Clinical Cases in Dermatology
Series Editor: Robert A. Norman

Sharad P. Paul
Robert A. Norman *Editors*

Clinical Cases in Skin Cancer Surgery and Treatment

Springer

Clinical Cases in Dermatology

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This series of concise practical guides is designed to facilitate the clinical decision-making process by reviewing a number of cases and defining the various diagnostic and management decisions open to clinicians. Each title will be illustrated and diverse in scope, enabling the reader to obtain relevant clinical information regarding both standard and unusual cases in a rapid, easy to digest format. Each book will focus on the one disease or patient group, and will include fairly common cases to get people to know they are doing things right if they follow the case guidelines. Each will be about 15–20 cases and 100–125 pages total with key pictures for each case. The deadlines/timelines for each title will be short and facilitate rapid publication models.

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Clinical Cases in Skin Cancer Surgery and Treatment

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Preface

Clinical Cases in Skin Cancer Surgery and Treatment is designed to be a guide for dermatologists, surgeons, family practitioners, residents and anyone who is engaged in the practice of cutaneous surgery to do with skin cancer. The case-study-based format allows readers to understand planning of procedures and surgical techniques, and the differing cases are designed to relate to different situations that may arise within dermatosurgery practices.

Clinical Cases in Skin Cancer Surgery and Treatment provides relevant surgical and anatomical tips, and finer points of surgical techniques gleaned from the author's experience. Each chapter covers a different type of case, flap or skin graft closure, and will help the attending physician or surgeon in improving their skill levels and knowledge. The author, who has been teaching cutaneous surgery for two decades, provides enough detail to allow residents or family practitioners to develop further competence in the surgical management of skin cancers, while ensures that this book serves as a useful guide. For more experienced cutaneous surgeons, the book helps in fine-tuning techniques and reinforcing good practice methods.

Auckland, New Zealand — Sharad P. Paul
Tampa, FL, USA — Robert A. Norman

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Chapter 1
Skin Cancer of the Ear: Mastoid Interpolation Flap Reconstruction Tips

Sharad P. Paul

Background

Skin cancers are very common on the ear, due to its unprotected position on the body during outdoor activity, and continuous exposure to the sun through the car window while driving. The incidence of squamous cell carcinomas on the ear appears to be higher than that of basal cell carcinomas – with reports suggesting squamous cell carcinomas being the most common (>50 %), followed by basal cell carcinomas (30–40 %), and less frequently, melanomas(<5 %) [1]. The ear has special considerations due to its lack of underlying subcutaneous tissue. This allows for the potential of early perichondrial involvement of cutaneous tumors. It is therefore important to always examine regional lymph nodes of the neck, especially in cases of squamous cell carcinoma and malignant mela-

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noma. When it comes to skin cancers of the ear with perichondrial involvement, up to a third of patients may have lymphatic spread [2]. Of course the goal following oncological resection is to recreate the ear to match the other ear; however as both ears are rarely viewed simultaneously in any facial view and may be partially or completely covered by hair, the size, position, and orientation of the ear to the scalp and anterior face may be more important than a geometrically exact match of the other ear. The most important skin-cartilage components that are necessary to make a recognizable ear are the helix, tragus, antitragus, and concha [3].

Many techniques have been discussed for reconstruction of the ear using flaps and grafts, after removal of skin cancer [4–7]. I am presenting a case of a malignant melanoma of the ear that needed a wider excision after excision of an initial 2 cm lesion (which was closed primarily with a wedge-excision after undermining) – in this case a mastoid interpolation flap was used after the wider excision. The technique of the retro-auricular mastoid interpolation flap, its planning and useful tips are detailed in this article.

Case History

A 62-year old white female patient presented with a changing pigmented lesion on her R ear. Clinical examination and dermatoscopy suggested a probable malignant melanoma in situ and the lesion was excised. The histological examination revealed a melanoma-in-situ and a malignant melanoma – Stage 1 A, Breslow thickness 0.3 mm, Clark level 2, non-ulcerated malignant melanoma.

Histopathology report:

EXCISION RIGHT EAR

Gross Description:

The specimen consists of a skin ellipse 24 x 14 x 5 mm with a central

variegated light and dark brown patch 15 x 6 mm. The entire lesion is processed.

SYNOPTIC REPORT FOR INVASIVE MALIGNANT MELANOMA

Tumour Type: Invasive malignant melanoma arising in an area of melanoma

in-situ

Clark Level: 2

Breslow Thickness: 0.3mm

Size of Invasive Tumour: 0.6mm width

Ulceration: Nil

Tumour Infiltrating Lymphocytes: Nil

Regression: Nil

Angiotropism: Nil

Lymphovascular Invasion: Nil

Perineural Spread/Neurotropism: Nil

Mitotic Rate: Not enough invasive tumour for a 1 sq mm count

Microscopic Satellitosis: Nil

Radial Margin of Excision: Margins clear of lesion. Closest melanoma

in-situ margin is 4mm. Closest invasive melanoma margin is 5mm.

Associated Nevus: Nil

SUMMARY DIAGNOSIS:

INVASIVE MALIGNANT MELANOMA, CLARK LEVEL 2, BRESLOW THICKNESS 0.375mm

MARGIN CLEAR

This tumor had an in-situ margin of 4 mm and the invasive melanoma had been removed with a margin of 5 mm. Margins for melanoma-in-situ have been the subject of recent debate. The accepted 5 mm guidelines were originally developed at a consensus meeting in 1992. A recent review in 2012, by a Moh's surgery team at a referral center for melanoma-in-situ suggested that the frequently recommended 5-mm margin for melanoma is inadequate. Standard surgical excision of melanoma in situ should include 9 mm of normal-appearing skin, similar to that recommended for early invasive melanoma [8]. Given our patient had a Stage 1 A invasive malignant

melanoma with an in-situ component, it was decided to wide-excise this excision site with 1 cm margins. An interpolation flap was planned (see Figs. 1.1 and 1.2) avoiding the hair-bearing area. Given the original lesion was already 2 cm in diameter, the ear was already tissue deficient and this created an additional challenge.

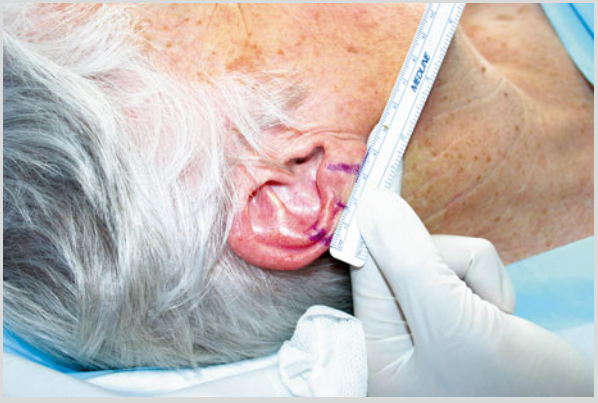

FIGURE 1.1 Ear wide excision plan

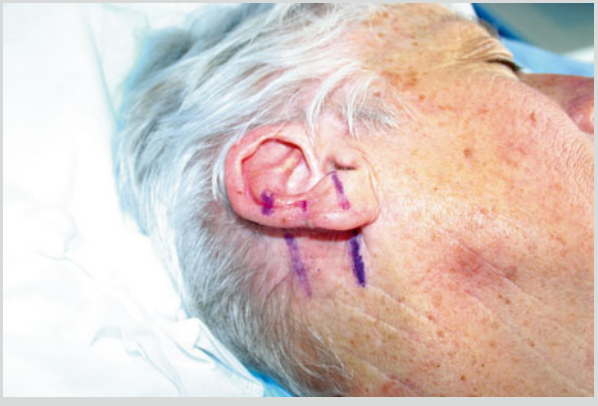

FIGURE 1.2 Ear interpolation flap plan

The Technique

The mastoid interpolation flap, which is the staged pedicle flap described herein, is very useful for helical ear defects when cartilage needs to be removed. It helps re-create a normal-looking ear. For smaller helical rim defects, a skin graft, cutaneous helical rim advancement flap, primary closure, or wedge resection often provides an excellent reconstructive result. Helical rim area can be a problem in itself with thin skin. However when cartilage needs to be removed, this increases the risk of perichondritis, which can be a surgical nuisance.

In a large series of patients after ear reconstruction, it was shown 2–4 % of cases become infected and may progress to perichondritis, if untreated [9]. Trauma, surgical or otherwise is the most common cause in nearly half the incidences of perichondritis and *Pseudomonas aeruginosa* the most common micro-organism isolated [10]. The treatment of such perichondritis is primarily antibiotics and surgical debridement when needed, and the antibiotic of choice is Ciprofloxacin [11].

It is important to secure hemostasis during the procedure and place a drain to prevent hematoma formation. If perichondritis develops in spite of antibiotics, which is rare, then it is important to aggressively drain any abscess early. Fortunately, this is very rare after elective surgery for skin cancer.

As a general rule, the initial reconstructive effort is aimed only at repair of the anterior portion of the primary defect. Re-creation of the helical rim and posterior primary defect coverage is done at the second stage – when the pedicle is detached and the ear is reconstructed. Some surgeons cut a template of foil or paper and lay over the mastoid to mark the outlines of the flap. It is important to avoid hair-bearing areas to avoid a hairy ear post-operatively. Rather than cutting out a template, I prefer to press the ear and lay it flat against the mastoid. Given that the excision margins are already marked on the ear, this allows to accurately plan the flap by continuing the markings onto the mastoid skin surface (Fig. 1.2). The combination of posterior ear, postauricular sulcus, and mastoid skin usually provides an

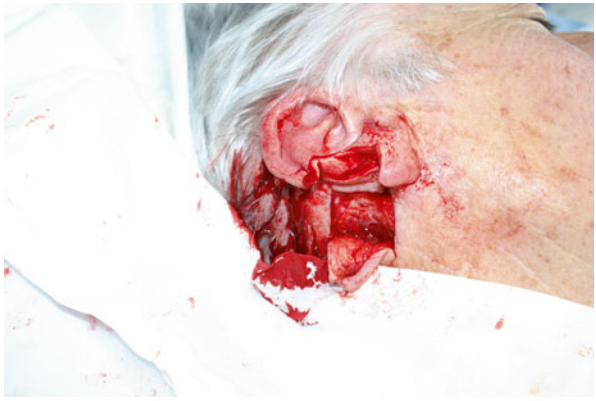

Figure 1.3 Ear mastoid interpolation flap being raised

excellent tissue match for the anterior helical soft tissue defect. The flap is elevated and the secondary mastoid scalp and primary anterior helical defect margins are slightly undermined to provide increased flap mobility (Fig. 1.3) [12]. In our case, some thinning of the flap was needed as the mastoid skin was thicker than the excised skin of the anterior helical defect. If the ear has a prominent helical rim curl with or without loss of the rim cartilage, a few double-armed or basting sutures may be placed through the cartilage into the anterior lip of the helical rim to recreate the natural curl [12].

Even with such sutures in place, it is often necessary to later on thin the flap to achieve perfect contours. I normally wait for 6 months post-operatively before planning any tertiary procedure such as this.

If the defect extends only to the helical rim, the flap can be started at the junction where mastoid skin meets the posterior ear. If the defect extends further medial to the scaphoid fossa or beyond, the flap incision is then ideally started on the posterior ear and extended onto the mastoid area. The flap should be sized slightly larger than the measured width of the defect and be long enough so that excessive tension is not placed on the flap after it is sutured [13].

FIGURE 1.4 Mastoid interpolation flap sutured in place with drain

Once the flap is sutured in place, a drain is inserted to avoid any post-operative collection or hematoma formation. I tend to use a Penrose or a 'glove' drain fashioned using a sterile surgical glove. Some authors prefer to use nasal packing or gel foam but in my experience, I have found this unnecessary. It is standard to apply a pressure dressing for 48 h, after which I usually remove the drain. I avoid suction drains (and prefer the glove drain) as the former are more bulky. I prefer to use a light dressing post-operatively which is not as noticeable (Fig. 1.4).

I usually divide the flap at 3 weeks. Some authors divide the flap at 2 weeks and suggest that there is little benefit to cutting the pedicle closer to the ear (Figs. 1.5 and 1.6). The reasoning here is that it is difficult to see how long the flap needs to be cut once it is sewn in place, there is a risk of making the flap too short [3].

One of the most important steps in this mastoid interpolation flap is that the incisions are made precisely around the outline of the flap, taking care to *preserve a vertical band of subcutaneous tissue at the ear-mastoid groove*. This preservation of tissue at the ear-mastoid groove is often overlooked and in my view is very important. This is seen in Fig. 1.3. where the flap has been raised and portion of the ear has been removed. This ends up the vascular pedicle that allows

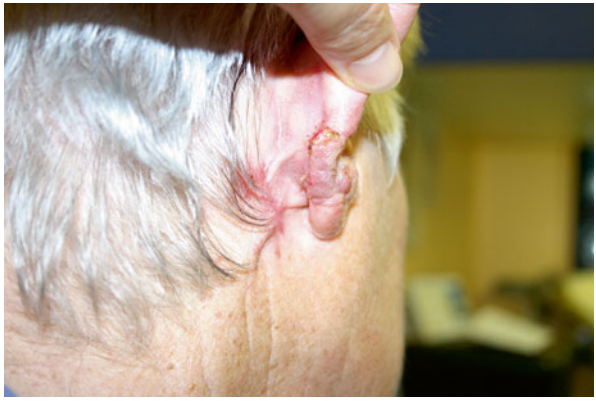

FIGURE 1.5 Flap division done at 3 weeks; image at 1 month postoperatively

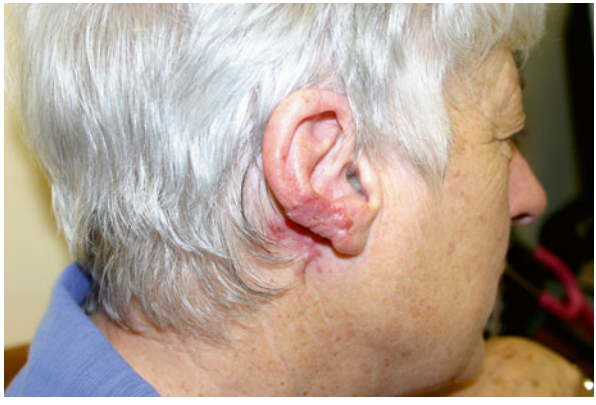

FIGURE 1.6 Post-flap division; image at 1 month postoperatively

the skin island to be passed onto the anterior surface of the ear to re-create of the shape of the ear back to its original shape. The donor defect is closed primarily.

