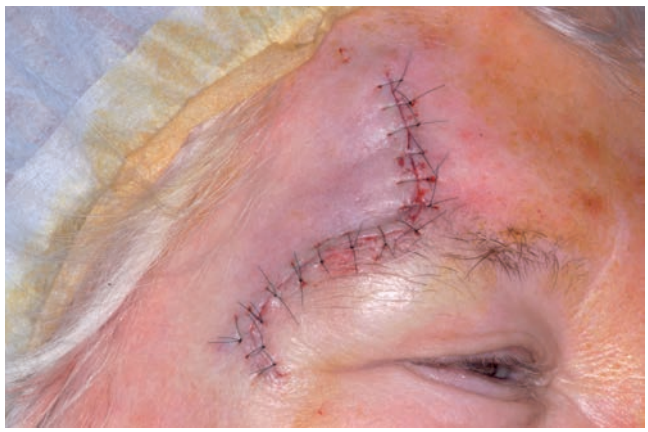

Figure 36-7 Unilateral advancement flap. A unilateral advancement flap with one limb of the repair hidden along the supraeyebrow.

that most of its vascular supply derives from a subcutaneous pedicle. All dermal margins of the flap are severed as the flap is advanced. Many types of island pedicle flaps have been described, the most common of which is a triangular flap that derives its blood supply from a deep mobile subcutaneous or muscular pedicle.

Because the traditional island pedicle flap has a conspicuous kite-shaped outline, its greatest use is in locations where one or two of the margins of the flap can be hidden within a contour line or aesthetic unit boundary. Surgical defects on the upper lip near the nose-lip-cheek junction and on the lateral nasal sidewall are particularly well suited for repair with an island pedicle flap. The flap is also useful in the reconstruction of the eyebrow, where the flap can advance the remaining brow medially to recreate brow continuity. In addition to the traditional design, many variants of the island pedicle flap have been discussed.[22] Curved island pedicle flaps can be particularly useful on the nose, where the incision lines can be placed along the alar groove. The epithelialized flaps or even flaps that have the entire pedicle buried in a subcutaneous tunnel can occasionally be quite useful for the repair of deep nasal wounds. Regardless of their design, all island pedicle flaps have as their chief advantage a healthy and protected vascular supply.

Rotation flaps

Surgical wounds that cannot be closed primarily or with local tissue advancement may be repaired by recruiting adjacent lax tissue while directing wound closure tension vectors away from the primary surgical defect. This redirection of wound closure tension is the primary purpose of a rotation flap.

The design of a traditional rotation flap uses a curvilinear incision along an arc adjacent to the primary surgical defect. As a rotation flap is created, the direction of wound closure tension is effectively changed. This allows a rotation flap to use abundant donor tissue located a considerable distance from the primary defect to close wounds in areas in which tissue availability is minimal. In addition to reorienting tension vectors, rotation flaps also frequently allow for displacement of dog ears to more favorable locations. If well designed, rotation flaps create scar lines that are hidden along facial boundaries or within relaxed skin tension lines or are camouflaged within hair-bearing skin.

Rotation flaps have their greatest use in the closure of scalp, temple, and cheek defects and other nonfacial areas. In selected cases, rotation flaps can be useful on the nose. On the scalp, a lack of adjacent skin mobility requires rotation flaps to be especially long to close even small- to moderate-sized operative wounds. On the cheek, rotation flaps are particularly useful to repair medially located wounds because the rotation flap can effectively mobilize the large reservoir of loose skin in the entire area of the lateral cheek (Fig. 36-8A,B).