One of the other important points to note in a case such as this – even where a significant chunk of cartilage has been

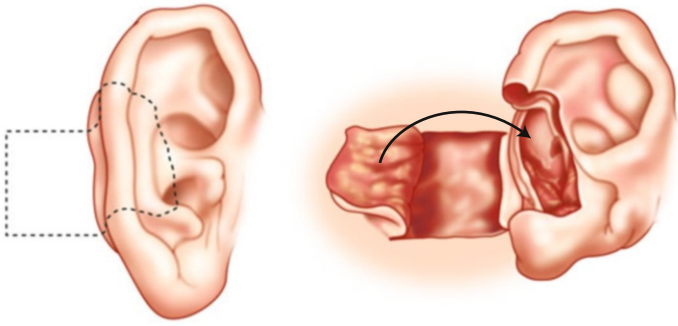

FIGURE 1.7 Illustration of mastoid interpolation flap used

removed, is that the restoration of ear cartilage support after resection is usually not necessary in concave hollows of the ear.

Cartilage support of the shape and position of the ear is maintained primarily by the shape and length of the helical rim and antihelix. Concave hollows such as the concha and triangular fossa add to the individual architecture and variations in ear shape but little to structural support. Therefore, when adjacent cartilage is still present, even when cartilage is removed the defect may be replaced by soft tissue only.

In summary, the post-auricular mastoid interpolation flap is an exceptionally useful tool to have in our armamentarium for the reconstruction of helical rim defects (Fig. 1.7). In my experience, it provides excellent helical contour when performed correctly and can be used after removal of large defects. In the case presented here, the patient already had a 2 cm lesion removed that turned out to be a melanoma. The wider excision was done to ensure 1 cm margins. Even allowing for all these factors, the patient ended up with normal ear contour, with minimal 'lipping'. Once the mechanism of the flap is understood, this is a relatively easy technique to execute, even if the procedure needs to be completed in two stages.

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Chapter 2
One Technique Fits All: The Versatility of the Full Thickness Graft on the Lateral Wall of the Nose

Sharad P. Paul

Background

It is extremely difficult to reconstruct the human nose to achieve anatomic perfection. The essential tropes of nasal reconstruction are support, lining and cover. There are many techniques used to reconstruct the sidewalls of the nose after cutaneous surgery for skin cancer – advancement flaps, pivotal flaps, island flaps and skin grafts. One of the problems with skin grafts and indeed virtually all scars is that they contract with time. Therefore choice of technique or skin graft should take these factors into account while planning reconstruction.

Some authors have even called the nose a separate aesthetic 'unit' of the face [1]. The nose is made up of concave

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and convex surfaces with several intervening ridges and valleys. The nose, from a reconstructive viewpoint has been divided into seven subunits – ala (2), sidewalls (2), dorsum, soft triangles and nasal tip. The subunit principle of nasal reconstruction suggests that if greater than 50 % of a nasal subunit has been removed or affected, then replacing the entire subunit gives a superior result to 'defect-only' reconstruction [2]. When it comes to lesions under 1 cm, some have suggested that a defect-only approach, rather than following the subunit principle should suffice [3].

In this case report, I discuss reconstruction of a large multi-subunit lesion on lateral aspect of the nose using a full thickness skin graft. Tips and techniques are discussed along with donor site selection. When it comes to the lateral aspects of the nose, the versatility of the full thickness graft and the defect-only approach when dealing with defects even >2 cm are discussed.

Case History

A 70-year-old lady underwent excision of a large basal cell carcinoma on the lateral aspect of her nose. After we achieved margin control, she was left with a large defect involving virtually the entire lateral aspect of her nose – the alar subunit and the nasal sidewall were involved with some extension onto the dorsum of the nose (Fig. 2.1). The defect extended to the perichondrium (but did not involve cartilage) in its depth. Even given the size and depth of this defect, I elected to use a full thickness skin graft taken from the pre-auricular region to close this defect as I felt it would give the best possible esthetic result. Of course, when dealing with skin cancer, these subunits cease to be purely aesthetic and should be more considered anatomical subunits.

The skin graft was 'quilted' in place with a quilting suture through the base of the wound (Fig. 2.2). This method allows me to avoid using a bolus or 'tie-over' dressing and therefore use a thin hydrocolloid or

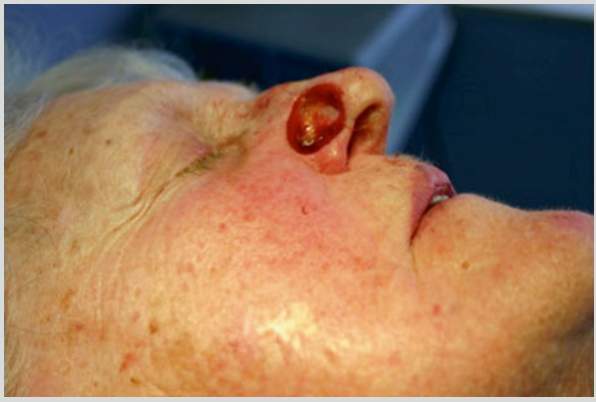

FIGURE 2.1 Large lateral nasal defect

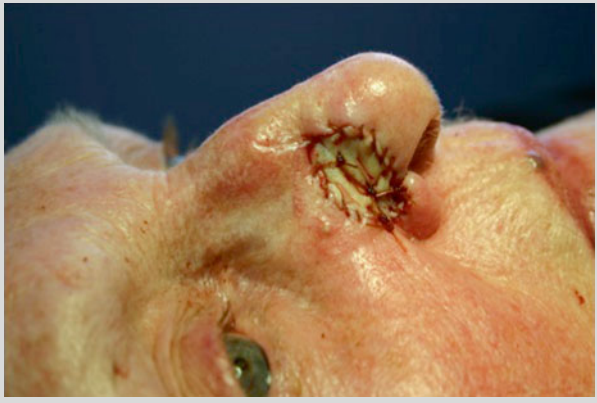

FIGURE 2.2 Skin graft sutured and quilted in place

foam dressing post operatively. One of the concerns when laying grafts on perichondrium is that graft take can be reduced by accumulation of fluid – seroma or haematoma, and it is important to try and reduce this risk. Tissue sealants or platelet gel and quilting sutures potentially provide an additional intra-operative modality for prevention of fluid accumulation.

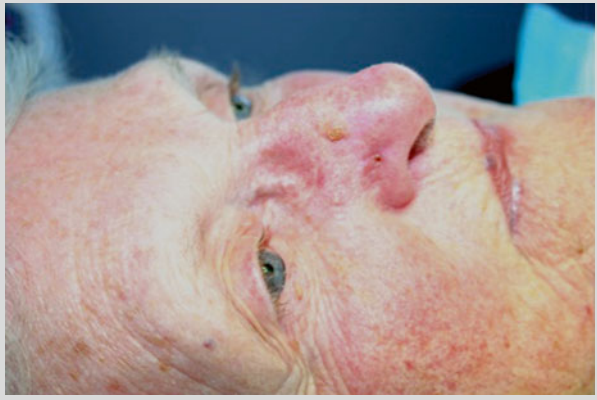

Figure 2.3 Postoperative appearance at 2 weeks

The mechanism is their ability to act as a hemostatic agent tissue sealant and improve wound healing [4]. When it comes to the nose and full thickness grafts, I have particularly found the quilting suture useful, both to reduce risk of fluid accumulation and to avoid using a bulky dressing post-operatively.

The initial graft dressing was done at 5 days post-operatively. After the surgery, the sutured graft was covered with a foam dressing (Allevyn, Smith & Nephew, Christchurch, NZ) and following that with a thin hydrocolloid dressing (DuoDERM® Extra Thin Dressing, ConvaTec, Australia) to make it inconspicuous.

The graft was fully healed at 3 weeks and did not leave any residual deformity, either contour or color mismatch. The image shown at 2 weeks post operatively shows some small suture granulomata on a well-healed graft (Fig. 2.3) due to my use of a continuous fast-absorbing braided suture (VICRYL RAPIDE™ (polyglactin 910) suture, Ethicon)

Discussion

Skin grafts have been known in surgery from circa 2500 BC, when Indian surgeons used them to reconstruct noses [5]. It was during this period the forehead 'Indian' flap was also developed to repair amputated noses (sadly, amputation was punishment for alleged adultery for women, and is still reportedly used as punishment in parts of the world such as Afghanistan). In 1875, Wolfe described the full-thickness skin graft that forms the basis for the technique described in this paper [6]. (As an aside, Wolfe was an interesting character, who threw himself into the war for unification of Italy along with Garibaldi [7]. After the war, he returned to his career as an ophthalmologist. Wolfe actually first described the full thickness skin graft as a method to correct ectropion of the eyelids).

Skin grafts have often been considered a less than ideal solution for closure of nasal defects due to the color mismatch they may cause. On the other hand, several plastic surgeons routinely use full-thickness skin grafts for large nasal tip defects. In my view, skin grafts are an excellent option when it comes to the lateral aspect of the nose, but not a good option for anterior surfaces of the nose such as the nasal tip or dorsum – because the color mismatch is more likely to become noticeable. On the lateral aspects of the nose, because light casts a shadow, minor alterations in color are often not noticeable.

It is good to review some general principles of reconstruction of the nose here, especially to do with full thickness skin grafting and also offer some useful tips and techniques.

It is more accepted that allowing for proper client and donor-site selection, a full-thickness skin graft can play an important role in reconstruction of lower third nasal defects, which were previously felt to be off-limits to skin grafts [8]. Unlike flaps which seem to be preferred to skin grafts (to avoid a color mismatch), a skin graft must recruit blood supply from the surrounding tissues at the recipient site. The stages in this process are well known: plasmatic imbibition, inosculation and the bridging phenomenon [9]. The bridging phenomenon is of particular use when laying grafts on

relatively avascular sites like the cartilage of the nose. As long as a portion of the defect is well vascularized, a skin graft can recruit vessels from this area to supply blood vessels to the graft overlying the avascular recipient site [10].

I generally perform the procedure under local anesthesia. Contact between the graft dermis and the recipient bed is critical for inosculation – however, I do not aggressively de-fat the graft – it is gently de-fatted using scissors and not by scraping, as in my view that can damage valuable dermal blood vessels. The donor site selection is critical, especially to match 'like with like,' as thickness of skin on the nose varies. The skin of the lower third is thick and composed of sebaceous glands, unlike the thin skin of the upper two-thirds of the nose [11]. While some authors do not prefer fenestration of the graft, I tend to make slits that not only allow fluid or blood to escape, but also to allow for easier quilting of the graft via those fenestrations. If the lesion extends to the alar rim, then it is not suitable for a full thickness graft as the 'alar notching' this causes can be unsightly. Suitable donor-sites are pre-auricular, post-auricular, glabellar and naso-labial region skin. Some authors specifically use non-absorbable sutures [12]. Some authors suggest that systemic antibiotics with an appropriate bacterial spectrum should be advised in full thickness skin graft reconstruction after surgery for non-melanoma skin cancer of the nose [13]. In my experience of performing skin grafts on the lateral aspect of the nose routinely for large nasal defects, I have not found empirical use of antibiotics has added any value. I also prefer to use absorbable sutures so that there is no need for suture removal and keeping the graft moist with dressings or ointment speeds up the resolution of the sutures.

As mentioned earlier, I do not aggressively de-fat the skin graft. In fact, in deeper defects, which may cause a contour defect and leave a 'pit', I find retaining the fat useful. This concept of skin-fat grafting of the nose and its usefulness has also been commented on by other teams [14]. If anything this makes skin grafting of the nose easy and more versatile.

In keeping with the principle of matching skin thickness, the naso-facial sulcus is often an excellent donor site. Some authors feel that the utility of the naso-facial sulcus is such that it should be considered as a primary donor site for full thickness skin graft repairs of small to medium-sized defects of the alar and distal nose [15]. However, in some men, the hair-bearing potential of the melo-labial skin may preclude it as a donor site [16].

After a review of the appearance of full-thickness grafting cases, the authors offered the following seven suggestions: [17]

1. For the thicker skin of the nasal ala and tip, conchal bowl or pre-auricular skin prove an ideal match owing to the matching number of sebaceous glands. The post-auricular skin is thinner and less exposed to the sun and is used for grafts for the nasal sidewall.
2. If any area of the donor skin has actinic keratosis or seborrheic dermatitis, another site is chosen.
3. If there is scarring from previous surgery, this skin is avoided.
4. The conchal bowl is limited in its size as a donor site, and for larger grafts, either a pre-auricular or post-auricular site is selected.
5. If the recipient site shows severe sun damage with elastosis and telangiectasia, prefer the pre-auricular skin followed by the conchal bowl skin is preferred.
6. Because the nose tip is convex, defects in this area are covered with conchal bowl skin, which is concave and will fit a convex surface.
7. On the nose tip or ala, whenever the superior margin of the defect can be closed vertically as a partial elliptical closure, the resulting dog-ear grafts may be used to fill the remaining defect.

In a study comparing flaps and grafts, it was noted that grafts are less acceptable cosmetically for nasal-tip defects after Moh's surgery [18]. Recent advances have also suggested using adipose-derived-stem cells without skin grafts [19]

to close nasal defects but full thickness skin grafts are a much simpler option.

As I mentioned earlier, I also personally avoid grafts for the nasal tip. However, *for nasal sidewall and lateral aspects,* full thickness skin grafts offer an excellent outcome.

Some authors also fenestrate the grafts like I do, and also stress that the key to the success of this graft is maintaining a firm, constant and equal pressure over the graft in order to prevent separation from the vascularized surface by haematoma [20]. In my experience, I find this is easily achieved by quilting the graft onto the perichondrium, when the graft has to be laid on cartilage.

In conclusion, full thickness skin grafts can be the default or 'go to' option for lateral defects of the nose, even for distal parts of the nose (as long as the defect does not involve the alar rim). A full thickness graft is easy to perform, versatile and the tips and techniques described above can help the surgeon achieve excellent results.

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Chapter 3
Islands on the Cheek: Island Flaps on the Cheek and a Modified Oblique-Sigmoid Flap

Sharad P. Paul

Background

Cutaneous island flaps have long been used in plastic and dermatologic surgery to reconstruct cheek defects following excision of skin cancers. One of the first to use such an island flap was the German Surgeon, Ernst Blasius (1802–1875), who described this technique in the closure of skin defects in 1850 [1]. As we know, The design of a V-Y flap is very simple. The principle is to use skin from an area of relative excess to fill an area of deficiency. A "V"-shaped flap is incised adjacent to and advanced into the defect [2]. However, one of the major problems with the V-Y advancement flap when used as

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a cheek advancement flap is the vertical scar, which violates the relaxed skin tension lines of the cheek [3]. Therefore it is best reserved for lesions alongside creases such as the nasolabial fold. Defects involving the lower eyelid region on the cheek can be challenging because of the unique anatomical arrangements of the structures in this region. One of the risks of using V-Y advancement flaps are poor scars and ectropion of the lower lids [4]. It is important to assess this risk preoperatively. The "pinch test" and "snap back test" are used to detect the presence of lower lid laxity. The result is abnormal if the lid can be distended more than 6 mm from the globe or does not briskly returns to its natural position [5]. Gravity may also exert a pull on the lower eyelid leading to delayed ectropion formation in inferiorly based island flaps on the cheek. Therefore it is often advisable to anchor the flap to the periosteum of the lower orbit [2]. Standard technique in such situations is to anchor the flap dermis to the periosteum of the infraorbital rim with permanent sutures. While some surgeon use absorbable sutures, I prefer to use 4.0 nylon or polypropylene permanent sutures in this situation.

Larger V-Y flaps can be complicated by their gravitational weight and contraction that can pull down on the lower eyelid margin despite the appropriate orientation of tension vectors [6]. In the author's experience, such ectropion formation is often delayed and noticeable after several months, even a year post-surgery. There are also problems with using a pedicle flap against a skin crease line – while using a island flap, the tension across the flap suture line tends to aggravate skin tension and leads to trap-door deformity. In contrast, when using a transposition flap such as a bilobed flap, the tension across the line of closure will result in pin-cushioning of the flap.

In this case report, we review the oblique-sigmoid island flap and our modification of the flap to suit lower eyelid defects and cheek defects against the RSTL. Given the tension vectors and the orientation of the scar, it reduces both

the risk of ectropion and also scar contraction – given the scar is not orientated vertically, and therefore gravity plays less of a part.

Case Study

This 65-year old patient presented with a large left lower eyelid skin basal cell cancer. The horizontal lie of the lesion meant that primary closure was not possible if following the relaxed skin tension lines.

Pre-op assessment revealed the risk of ectropion given her lax lower eyelid skin. Further given the orientation of the lesion, closure against the RSTL on her mid cheek would leave a poor cosmetic outcome. It was decided to use a modified sigmoid-oblique island flap. Figures 3.1, 3.2, and 3.3 shows the RSTL as well as the orientation of the excision 'ellipse' being against the RSTL. The illustration (Fig. 3.4) shows the tension vectors of the oblique-sigmoid

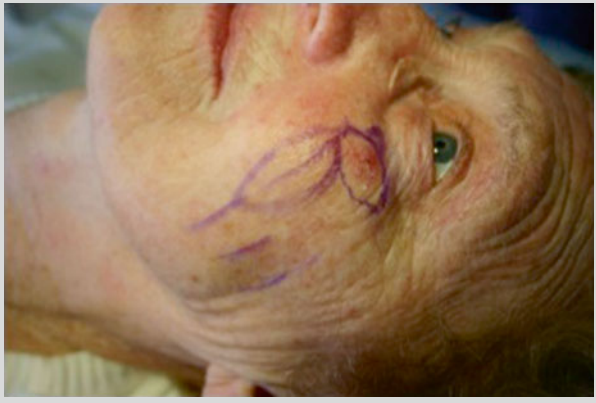

FIGURE 3.1 Sigmoid oblique flap plan

island flap. The clinical photographs show my modification of the oblique-sigmoid flap and the discussion below details the technique as well as offers helpful tips and techniques.

FIGURE 3.2 Sigmoid oblique flap being raised

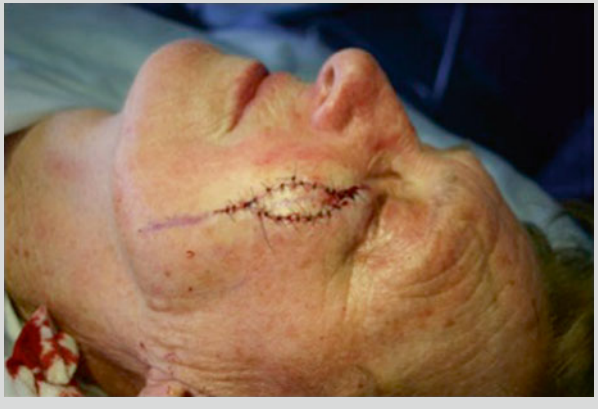

FIGURE 3.3 Sigmoid oblique flap sutured

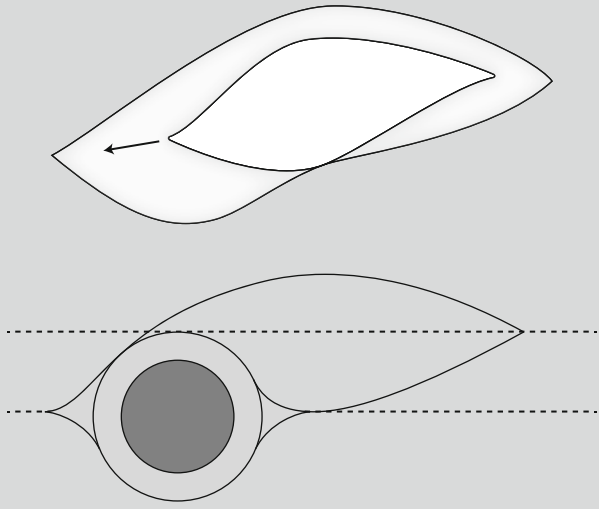

FIGURE 3.4 Sigmoid island flap

The Oblique-Sigmoid Island Flap

The oblique-sigmoid island flap was originally described by Ono and colleagues [7]. The design was developed as an attempt to overcome traditional problems with cutaneous island pedicle flaps [8] – trapdoor formation, depressed scar (due to orientation of scar against RSTL or vertical scars on the cheek) and dog-earing.

The Technique

The tumor is excised with adequate margins. Ono originally described a circular excision of the tumor. In my experience, we can simply excise the lesion with adequate margin without paying attention to the exact shape. Ono describes creating

triangular skin flaps 1–2 mm in length. This is a particularly important step in my view and it is especially important to orientate the tips of these isosceles triangles in the direction of the RSTL as per the illustration and clinical photographs. A subcutaneous island pedicle flap is created – this has a lazy-S orientation facing the defect and a spindle-shape on the other side (see clinical photographs). The flap then slides in an oblique fashion to close the defect. It is this oblique advancement that reduces the risk of ectropion formation for lower eyelid defects. In my experience, as in Ono's original review of 32 patients, we don't usually see trap-door formation or depressed scars, which are relatively common with island pedicle flaps on the cheek – especially if attention is paid to 'unfolding' the pedicle while dissection (explained further below). Further, as the post-operative scar is spindle shaped, and orientated along the RSTL, this allows for a much more natural contour defect post-operatively.

It is worth spending some time in discussing the mobilization of subcutaneous island pedicle flaps and the approaches espoused by various authors. Field described a technique wherein longitudinal dissection is done through the pedicle – this effectively creates a bi-pedicled flap is the safest in terms of preventing disruption to the sensation of the flap [9]. Dzubow advocated incising the underlying muscle on all but one side to allow the flap to swing on a muscular pedicle [10]. Heller, on the other hand Heller, describes elevating the flap on a long horizontal pedicle [11].

Chan [12] has described an elegant technique of dissecting island flaps, which in my experience helps to reduce the pin-cushioning that can occur with island flaps. This unfolding of the pedicle also creates less bulkiness post operatively. In Chan's method, defect XY is created as shown in Fig. 3.5. (my modification of the Chan technique) – A triangular advancement flap AX is marked out. The leading edge of the triangular flap X is undermined just deep to the sub-dermal plexus to about *a third of its length* B. The tail of the Flap A is then undermined towards the defect, going deeper at a 30° angle as one approaches the defect, to *about half of the length* of the

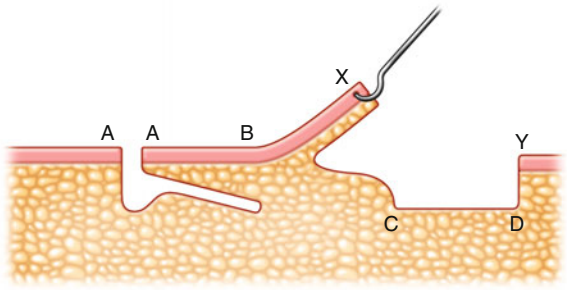

FIGURE 3.5 Dissection technique of Island flaps cheek

flap. An oblique subcutaneous pedicle AC is therefore created. The flap is then advanced using AC as a long oblique pedicle, helped by the "unfolding" of the flap BX when the leading edge of the flap was undermined to create the pedicle.

For small defects where there is adequate mobility of the subcutaneous tissue, conventional methods of lateral undermining may be sufficient to advance the flap and no undermining beneath the flap need take place – allowing the flap to 'sit-on' the defect. However, when larger defects are concerned (and in this case report I am discussing the use of oblique-sigmoid island flaps to close a large defect >1 cm) conventional techniques of dissecting the V-Y island flap (or indeed any island flap) prove inadequate. This dissection technique often avoids the need for undermining.

If the pedicle of the flap is totally free from any tethering tension, then the caudal part of the flap can be sutured on to the adjacent skin on each side for support and the cephalad part of the flap, under no tension at all, can be "stacked" on itself with an abundance of tissue to support the lid margin [12].

When compared to the V-Y island flap, the oblique-sigmoid flap has a narrower width (as it is more elliptical, rather than a triangle) and this serves to exert some horizontal tension, which in turn reduces the risk of lower eyelid ectropion.

One of the problems with island flaps in the loss of sensation that can occur due to the dissection and patients need to

be warned about numbness. In 1975, Field described a new method of dissecting island flaps of the cheek. He originally developed it as he grew 'disenchanted' with the post-operative bulkiness -- his method of undermining and effectively creating dual neurovascular pedicles [13] has been shown to reduce the risk of post-operative loss of sensation. While I have found Field's method useful for V-Y island advancement flaps, for the oblique-sigmoid flap, due to its design characteristics, the method I described earlier – of creating an 'unfolded' pedicle works well.

In discussing the oblique-sigmoid flap, some authors have noted the reduced incidence of pin-cushioning using this technique when compared to others. When a surgeon removes a lesion, the skin edges fall back due to elastic recoil of the dermis. This creates a wound that is initially 20–30 % wider than the defect. As healing occurs over the next days and weeks, the skin around the defect contracts. The amount of contraction depends on the site of the defect. If the width of the flap has been made equal to that of the immediate defect, contracture of the wound edges will cause the flap to buckle upward or "pop up," i.e. pin-cushion [14].

Ono originally described the defect for removal of small skin tumors of the cheek under 1 cm. In my opinion, for such small tumors undermining and primary closure utilizing the RSTL often achieves superior results when compared to the island flap. In my modification, this flap becomes very useful for larger cheek defects and lower eyelid defects – especially where the vectors of excision lie against the RSTL.

In conclusion, the oblique- sigmoid flap is an excellent technique to use on the cheek when an island flap is planned. It has less complications when compared to traditional V-Y advancement flaps and allows for a scar that is more aligned with the normal contours of the cheek. I reserve the V-Y island flap when the lesions are located along the nasolabial crease. For mid cheek and lower eyelid lesions the oblique-sigmoid flap, modified using the techniques I have described above, makes a good choice.

However, we must pay heed to Blasius, who is credited with inventing the island pedicle flap for closure of cheek

defects. Blasius stressed: "Die Heilung erfolge per primam intentionem." Namely, the best healing is by primary closure. It was his intention to convince surgeons that primary closure in plastic surgery is superior to all other methods and that is something that must not be forgotten in our eagerness to try out new techniques.

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Chapter 4
Rotation Flaps of the Scalp: Study of the Design, Planning and Biomechanics of Single, Double and Triple Pedicle Flaps

Sharad P. Paul

Background

The scalp is a common site of skin cancer. Rotation flaps are considered workhorses when it comes to reconstructing scalp defects following skin cancer surgery or after surgery to correct alopecia. These are 'random flaps' i.e. depend on the vascular supply of the subdermal plexus and not based on a named skin perforator or specific cutaneous artery (the latter are termed 'axial' pattern flaps). The length of the random flap depends on the intravascular resistance of the supplying vessels and the perfusion pressure. When the perfusion pressure drops below a critical closing pressure of the arterioles in the subdermal plexus, nutritional blood flow ceases and flap ischemia occurs [1].

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Another way to differentiate random flaps is to classify them based on it their movement: is pivotal (rotating about a pivot as in rotation, rhomboid or bilobed flaps) or advancement flaps (wherein the skin is advanced forward with little sideways movement).

When it comes to rotation flaps, there is a biomechanical difference when compared to advancement flaps (even if rotation flaps do have a component where skin is 'advanced'). In an advancement flap, the length to width ratio is critical. In a rotation flap, the traditional concept of a width-to-length ratio does not dictate flap survival – rather perfusion pressure becomes more important [2].

As the name indicates, the rotation flap is a hemicircular flap and closure of a defect is effected by gently rotating skin about a pivot, along the perimeter of a portion of a circle. Typically, rotation flaps are designed to move along an arc of 30° or less with the radius approximately two to three times the diameter of the defect and the arc length approximately four to five times the width of the defect [3, 4].

In these case studies, I review the different types of rotation flaps and the methods of adapting these flaps to close large defects of the scalp following cutaneous surgery for skin cancer. A detailed explanation is given of the different tension vectors and the orientation of different types of rotation flaps. While single, double and triple pedicled rotation flaps may be considered similar, they each have different biomechanical considerations that need to be taken into account while using these flaps to close large scalp defects.

Case Study 1

A 75 year old lady presented with a 3 cm keratinizing non-healing lesion on her scalp that she had attributed to trauma. Biopsy had proven this to be a squamous cell carcinoma. The lesion was excised. It was decided to avoid a skin graft as it would leave an area of hair loss. I elected to perform a single rotation flap as per the figures (Figs. 4.1, 4.2, and 4.3). The biomechanics and planning of a single rotation flap are discussed.