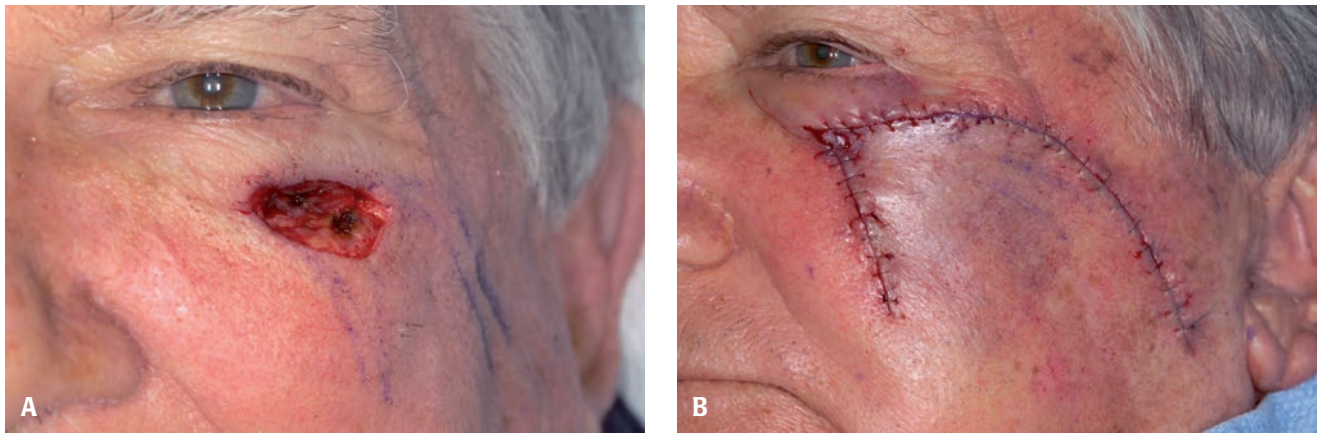

Figure 36-8 Cheek rotation flap. **A:** A rotation flap on the cheek allows for repair of a large defect. **B:** Most of the scar is hidden along the preauricular cheek and at the junctions between cosmetic units.

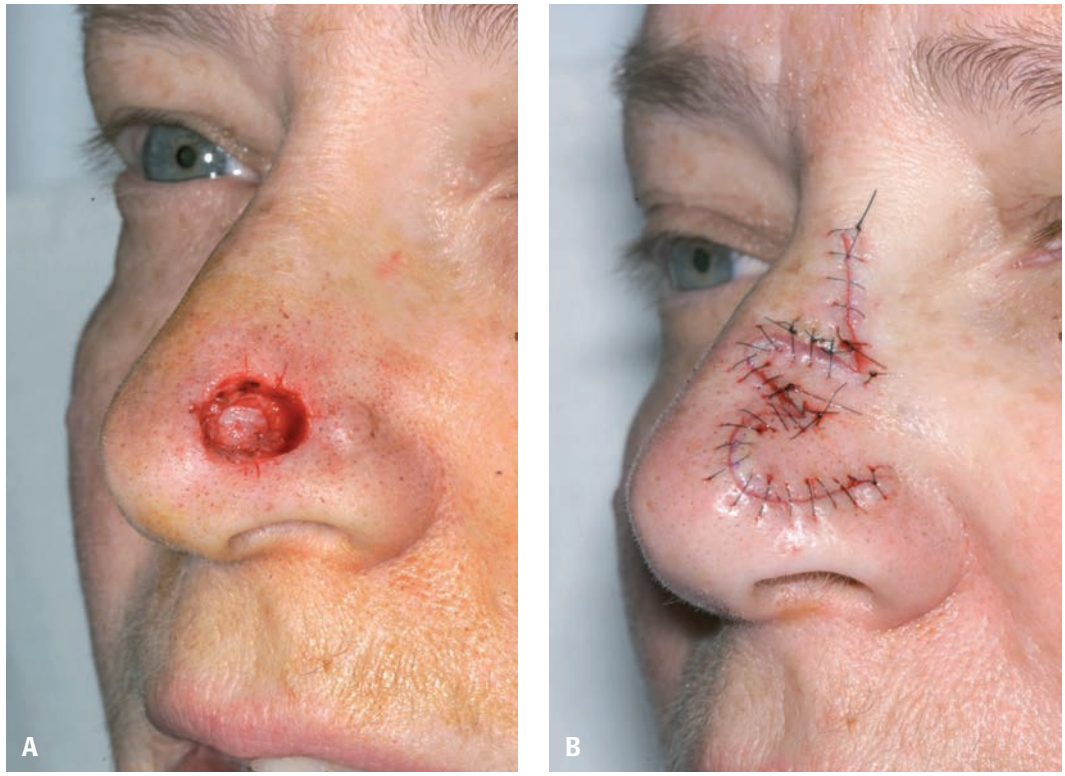

Figure 36-9 The bi-lobed transposition flap. **A:** Surgical defect at the nasal tip. **B:** Flap sutured in place. The flap was carefully designed to appropriately size the primary and secondary lobes of the flap.

Transposition flap

Transposition flaps are the most complex of the random pattern flaps. These flaps allow for complete redirection of wound closure tension by moving tissue from an area of surplus to an area of need by transposition of skin across intervening islands of normal, unaffected tissue. These flaps can be used to close difficult wounds near free margins such as the nasal ala, lip, proximal helix, or eyelid. In a nasolabial fold transposition flap, for example, redundant tissue in the area of the medial cheek can be transposed over the unaffected lateral nasal ala to cover a more medially located nasal ala or nasal tip wound.