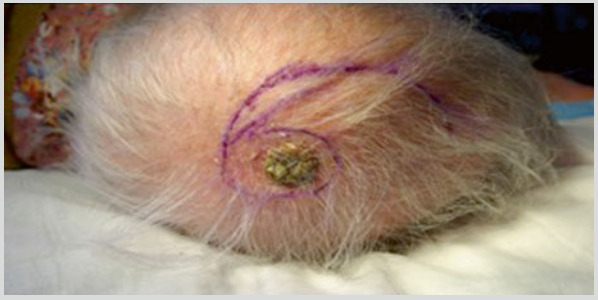

FIGURE 4.1 Single rotation flap plan

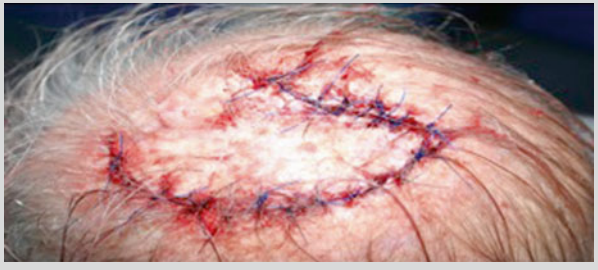

FIGURE 4.2 Single rotation flap sutures in place

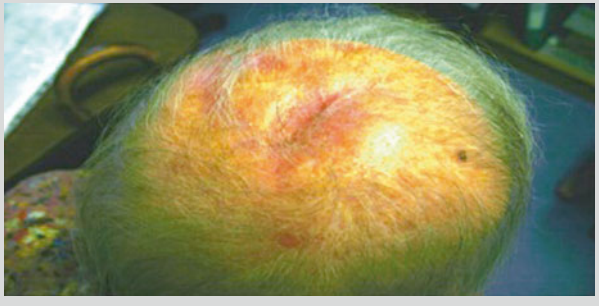

FIGURE 4.3 Single rotation flap post op

Case Study 2

A 65 year old lady was referred to my clinic with a large 3 cm basal cell carcinoma on her scalp. A skin graft would had left her with a 3 cm area of hair loss. A skin graft would also result in a color-mismatched contour defect. It was not possible to close this defect primarily.

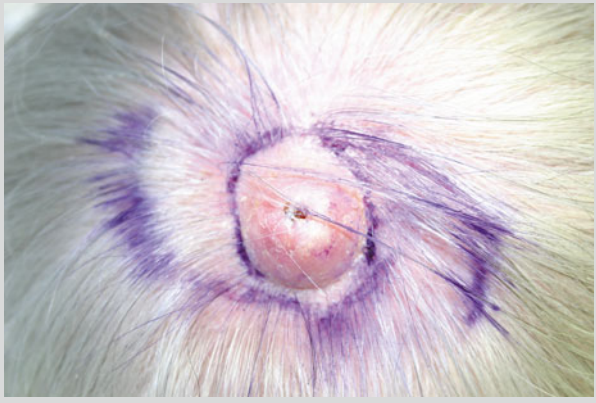

FIGURE 4.4 Double rotation flap plan

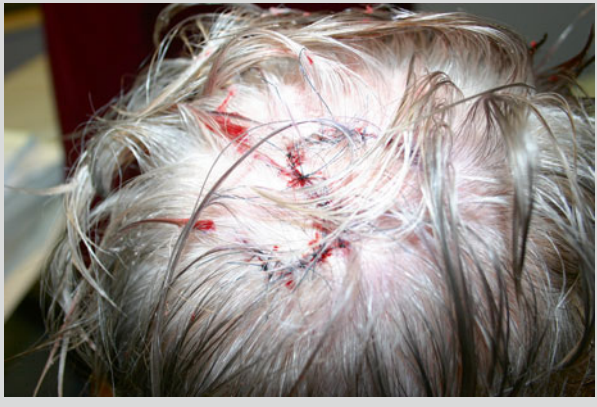

FIGURE 4.5 Double rotation flap sutured in place

I elected to use a double rotation flap (O to S flap) as the biomechanics and line of closure would not distort the hair pattern at the vertex and also allow for a smaller area of mobilization than if I had used a single rotation flap. The planning and biomechanics of the double-rotation flap is discussed (Figs. 4.4 and 4.5).

Case Study 3

A 60-year old bald gentleman was referred with a large 3.5 cm exophytic lesion on his scalp which turned out to be a squamous cell carcinoma. Options of closure in this case involved a skin graft (given the gentleman was already bald), a single or double rotation flap. On examination of the scalp, due to previous radiotherapy to the scalp (not close to the present lesion) there was limited mobility to allow for a rotation arc of a single rotation flap. While, the O to S (double rotation flap) was also an option, I elected to use a tripolar-rotation flap given the location of the lesion at the vertex of the scalp. I have found this particularly useful on the vertex of the scalp where dissection of each of the pedicles is begun at 3, 7 and 11 O'clock positions. The planning of this flap is discussed. Unlike a 'Mercedes Flap' this flap is more a rotation than an advancement flap (Figs. 4.6 and 4.7). While

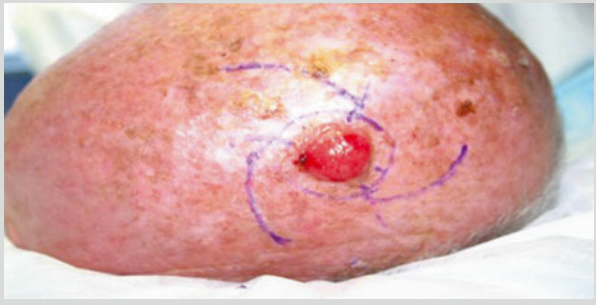

Figure 4.6 Triple rotation flap plan

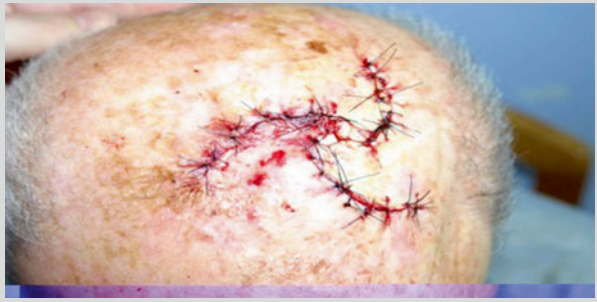

FIGURE 4.7 Triple rotation flap sutured in place. The bruising was temporary and flaps remained fully viable

there was some bruising of the flap at the end of surgery the flaps remained fully viable with no tip necrosis or need for any further dressings or procedure.

The Single-Rotation Flap

The classical rotation flap is pivoted around a fixed point at the base of the flap and rotated along an arc toward the defect (Fig. 4.8).

Classically, rotation flaps are designed to move along an arc of 30° or less with the radius approximately two to three times the diameter of the defect and the arc length approximately four to five times the width of the defect [4].

Larrabee conducted a series of elegant experiments [5] to test the tension and closure lengths of rotation flaps. He created a series of single rotation flaps. The variables he measured included the radius of each semicircle, the size of the defect, and the amount of undermining that was needed to close the defect using the flap. He also measured the force needed to close the defect at each stage i.e. no flap (primary closure), 45° flap, 90° flap, 135° flap and 180° rotation flaps.

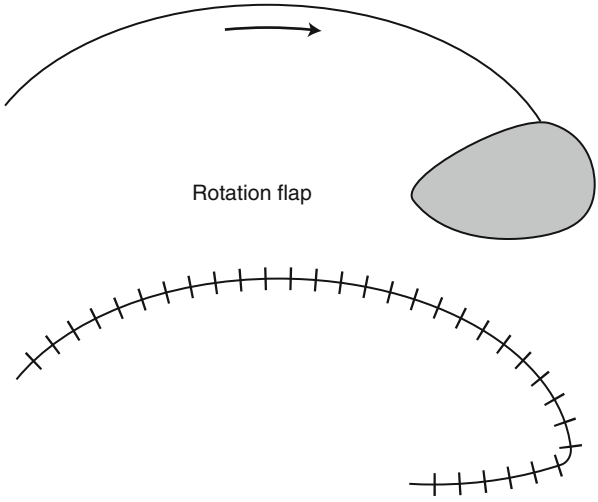

FIGURE 4.8 Rotation flap

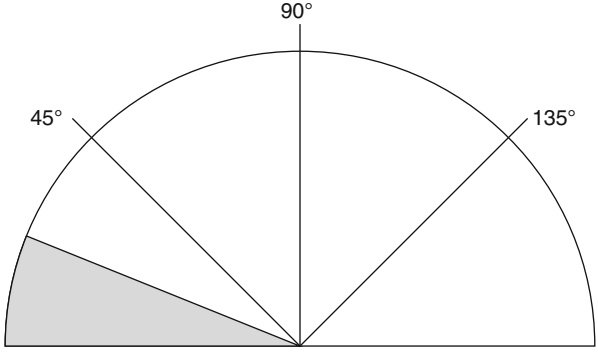

FIGURE 4.9 Rotation flap biomechanics

What he found was that tension was concentrated at 90° and 135°. In other words, *extending the semicircle of the flap beyond 135° did not allow for easier closure, although sometimes there were cosmetic indications for doing so* (Fig. 4.9).

In another series of experiments, Throckmorton [6] and others studied the relationship between the length of the incision and the amount of linear movement required to cover a defect using a rotation flap by trigonometric analysis. Their analyses showed the amount of flap stretch required to close defects, assuming a 2-dimensional surface and uniform 'deformation' of the flap during rotation. They found that for any incision longer than twice the diameter of the defect, the linear distance that the flap must be rotated ends up between 1.0 and 1.5 times the diameter of the defect.

They concluded that *extending the incision beyond twice the diameter of the defect produces only a small decrease in the required linear movement of the flap and a small decrease in tension*. Therefore there is little benefit in extending the incision. I usually remove the lesion with adequate margins and do not create a triangle as advocated in the classical rotation flap design. After the flap is rotated, I simply remove the dog-ear at the end.

Throckmorton's trigonometric analyses suggest that a ratio of 1.6:1 represents the ideal proportions of flap length to defect diameter [6]. However, the effect of altering the curvilinear 'releasing' incision was not addressed by their mathematical model. We have already discussed that the arc of closure is usually four to five times the width of the defect and this seems to be the norm. When it comes to the scalp, the single rotation flap usually faces antero-posteriorly.

The Double-Rotation Flap or the O-to-S Flap

The 'O to S' flap may appear like a single rotation flap performed on two fronts (Fig. 4.10), but biomechanically it is a different flap. The fundamental necessity to perform this flap is the availability of lax tissue on opposing sides of the defect (Fig. 4.11) Therefore each flap is rotated and fixed at about half of a hemi-circle i.e. 90°. Because the final shape ends up as a zigzag resembling a 'S' or 'Z' shape, this flap is variably referred to as an O-to-Z or O-to-S flap. While the two flaps are identical and opposite to each other, this design tolerates some discrepancies in size and therefore allowances

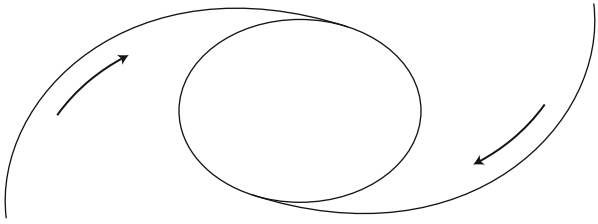

FIGURE 4.10 O to S flap

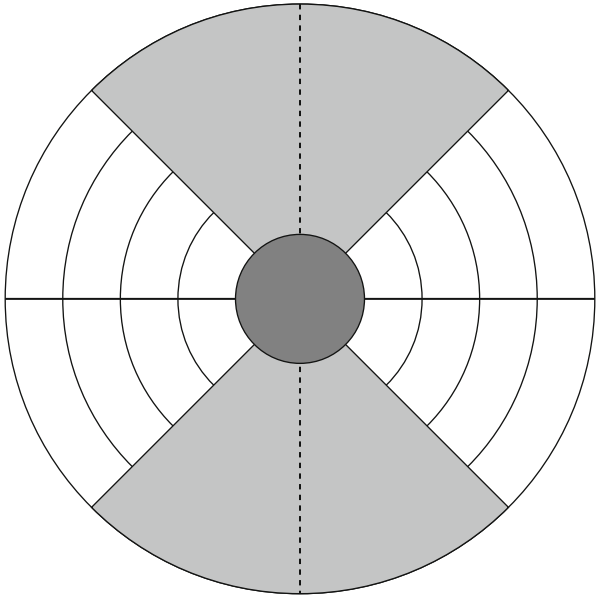

FIGURE 4.11 O to S flap

can be made to fit the flap in with sub-units or contours of the face. For an anterior scalp defect, for example, it is often necessary to extend the scalp flap incision further than the forehead/temple to achieve equivalent mobility of the inelastic scalp tissue [7].

Buckhingham [7] and colleagues undertook a series of cadaver experiments to study the biomechanics of the O-to-S

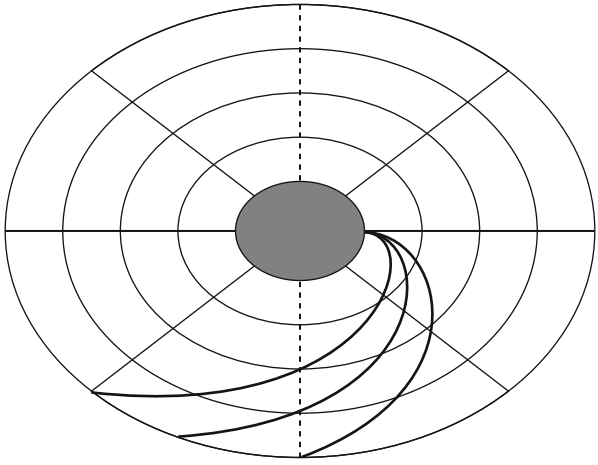

FIGURE 4.12 O to S flap biomechanics

flap. They drew concentric circles and measured flap angles as well as lengths by increasing lengths to 2, 3, 4 and 5 radii. They found that optimal design is achieved by selecting a starting-point of the flap (on the defect) and creating a curvilinear flap with points 45° from each other at 2, 3, and 5 radii. However, their experiments came up with an important finding: While 45° is the optimal angle for these flaps, undermining alone confers no advantage to decrease closing tension without accompanying flap incision, and incising the flap farther than 4 radii did significantly reduce the closing tension in this study (Fig. 4.12). Therefore, they concluded that flap lengthening or increased undermining beyond 4 radii did not confer any advantage [7].

The Triple or Tri-polar Rotation Flap

While using multiple flaps is often needed on the scalp after cutaneous surgery for skin cancer, these techniques were first popularized by wartime surgery [8]. On the basis of the original three-legged incision introduced by Cushing, Gillies

described the curved tripod, also known as the Isle of Man flap, due to its similarity to the Viking sun symbol on the Isle of Man crest. This was the forerunner of the triple rotation flap of the scalp [9].

A crude way to understand the biomechanics of a triple rotation flap is to consider the purse-string suture. Many authors have advocated undermining and the use of a purse-string suture to close circular cutaneous defects [10, 11]. Indeed, circular defects are quite common on the scalp after excision of skin cancers. However, the purse-string suture is rarely used because the skin of the scalp is not as easy to mobilize in a circular fashion, as tension lines tend to run horizontally. Further, attempting such closure may not only cause puckering and buckling of the skin, but also results in poor scarring or wound breakdown [12]. A modification of the purse-string principle and the rotational elements of the 'Isle of Man' flap led to the original 'Mercedes' flap (named because the design is similar to the insignia of the vehicle) – in this, three points are chosen around the defect depending on the direction or length needed for the three 'arms' of this formation. Three flaps are then 'advanced' (rather than rotated) as indicated in the illustration (Fig. 4.13. 'B' shows this direction of the advancement).

When the tripolar flap is planned using triple rotational flaps, the resulting closure ends up like a pin-wheel or the closure of a traditional camera lens. In a review of the triple rotation flap, the authors concluded that the triple rotation flap appears to serve best the essential purpose of immediate expedient coverage of the defect and primary closure of the donor area, permitting distribution of tension over the surrounding scalp away from the suture lines [13].

When I utilize this flap for scalp defects after skin cancer surgery, I reserve this flap for vertex of the scalp defects. Given hair follicles tend to form a 'whorl' here, it is easy to orientate the flap antero-posteriorly at the 3, 7 and 11 O'clock positions at the vertex of the scalp (Fig. 4.7)

In conclusion, scalp rotational flaps are extremely useful in closing circular defects of the scalp >2 cm after excision of skin cancers and are a superior alternative to skin grafts – as

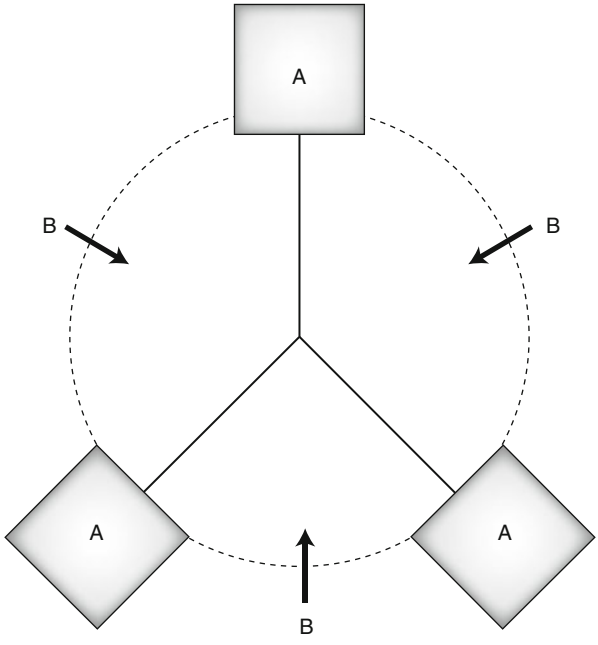

FIGURE 4.13 Tripolar advancement flap

they avoid creating areas of alopecia and do not leave a contour defect as split-skin grafts tend to do. However, single, double and triple rotational flaps have different geometry and biomechanics and it is therefore useful to revisit their general principles as I have done here. Closing the scalp without tension is important as tight closures in the scalp can lead to necrosis and skin loss which may in turn lead to more complicated bare-bone defects.

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Chapter 5
Double-Advancement 'H' Flaps for Very Large Defects of the Forehead: Design, Planning and the Use of Sub-periosteal Dissection to Increase Mobility

Sharad P. Paul

Background

Celsus, of ancient Rome, is the first person credited with using advancement flaps to close skin defects. In the early 1800s, French surgeons described and advocated advancement flaps under the term "lambeau par glissement" (sliding flaps) [1]. Since then these flaps have become widely used to close skin defects, especially those of the forehead.

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The forehead is a large and highly expressive and dynamic cosmetic unit. Most forehead defects that cannot be closed primarily are reconstructed with laterally based advancement flaps [2]. As with any cutaneous defect, options for closure include secondary intention (no closure), primary closure, skin grafting and rearranging adjacent tissue as a random cutaneous flap. Of course tissue expansion works well but not only does this need two stages, but it is inconvenient for a patient to be walking around with the noticeable bulge of a tissue expander under the skin of his forehead. Rotation flaps work very well on the scalp as we have discussed, but given their scar-line runs across forehead crease lines, they offer a poor choice for reconstruction of forehead defects. Skin grafts are routinely performed by many plastic surgeons for mid-forehead defects. However, in my opinion, skin grafts are a poor choice for the middle of the forehead, as they tend to leave a very noticeable color mismatch.

It is extremely common to use advancement flaps on the forehead, as their incision lines can be hidden among forehead wrinkles. For larger defects, bilateral advancement flaps are useful and for lateral forehead and temporal defects, transposition flaps are often used [2, 3]. Within the dermis there are two distinct vascular arcades: a superficial vascular plexus that runs between the reticular and papillary dermis, and a more robust deep vascular plexus or "subdermal" plexus that runs between the reticular dermis and subcutaneous tissue [4]. As the advancement flaps become longer to close larger defects, it is important that the dissection is progressively deepened towards the base of the flap to ensure supply from the larger-bore vessels.

Advancement flaps depend on the advancement of the surrounding tissue along a linear axis to close a defect (Fig. 5.1a, b illustrate double advancement flaps). The advancement of two skin edges from a fusiform skin excision represents the simplest of advancement flap design [4]. Classically, advancement flaps have a length-to-width ratio of 1:1 or 2:1 [5, 6] – and going beyond 3:1 may lead to flap necrosis.

Advancement flaps are reliant on a random pattern blood supply, which comes from the anastomoses within the subdermal

or dermal plexus. The perfusion pressure of feeding vessels and intravascular resistance determines the viable length of an advancement flap. In well-vascularized areas such as the forehead and scalp, it is possible to sometimes go beyond the 3:1 length-to-width ratio.

However, closure of very large >5 cm defects can pose a great challenge for the cutaneous surgeon. Reconstruction of the forehead using bilateral advancement 'H' flaps is discussed here, with my preferred method of increasing tissue mobility by utilizing the concept of sub-periosteal undermining.

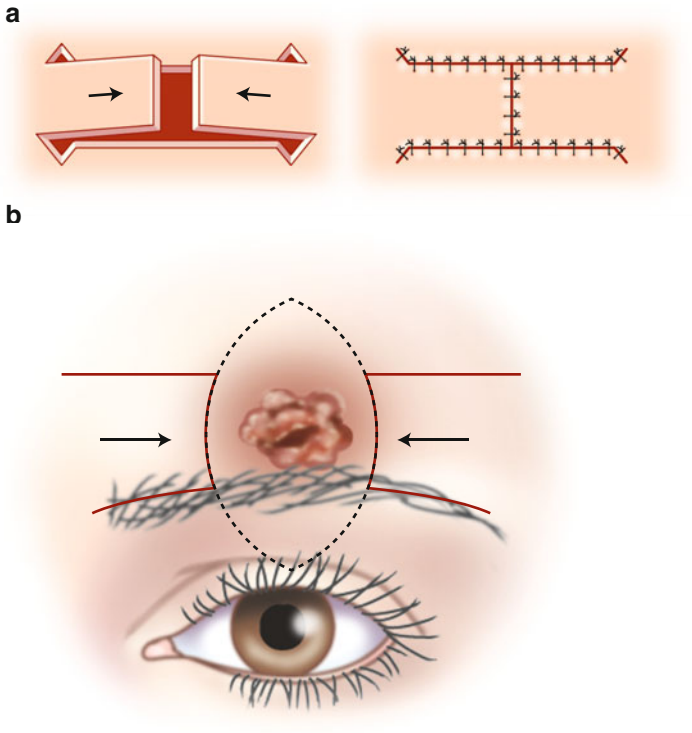

FIGURE 5.1 (**a**) H-advancement flap design. (**b**) Advancement flap illustration

In this context, the relevant anatomy of advancement flaps, the underlying structures of the forehead, dissection techniques and a review of advancement flaps is undertaken.

Case Studies

1. A 36 year old Chinese gentleman presented with a large 5 cm squamous cell cancer on his forehead. Firstly the diagnosis was unusual for his skin type, especially given his age. This further posed a reconstructive conundrum – if the flap involved the lower forehead, it would pull his eyebrows closer together. Obviously, a lesion of this size could not be closed primarily. I decided to use a double-advancement flap with one of the incisions extending onto the frontal hairline. This minimizes the visible scar on the forehead. I have found this useful forehead in patients with few wrinkles on the forehead, as if often the case in young Asians. Secondly, dissection was proceeded in the sub-periosteal plane in the temporal scalp to gain further mobility of the skin flaps and to achieve primary closure (Figs. 5.2 and 5.3).

FIGURE 5.2 SCC forehead and plan of advancement flaps

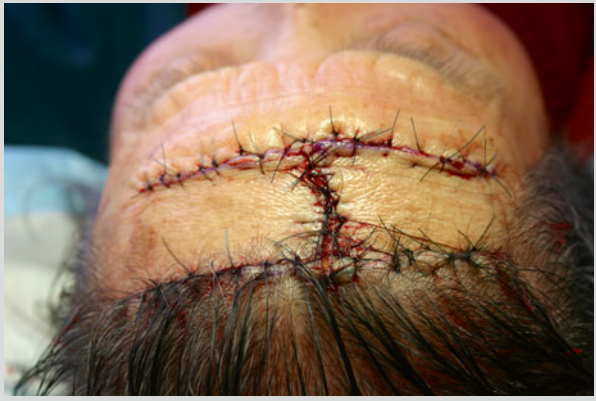

FIGURE 5.3 Advancement flaps sutured in place

2. An 80-year old gentleman presented with a large 5 cm deeply infiltrating BCC of his central forehead. The simplest choice here may have been a skin graft but this would leave him with an area of de-pigmentation on his central forehead. Planning a double-advancement flap in this case isn't easy – because when faced with a lesion of this size, mobilizing flaps would move the eyebrows closer. This is where the technique of sub-periosteal undermining in the temporal region proves effective in gaining valuable inches of skin. For a start, sub-periosteal dissection spares the temporal blood vessels which are liable to get damaged during superficial dissections. Further there is also concern of damage to the facial nerve branch if one was to proceed the discussion over the upper zygomatic region. Inferior to the zygomatic arch, the facial nerve branches travel below the SMAS layer and innervate the muscles of facial expression via the underside of the muscles. With standard double advancement flaps and utilizing sub-periosteal undermining, primary closure was achieved easily while ensuring the safety of vital structures (Figs. 5.2, 5.3, 5.4, and 5.5).

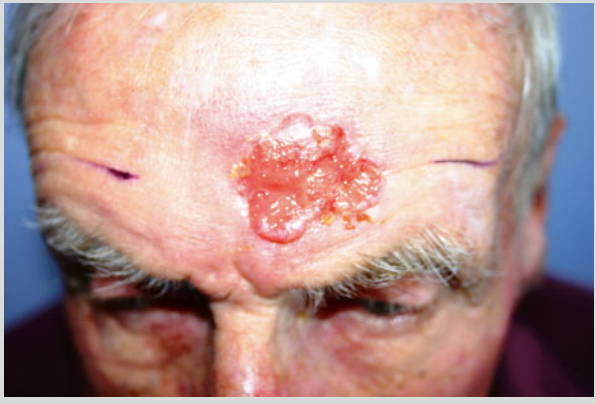

FIGURE 5.4 Large infiltrating BCC central forehead

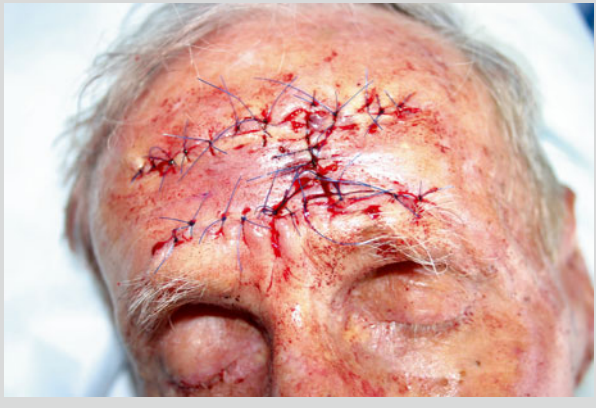

FIGURE 5.5 Bilateral advancement flaps sutured in place

Discussion

Double opposing 'H' flaps offer a high degree of patient satisfaction when planned well and can be used for defects up to 6 cm in diameter [7]. While planning any large flaps

(or indeed any flap), it is preferable to achieve margin control i.e. ensure that the tumor has been excised completely. As discussed earlier, the H-flap is essentially two rectangular flaps that are advancement from opposing sides to close the defect. Ebrahimi and colleagues reserve this flap for tumors in upper middle or lateral portion of the forehead, defect size between 4 cm and 6 cm, no bone involvement, and patients with no history of radiotherapy [7]. When one of the limbs of the flap is hidden in the hairline (as we have done in "Case study 1.") it allows for a superior end result.

However, when dissection proceeds over the temporal scalp and temporal region, typically it becomes more difficult to achieve flap mobility. Psillakis and others described the technique of sub-periosteal dissection while performing face-lifts as open non-endoscopic procedures. The thinking was that as the SMAS was firmly attached to the periosteum through the facial muscles, this technique improved mobility of the cheek and temple [8].

In the temporal region, the dissection is deepened to expose the deep temporalis fascia. The loose areolar issue that forms the plane between the superficial and deep fascia in the temporal region allows for easy dissection down to the sub-periosteal plane, which is then raised using tissue elevators. The lateral extent of this sub-periosteal dissection is marked to ensure no damage to the branches of the facial nerve [9]. Dissecting in the sub-periosteal plane avoids branches of the supraorbital and supratrochlear vessels [10]. Revascularisation in the sub-periosteal plane is rapid, as early as 4 days according to several authors [11]. However, I would stress that I only resort to sub-periosteal dissection when the defects are greater than 5 cm and it is obvious that closure of the advancement flaps is not possible in the conventional fashion. In other cases of scalp dissection, the sub-galeal plane is both easier and is adequate. There have been some concerns raised by some authors [12] about the possibility of sub-periosteal dissection affecting the regenerative capacity of the calvarium, even though the technique does help close these large defects. This is after all a method that has been

borrowed from techniques honed by years of facelift anatomical research. Periosteal elevation causes an increase in overall cell counts during wound healing as well as cortical abnormalities. Dissection in the sub-galeal plane preserves the important bone–periosteal interface and seems to elicit less vigorous wound healing response both cellularly and vascularly [12]. While more histological research is needed, the technique of sub-periosteal elevation does offer major advantages in helping us close very large defects of the forehead with less eyebrow and vital structure distortion (than would be the case otherwise).