The most commonly used transposition flaps are the rhomboid transposition flap, bilobed transposition flap, and the nasolabial fold transposition flap. The basic rhombic flap is useful for closing defects of the medial canthus, upper nose, lower eyelid, temple, and lateral cheek. The bilobed transposition flap is particularly useful for repair of difficult wounds at the nasal tip subunit (Fig. 36-9A,B). The nasolabial transposition flap is used to reconstruct lateral and central nasal alar defects.

Complications

There are many potential complications associated with random pattern flap reconstruction. Most flap failures on the face can be traced to crucial errors in flap design or poor surgical practices. The successful creation of facial flaps involves finding the correct balance between flap elevation and preservation of blood supply. For proper mobilization, flaps generally require relatively long incision lines and generous undermining. With appropriate training and experience, the overall risk of developing major complications is low. Complications are the same as those seen with any other surgical procedure and include bleeding, infection, tissue necrosis, and wound dehiscence.

Most surgical complications that follow facial flap repairs result from postoperative bleeding.[21] Careful attention should be placed on proper patient selection, the occasional use of preoperative screening laboratory tests, and thorough intraoperative hemostasis. Most minor bleeding can be controlled with simple sustained pressure over 15 to 20 minutes. Sudden swelling in the operative field heralds the formation of a hematoma. Because hematomas are associated with an increased risk of flap ischemia and tissue death, these should be immediately evacuated.

Wound infections that accompany flap reconstructions on the face are uncommon.[21,23] With sterile preparation of the skin and an aseptic operative technique, the risk of infection is even further reduced. Clinical experience and laboratory evidence have shown that ischemic flaps are more prone to surgical wound infections, so the

importance of proper flap design and gentle surgical technique are emphasized.

Dehiscence of a wound is defined as the separation of previously opposed wound edges. One of the leading causes for wound dehiscence is the presence of wound infection. Dehiscence can also occur as a result of poor wound approximation.

Distal flap tissue necrosis is occasionally seen with flap reconstructions. This is generally caused by excess tension on the wound edges.

Flaps offer unparalleled opportunities to restore the appearance of the face after the excision of cutaneous malignancies. Flap techniques can be safely and predictably performed only if the surgeon has an in-depth understanding of skin-flap designs and a thorough knowledge of basic and advanced surgical techniques and anatomy. When appropriately designed, flaps are extremely safe and predictable options for facial reconstruction. The aesthetic result of flap procedures commonly exceeds the results obtained from second-intention healing or skin-grafting procedures.

MOH'S MICROGRAPHIC SURGERY

Most BCCs and SCCs are managed successfully by surgical excision, electrodesiccation and curettage, curettage and cryotherapy, and, occasionally, irradiation. For high-risk recurrent or histologically aggressive tumors, or those in high-risk sites, Mohs micrographic surgery (MMS), is the procedure of choice. The technique was initially developed by Dr. Frederick Mohs and subsequently refined by Tromovitch and Stegman.[24] This technique offers the highest cure rates while maximizing the preservation of normal tissue to simplify reconstruction of surgical defects.

MMS is a specialized excision used to obtain accurate histologic tumor-free margins. The key difference between MMS and conventional excision lies partly in the surgical technique but mainly in the orientation and histologic visualization of the margins of the specimen. The surgeon performing MMS examines 100% of the true surgical margin by using specially embedded and tangentially cut frozen sections.

Indications for MMS have been clearly established. A major criterion is the anatomic site of the tumor. Sites associated with high risk of recurrence include the junctions between anatomic units, nose, scalp, temple, eyelids, lips, and ears. Large or deeply invasive and recurrent tumors are best managed by MMS. This histologic subtype of the tumor is another important criterion in determining whether MMS is indicated. Morpheaform, metatypical, and micronodular BCC are more aggressive; the clinical margins are less distinct and may extend beyond the apparent tumor margins, both peripherally and deeply. Similarly, high-grade SCC frequently invades nerves, vessels, and other tissue fusion planes.

SUMMARY

Although the incidence of NMSC and melanoma is lower in darker racial ethnic groups, tumors in these populations tend to present in more advanced stages and carry a poorer prognosis than those in Caucasians. When faced with skin cancer in darker racial ethnic groups, the surgeon's primary focus must be complete removal of the tumor, preservation of function of key anatomic structures, and restoration of cosmesis. A dermatologic surgeon must have a thorough knowledge of local anatomy, cosmetic units, incision technique, tissue handling, and wound management. In addition, surgeons must be comfortable with preventing and managing potential complications. Mastering these elements can help assure reliable, consistent, excellent cosmetic results.

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