Any patient with a large forehead defect >5 cm needs a careful assessment and a radiological examination to ensure no bone involvement by the tumor being removed. Given these large double advancement flaps are still random pattern flaps, they are avoided in smokers and those with a history of radiotherapy. While dealing with large central forehead defects and the need to preserve eyebrow position, several authors have proposed the one-stage combination of advancement of a lateral U-shaped flap and a median forehead rotation flap – for reconstruction of large defects in the paramedian and lateral forehead [2]. However, techniques such as these result in scars across wrinkle lines and therefore the technique of double opposed rectangular flaps we have advocated here achieves superior results. When reconstructing the lateral or middle parts of the forehead, it is important to maintain symmetry of the hairline and eyebrows. However, it is equally important to preserve the motor and sensory function [13]. It is especially important to note the anatomy of the facial nerve as it crosses the zygomatic arch. The temporal branch courses between the deep and superficial lobes of the parotid gland, then divides into multiple rami below the arch. It lies *deep to the SMAS and superficial to the periosteum of the arch*. The temporal branch then courses superiorly in close approximation with the superficial layer of temporal fascia [14]. When sub-periosteal dissection is done medially for cosmetic surgery endoscopic assistance is used. This is not needed at the lateral forehead and temporal region and

easily performed using a small flat elevator to initiate the dissection and a larger flat elevator to free up a broader area of periosteum [15]. Typically the advancement flap raised is anchored to the temporalis fascia to prevent any lateral 'recoil' post-operatively.

I concur with the opinion of other authors that the H-flap (or the double opposing rectangular advancement flap) is the preferred aesthetic flap for large upper forehead defects in central or lateral parts of forehead because direction of bilateral advancement is parallel to RSTLs and another advantage is upper border of flap is situated in the hairline and not visible [7]. I have found this approach extremely useful in closing large defects of sizes approximating 5–6 cm of the forehead.

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Chapter 6
The Modified Rhomboid Flap: An Improvement on the Traditional Technique and Its Use in Defects of the Ala Nasi

Sharad P. Paul

Background

The original rhomboid flap was described by Professor A.A. Limberg of (then) Leningrad, who first described this technique and spent a lifetime refining it [1]. However, it was in *Modern Trends in Plastic Surgery* that the English-speaking medical community really became aware of this surgical innovation [2]. In this book, Limberg detailed his rhomboid flap – essentially the shape is a parallelogram with two angles of 120° and two of 60° (Fig. 6.1). These angles, of course, can

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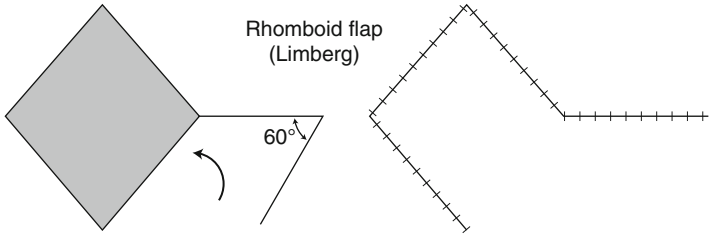

FIGURE 6.1 Rhomboid flap

be modified depending on the shape of the lesion or defect. All sides of a surgical rhomboid and all sides of the flap are equal. As many as four flaps can be raised from one rhomboid, when planned in the classical form [3].

Limberg and his followers (including us) use a bit of 'surgical license' when referring to the 'rhomboid' shape. Because, mathematically speaking, a parallelogram with sides of equal length (equilateral) is a rhombus but not a rhomboid (the latter does not have equal sides).

A rhombus has equal sides and 60° and 120° angles. In general, any quadrilateral whose two diagonals are perpendicular is called a kite. Every rhombus is a kite, and any quadrilateral that is both a kite and parallelogram is mathematically a rhombus. Therefore surgically speaking, we are using the term 'rhomboid' to mean 'rhombus.' As Euclid, the Greek mathematician clarified [4]:

> Of quadrilateral figures, a square is that which is both equilateral and right-angled; an oblong that which is right-angled but not equilateral; a rhombus that which is equilateral but not right-angled; and a rhomboid that which has its opposite sides and angles equal to one another but is neither equilateral nor right-angled. And let quadrilaterals other than these be called trapezia.

The rhomboid flap is a reliable, versatile, and widely used tool in head and neck surgery [5]. Although its geometry is well described, the mechanics of the flap when planned in the classical fashion do not always take into account the RSTL or skin creases. In this case study, I discuss the modified rhomboid flap and its applications for head and neck surgery after

skin cancer. More specifically, the unique design of the modified rhomboid flap makes an especially good choice for surgery to the ala nasi and the anatomy and planning are detailed in this regard.

The Modified Rhomboid Flap

In the classical design of a Limberg flap, a rhombus-shaped segment of skin containing the lesion is excised. A flap is created by incising the skin at a 180° angle relative to the short diagonal of the rhombus and then extending this excision parallel to one of the adjacent sides of the rhombus. This area is then undermined and the flap thus created is rotated into the surgical defect (Fig. 6.2) [6]. One of the interesting things we note in the rhomboid flap is that the flap itself closes only a portion of the defect while the 60° angle closest to the point about which the flap is rotated is closed directly. In other words, one is still closing a 60° 'ellipse' under tension [7]. There are two fundamental problems with the traditional rhomboid flap. The cutting out of a rhomboid shape does not take into account skin tension lines. Secondly, the closure line of the flap is also not orientated along the RSTL which is one of the guiding principles of cutaneous plastic surgery. Larrabee, who has made a remarkable contribution to the modern understanding of the dynamics of several different random flaps spent time analyzing rhomboid flaps. He concluded that

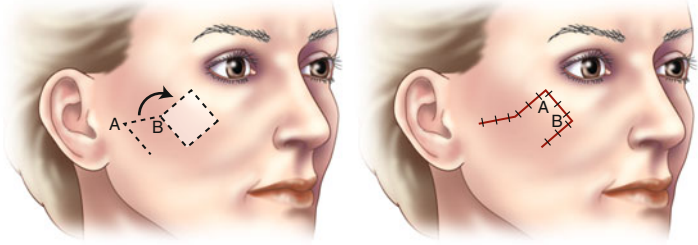

FIGURE 6.2 Rhomboid flap mechanism illustrated

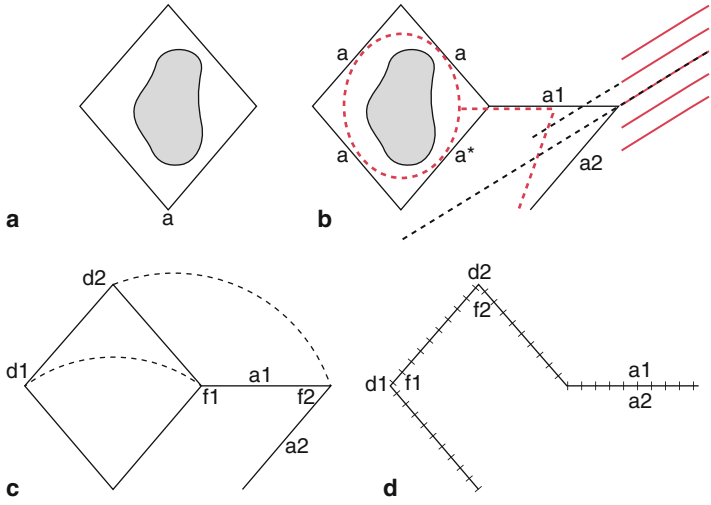

FIGURE 6.3 (**a**–**b**) Modified rhomboid flap is bisected by the RSTL

the actual position of the final scars is more variable than the changes in length of the flap and is related to local tissue characteristics, e.g. the ease of tissue advancement from different directions. The most important result from his study was a clarification of the distribution of tension in a 60° rhomboid flap. *Most of the tension is located at the closure of the donor site.*

In other words, an ideally designed rhomboid flap would have the RSTL bisecting the 60° angle of the flap. This is the basis of the modified rhomboid flap.

In the modified rhomboid flap, the lesion is cut out without attempting to create a rhomboid shape (therefore no unnecessary tissue is excised). The 60° flap is planned with the 60° flap angle being bisected by RSTL. Care is taken to ensure that the limbs of the flap are equilateral. Figure 6.3 illustrates a modified rhomboid flap on the cheek (unlike in Fig. 6.2 the shape is not made into a rhomboid; rather the defect is simply cut out – in this case a circular lesion – the black line in the image indicates the RSTL in that location which bisects the 60° flap). And Fig. 6.3 illustrates the difference between a traditional rhomboid flap and the modified version – in the latter, the RSTL or skin creases bisect the 60° flap. However, in the

modified rhomboid flap, there is no need to cut additional tissue for the sake of creating a rhomboid shape.

Case Studies

Case 1: A biopsy-proven basal-cell carcinoma was excised from the R ala nasi of a 71-year-old woman and the defect was closed with a modified rhomboid flap. I simply cut out the lesion with adequate margins, then plan the modified rhomboid flap using the three essential principles in my method: flap angle bisected by the nasolabial crease; flap lengths equal; flap lengths somewhere between radius and diameter (Fig. 6.4). The end result is shown with the flap sutured in place (Fig. 6.5). The unique shape

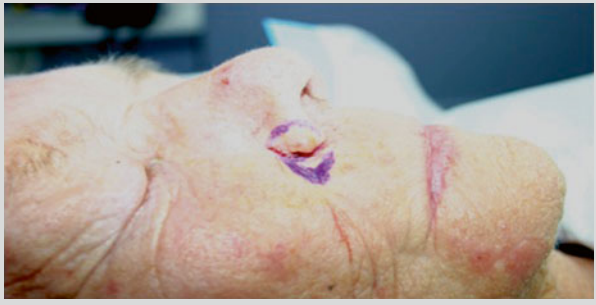

FIGURE 6.4 Modified rhomboid flap of the ala nasi plan

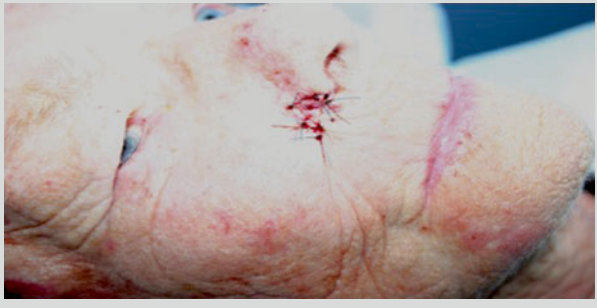

FIGURE 6.5 Modified rhomboid flap of the ala nasi sutured in place

of the ala nasi and the adjacent naso-labial crease ensures that there is no scar visible post-op as all the sutures are in skin creases or the margin of the ala nasi.

Case 2: A nodular BCC involved more than half the ala nasi on the L side of the nose on a 60-year old woman. After the lesion was excised and tumor clearance ensured, the modified rhomboid flap was planned. The image (Fig. 6.6.) shows the design clearly with the nasolabial crease bisecting the flap. Figure 6.7 shows the flap sutured in place with no distortion of the ala nasi and suture line well hidden in crease lines. You will note that in both examples discussed in this paper, I have based the flap caudally rather than cranially. This is because if a rhomboid flap is planned from the superior aspect i.e. cranially, then it tends to 'bridge' over the ala nasi as some nasolabial flaps tend to do (and often need revision). In Fig. 6.7. the slight notch on the L ala nasi was the pre-existing 'normal' shape of the patient's L ala nasi. There was no discrepancy between the sides at the end of the procedure. The nasolabial crease provides a perfect site for the modified rhomboid flap as it lies alongside a rounded structure (the ala). This flap is also useful in other sites like the ear lobe or indeed anywhere where a conventional rhomboid flap is planned. It has the advantages of a more 'anatomical' closure utilizing the RSTL.

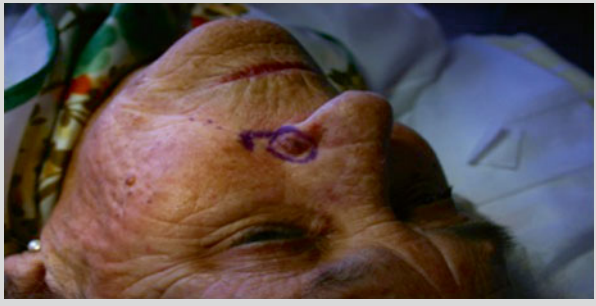

FIGURE 6.6 Modified rhomboid flap of L ala nasi plan

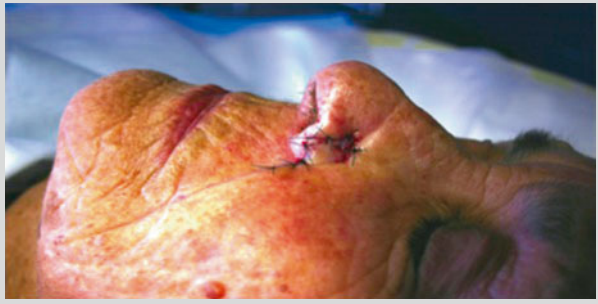

FIGURE 6.7 Modified rhomboid flap of L ala nasi sutured in place

Discussion

Many surgeons like Lister and Gibson spent considerable time in analyzing the closure of wound defects using rhomboid flaps and several variants of the original design [8]. One important point with either the classical Limberg design or the modified version I have presented here is this – at any angle other than 60° we will theoretically have either compression or stretching of the flap itself [9]. *Therefore 60° is the optimal angle for the flap.*

It is worth looking at other variants of rhomboid flaps.

Dufourmentel modified the rhomboid flap and published his paper in 1962 [10]. As in a classical Limberg flap, the defect is created in the shape of a rhomboid. The excision is then extended at an acute angle of up to 60° relative to the original incision (see 1. In Fig. 6.8) – therefore this flap creates unequal tension on the lateral borders of the defect and is useful in repairing rhomboid defects where the acute angle of the defect is between 60° and 90°. Dufourmentel felt that this flap was ideally suited to close 'lozenge-shaped' defects. Some authors feel that even if the rhomboid flap is a pivotal flap, Dufourmentel's design actually ends up making this a 'straight advancement of tissue' [7].

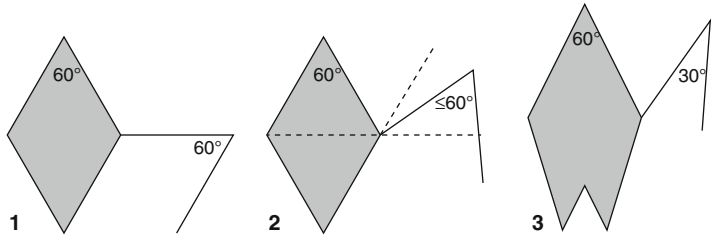

FIGURE 6.8 Limberg (*1*), Duformental (*2*) and Webster (*3*) Flaps

In 1978, Webster et al. [11] described the combined use of a 30° transposition flap and an M-plasty to repair rhomboidal defect – however his technique was also plagued by unequal tensions on the lateral borders of the defect.

However, while it is easy to be geometrically accurate while planning the flap, the variability of tissue dynamics between individuals makes it difficult to accurately predict tension. When measurements were done in piglet skin by Larrabee, he noted as much as 29 % discrepancy from predicted values [5]. As Lister and Gibson noted as early as in 1972, predicting the flap movement needs a 'computer rather than a plastic surgeon' [12]. Therefore as I discussed earlier, 60° seems to cause the least distortion (and least disagreement) when it comes to rhomboid flaps.

The closest to the technique I am describing here was a paper titled 'A square peg into a round hole' flap which was published in 1987 [13]. The authors, Quaba and Sommerlad mention the modifications they made to traditional rhomboid flaps thus [13]:

1. The lesion is excised as necessary without considering the shape of the defect produced; corners need not be sacrificed to produce a rhomboid-shaped defect. Many defects will end up having an almost circular shape.
2. The flap is always planned to be smaller than the defect. The chosen diagonal is therefore, extended by about two-thirds of its own length. In other words, they suggest that the flap length be 2/3 the diameter of the defect. I have

found that the flaps works as long as the flap length is somewhere between radius and diameter and precise measurement is not necessary.
3. Although it may look rather like putting a "square peg into a round hole," surprisingly, it is rarely necessary to trim the corners of the flap.
4. One of the problems with transposition flaps of this nature is the risk of pin-cushioning, which is also sometimes referred to (as Quaba and Sommerlad do) as trap-door formation, although there is an important distinction, in my view – trap-door deformities result while using a island flap, as the tension across the flap suture line tends to aggravate the tension. In contrast, when using a transposition such as a bilobed flap or rhomboid flaps, the tension across the line of closure may result in pin-cushioning of the flap.

Quaba and Sommerlad, in their excellent paper suggest that this 'trap-dooring' was observed in approximately 9 % of patients, especially where small defects were closed with apparently over-generous flaps. Therefore keeping the flap small often works better. As I have illustrated in Fig. 6.3, the modified rhomboid flap often looks rather small for the defect, but with planning as detailed in this paper it is a very versatile flap.

In conclusion, the modified rhomboid flap is a major improvement on traditional rhomboid flap designs. While these flaps can be used anywhere a traditional rhomboid would have been contemplated, it is especially suited to defects of the ala nasi region as the anatomy of the site allows for perfect alignment of this flap.

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Chapter 7
The Keystone Design Perforator Island Flap: An Easy Option for the Lower Limb, But How Does It Actually Work?

Sharad P. Paul

Background

Closure of wounds after excision of skin cancers on the leg provide a challenge, especially after wide excision of melanoma. For these cases, the traditional approach is to use a split skin graft – however this leaves the patient with a deep contour defect and color mismatch. Many authors have echoed the question after excision of a melanoma: Is flap closure preferable to skin grafting? In a study of over 700 patients after skin cancer excisions, in the flap repair group 26.0 % of cases noted post-operative complications

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compared to 43.1 % in graft repair group ($p < 0.03$) where conventional split-skin grafts were used. Failure rate was significantly higher in the graft repair group than the flap repair group (20.8 % vs. 9.09 %; $p = 0.04$) [1]. These studies were done comparing traditional split-skin grafting from a separate donor site. Yang and Bartholomeusz have reported that, in another survey of skin grafting in Australia, 73.5 % of surgeons reported that, at 1 month, skin graft take of greater than 80 % occurred more than 90 % of the time [2]. However, there was some morbidity associated with hospitalization and lack of early mobilization of the patient. 78.6 % of surgeons wrapped the limb with bandages only, whereas 21.4 % placed the limb in a hard splint; 46.1 % of surgeons kept their patients in hospital for between 2 and 7 days after a split skin graft [2].

Part of the problem with lower limb skin is the relatively poor vascularity. Further, as many patients with sun-damaged skin have poor quality friable skin, skin grafting becomes a challenge. Partial-thickness grafts will 'take' on virtually any body tissue including periosteum (bare bone and bare cartilage being the exception). Full-thickness grafts, while the preferred choice on the face, due to the better cosmetic outcome often fare poorly on the lower limbs due to the poor quality skin and the increased metabolic demand of having an intact dermis. A study of full-thickness skin grafts of the lower limb in 28 patients found that the graft take was classified as good (>80 %) in 18 patients, partial (50–75 %) in 7 patients and poor (<25 %) in 5 patients [3]. These authors found that contrary to surgical wisdom, full-thickness grafts are feasible on the lower limb, albeit with reduced 'take' and increased risk of complications.

In the face and scalp random pattern flaps work well due to the excellent dermal and sub-dermal blood supply. Random flaps perform poorly on the lower limb for a reasons mentioned earlier. If a *large* random pattern flap survives on the lower limb, it would be the exception rather than the rule.

In Australasia, the guidelines for melanoma wide excision recommend the following: Melanoma in situ: margin 5 mm; Melanoma <1.0 mm: margin 1 cm; Melanoma 1.0–2.0 mm: margin 1–2 cm; Melanoma 2.0–4.0 mm: margin 1–2 cm; Melanoma >4.0 mm: margin 2 cm. For melanomas 2–4 mm thick, where possible, it may be desirable to take a wider margin (2 cm) for these tumors depending on tumor site and surgeon/patient preference [4]. Therefore following wide excision, the surgeon is faced with closing a deep defect >4 cm in diameter and this led to a search for island flap closures. Free flaps of course are the gold standard, but seem an 'overtreatment' for what is a relatively straightforward wide excision, notwithstanding that they require specialized resources, equipment and expertise.

Island flaps in the lower limb are an option but they need to be based on perforators to be failsafe. V-Y island advancement flaps have been described in the lower limb. While the design is similar to V-Y flaps in other parts of the body, the reach of the V-Y advancement flap, especially in the leg, can be improved by basing it on one or two perforators and dividing the deep fascia around the flap [5]. However, the first step in planning a perforator based flap is to identify a perforator close to the defect. This is best done using a Doppler probe [6]. In Australasia, where the majority of skin cancers are managed in primary care, this presents a resource problem and hence surgeons attempted to devise random patterned island flaps that would by their very design incorporate one or more perforators.

This paper presents different island flap techniques in the reconstruction of defects after excision of a malignant melanoma of the lower limb. The Bezier or the French curve flap, is also described and illustrated. However, greater attention is paid to the keystone flap, which has gained wide prominence internationally, at least in the melanoma capitals of Australia and New Zealand. The keystone Design Perforator Island Flap is detailed, with an analysis of the mechanics of the flap and some recent controversies regarding the 'science' behind the flap.

The Bezier Flap Technique

The Bezier flap is based on the French curve design of opposing ellipses (Fig. 7.1) [7]. The flap becomes a template of the excisional defect (a). The flap is advanced into the area that requires cover, with *enough freeing of the deep fascia or muscle attachment to allow movement on one side*, yet not detaching the flap fully from such underlying supports as to imperil its viability (b). The apices of the flap then fit into the defect, employing a double V-Y closure (c) [8]. As we can see, the Bezier flap is really an extension of the V-Y flap. Historically, Dieffenbach was the first to describe a V-Y type flap closure, in the nineteenth century, when he described this technique for the nasolabial region [9]. The development of the Bezier design can be seen as a transition from straight lines and triangular flaps to curvilinear patterns, to ultimately end up with an ellipse – the size of the flap almost equating to the size of the defect [8].

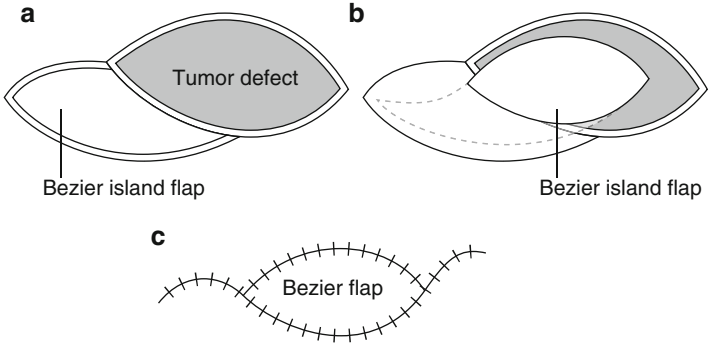

FIGURE 7.1 Steps of the Bezier island flap

The Keystone Design Perforator Island Flap

This flap was first described by Felix Behan [10]. In Roman architecture, it was necessary to design a stone called a keystone – a way of locking arches in a building using gravity. Behan felt that the shape of this flap seemed to lock into the defect.

The keystone flap is a curvilinear shaped trapezoidal design flap and the curvilinear shape of the flap fits well into body contours especially in the lower limb. The flap has a ratio of 1:1 for the width of the defect to the width of the flap. The length of the flap is determined by the size of defect that is excised and a 90° angle is created at the limits of the excision as shown in Fig. 7.2. Blunt dissection allows mobilization of the surrounding tissue while the flap advances to close the defect. We can see this is an island flap –being designed within dermatomal segments, and the longitudinal design allows nerves and veins to be incorporated in the flap design – therefore it is limited to certain bodily sites as illustrated in Fig. 7.3.

Additionally, Behan et al. [8] classified the keystone flap into several subtypes:

Type I: The deep fascia is left intact for smaller lesions up to 2 cm (Type I keystone) The trapezoidal shaped flap is contoured along the side of the defect with 90° angle at the limits of the island flap (Fig. 7.4).

Type II: For larger areas >2 cm, located over muscular compartments, the deep fascia is divided along the outer curvature of flap to permit further mobilization of the flap

Type IIA: Division of the deep fascia along the outer curvilinear line (in one case, our patient ended up with a troublesome seroma after division of fascia was performed as part of a keystone flap. However, this resolved after 4–6 weeks with compression stockings)

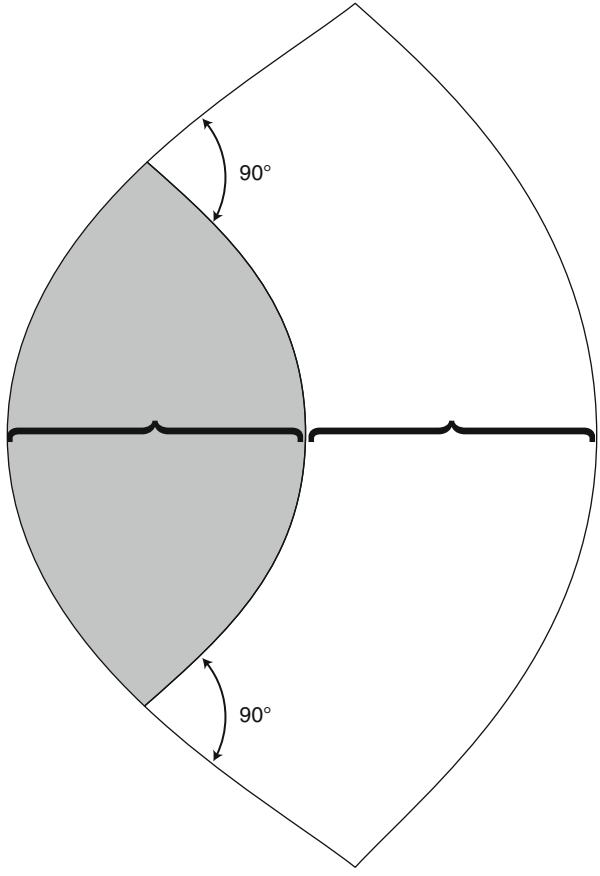

FIGURE 7.2 Keystone flap design

Type IIB: Skin graft to the secondary defect when undue tension exists (In type IIB a graft is often needed where tissue has limited elastic stretch on the lower one-third of the lower limb – which is why I personally avoid this type as if a skin graft is needed, it is simpler to just do a skin graft)

Type III: Double keystone flap (Fig. 7.5) – this is reserved for considerably larger defects (5–10 cm) where a double keystone design can exploit maximum laxity of the surrounding

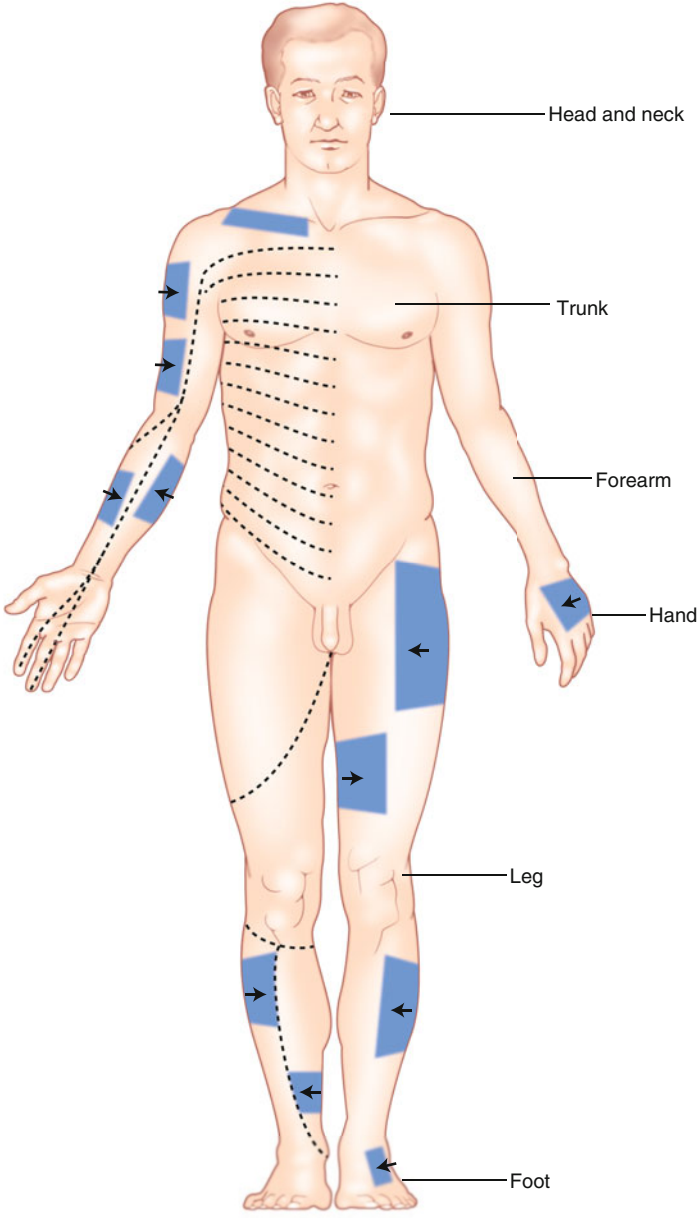

FIGURE 7.3 Sites for the Keystone flap

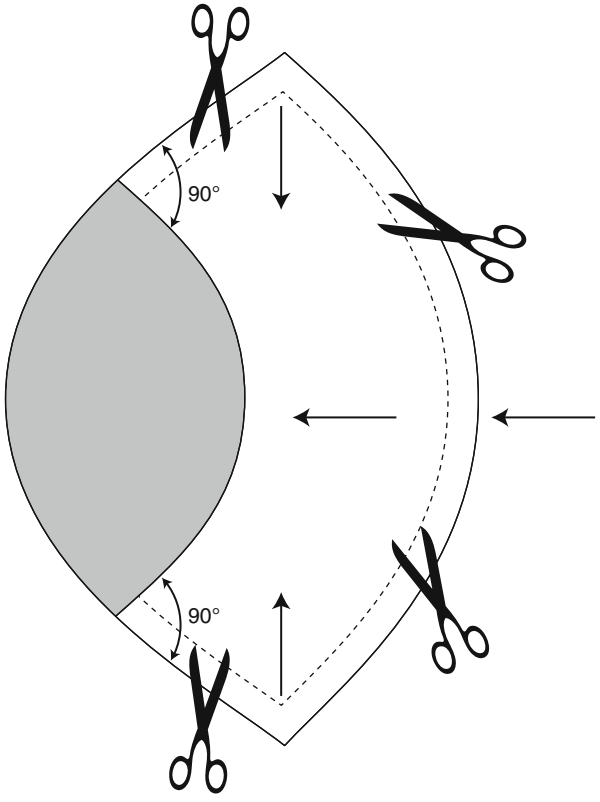

FIGURE 7.4 Type I Keystone island flap

tissues. (I've found this useful in sacral region for closure of pilonidal sinuses as well after wide excision of deep melanomas)

Type IV: Rotational keystone flap – this is more useful in joint contractures and I shall not detail this here.

For closure after wide excision of melanoma, the Type I and Type II (with division of fascia) keystone flaps are especially useful.

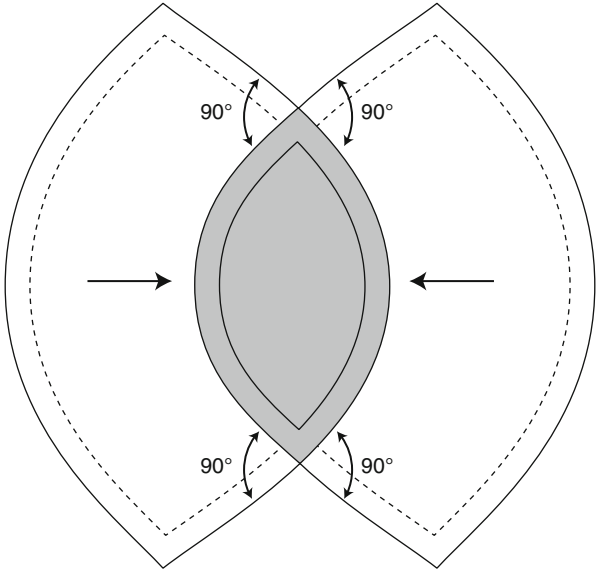

FIGURE 7.5 Double Keystone flap

Case Study

A 60-year-old woman presented with a 3 cm basal cell cancer on the lower limb. This was over the pretibial region and he had notable varicose veins. I elected to perform a keystone flap. In the image (Fig. 7.6) I have marked the direction of the RSTL to show why an elliptical closure would not work. A skin graft was an option but less ideal as the lesion was right on the pre-tibial region overlying bone. The keystone flap was raised and in this case a Type II flap was used with fascial division needed to achieve closure. The end result at 3 weeks post-operatively shows a well-healed flap with no contour defect (Figs. 7.7, 7.8, and 7.9). While most of this discussion has been for island flaps post-melanoma excision, as in this case it can be also used for non-melanoma skin cancers on the lower limb.

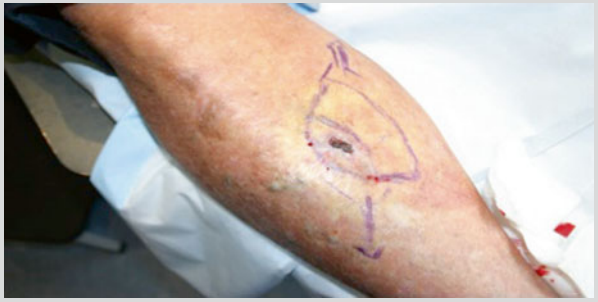

Figure 7.6 Keystone flap planning

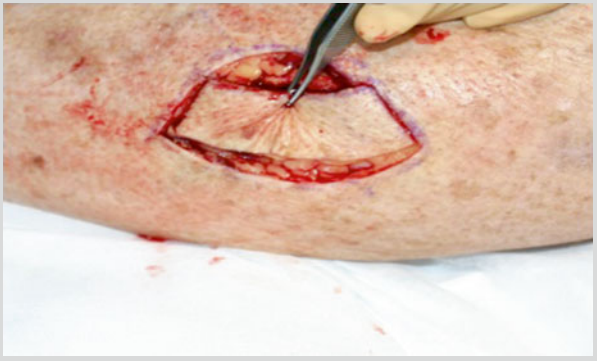

Figure 7.7 Keystone flap raised; in this case fascia was released to help closure

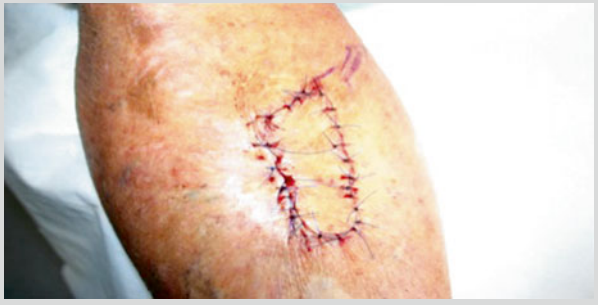

Figure 7.8 Keystone flap sutured in place

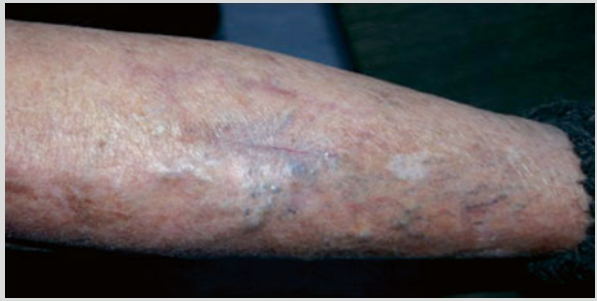

FIGURE 7.9 Postoperative appearance at 3 weeks shows well healed flap with no contour defect

Discussion

The keystone design perforator island flap is an elegant flap and easy to manage. However, the nature of the flap, and the anatomy of its closure have led to several misconceptions and controversies [11].

Going back the dynamics, in general a basic fasciocutaneous flap used to reconstruct a defect is one that is advanced into the primary defect in a V-Y fashion either in a straight (as in a standard perforator based V-Y flap) or a curved (Bezier) fashion. However, as the amount of advancement afforded by these techniques is often disappointing, people began to raise the flap as a fasciocutaneous island on a single perforating vessel [12]. Orientating the flap in the longitudinal axis helps conserve the subcutaneous lymphatic vessels under the lateral limbs and reduces the risk of distal lymphedema.

Moncrieff and others from the Sydney Melanoma Unit modified the keystone flap – along the lateral limbs, they excise the full thickness of the dermis but no deeper, and the subcutis is released with gentle, blunt spreading dissection. This preserves the subcutaneous venous and lymphatic flow-through underneath the flap (Fig. 7.10 from Moncrieff et al.)

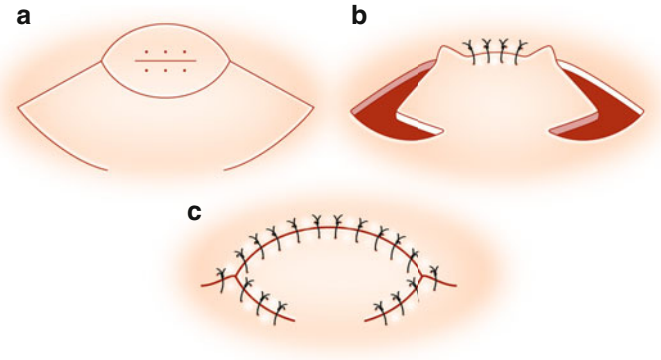

FIGURE 7.10 Steps of the modified Keystone flap by the Sydney Melanoma Unit

effectively creating a 'keystone peninsula'. The authors from the Sydney Melanoma Unit commented that their modification of the keystone flap was significantly associated with a significantly decreased major complication rate, including when the double opposing flaps were used [13].

However, Felix Behan, the original inventor of the technique disagreed. With regard to the adequacy of flap perfusion, the developer of the flap explains that the integrity of the *island flap increases the vascular perfusion* by a possible 'sympathectomy effect'.

Behan noted the oft-stated surgical dictum: In all *non-islanded flaps*, where the subdermal plexus is retained, *there is a suppressive effect on vascular dynamics* [11]. This is one of the reasons for island flaps in the first place. Indeed after experimental studies on island flaps, Milton had surmised that when it came to cutaneous surgery, *an island is safer than a peninsula* [14].

But the controversy surrounding the keystone design perforator island flap continues. Douglas questioned the soundness of the 'keystone science' [15]. Behan had originally stated that that the V-Y advancement at each end of the long axis of the keystone island 'creates a relative redundancy in the

central portion of the flap and relaxes the tension in the short axis' [10]. In a paper titled, 'The keystone flap: not an advance, just a stretch' [16], Douglas' team suggested that that the complete relaxation of skin in one axis (from in vivo length) does produce modest tension benefits in the orthogonal axis. However, the amount of increased orthogonal stretch was in the order of 1 mm, 'a very minimal and dubious benefit' [16].

The surgical debate continues and as in some surgical techniques, we know that the technique seems to do the job, even if the mechanisms are not clearly understood. While no objective study has proven (yet) that this flap indeed reduces tension, the flap has gained wide acceptance. As to the exact science behind this technique, further studies are needed to do with the biomechanics to put this debate to rest.

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Chapter 8
Amelanotic Malignant Melanoma of the Toe Presenting as an Ulcer: Management and Biopsy Guidelines

Sharad P. Paul and Michael Inskip

Background

The number of cases of malignant melanoma worldwide is increasing faster than any other form of cancer amongst white-skinned populations [1]. New Zealand and Australia have high ambient UV, Celtic–descent populations, and the highest incidence rates of and mortality rates from cutaneous melanoma in the world [2]. In 2007 in New Zealand, from a total population of four million people, 2173 new cases were

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registered of melanoma and 292 people died from the disease [3], whereas in Australia, a country of 21 million inhabitants, 10,342 people were diagnosed with melanoma and 1279 died from this disease [4].

One of the problems with nail and foot melanomas is the misdiagnosis and late presentation. These melanomas of the nail unit and toes are often amelanotic and typically diagnosed at a later stage than melanoma at most other body sites. It naturally follows that the tumors end up thicker, and the prognosis worse. A large UK survey of four regions demonstrated that nail unit melanomas represented 1.4 % of melanoma over a 10 year period, giving an incidence of 1 per million of population per year. This study noted that the 5-years survival for these tumors overall in the order of 51 % [5].

Diabetic patients have been estimated to have a lifetime risk of 15% of developing a neuropathic foot ulcer. Diabetic foot ulcers are a common occurrence and are often dealt with by podiatrists or nurses in diabetic clinics. Biopsy of ulcers is rarely performed in diabetic clinics, and this poses significant challenges in the diagnosis or misdiagnoses of melanomas in these patients [6].

Kong [7,8] and colleagues have previously reported two cases of foot melanoma presenting as diabetic ulcers and Gregson and Allain [9] have reported a case of an amelanotic malignant melanoma developing at the site of a diabetic foot ulcer.

While it seems obvious to biopsy a suspicious lesion, certain types of malignant melanoma may initially be misdiagnosed as benign diseases up to 39 % of the time and therefore it is important to have an experienced dermato-pathologist [10].

Early diagnosis and appropriate referral for treatment makes a significant difference in the survival rate and prognosis of the patient with a foot or toe melanoma. The difficulty in diagnosing it makes it a formidable challenge, especially where it presents as a foot ulcer, either attributed to trauma or diabetes. It is not only important therefore to examine the feet of diabetics, but also not be misled by a history of trauma. In the context of our case report, the presentation of toe melanomas, their management and guidelines regarding management and review are discussed [10].

Case Study

A 64 year old woman presented to a general practice surgery in outer suburban Melbourne with a tender, ulcerated lesion on the dorsal tip of her 4th L toe. This had begun 3 months ago. She gave no history of trauma. She was a non-smoker and was not diabetic. She had no history of peripheral vascular disease or venous insufficiency.

This lesion had been treated previously at another general practice for some 6 weeks with a course of oral antibiotics, regular dressings, and topical silver nitrate. No attempt at biopsy had been made.

Examination revealed a non-pigmented ulcerated lesion 15 mm diameter taking up the entire nail bed and nail matrix (Fig. 8.1). The nail itself was completely absent. Dermatoscopy was not revealing due to the degree of maceration and contact bleeding. There were no signs of peripheral vascular disease or venous insufficiency.

A 4 mm punch biopsy was taken under local anesthetic digital block. Histology was reported as 'invasive malignant melanoma with Breslow thickness of at least 1.2 mm'.

FIGURE 8.1 Toe melanoma

The patient was referred to the local regional melanoma service where a partial amputation of the toe was performed together with sentinel lymph node biopsy of the L groin.

Histology was reported as follows:

(Histology report from initial partial amputation of 4th toe)
Macroscopic description
Partial amputation 43×6×18 mm. The toe nail bed area consists of red brown crusted tissue 14×15 mm and a fragment of nail 4 ×4 mm. Three representative samples have been processed through this area. Remaining tissue submitted for decalcification.
Microscopic description – synoptic report – malignant melanoma
Site – Left 4th toe
Breslow thickness 4.2 mm
Clark level 4 (at least)
Architectural type – acral lentiginous
Predominant cell type – epithelioid
In situ component – present
Invasive component – present
Mitotic index – 13 mitoses per square mm (5 high power fields)
Tumour infiltrating lymphocytes – absent
Microsatellites – absent
Perineural invasion – absent
Lymphovascular invasion – present, lymphatic space invasion
Ulceration – present 5 mm wide
Regression – absent
Associated nevus – absent
Margins – in situ and invasive melanoma is completely excised with a minimum of 11 mm clearance of the proximal skin margin. Decalcified bone sections contain no melanoma
(Fig. 8.2. Histology 4× magnification shows the entire melanoma; Fig. 8.3. Histology ×20 magnification)

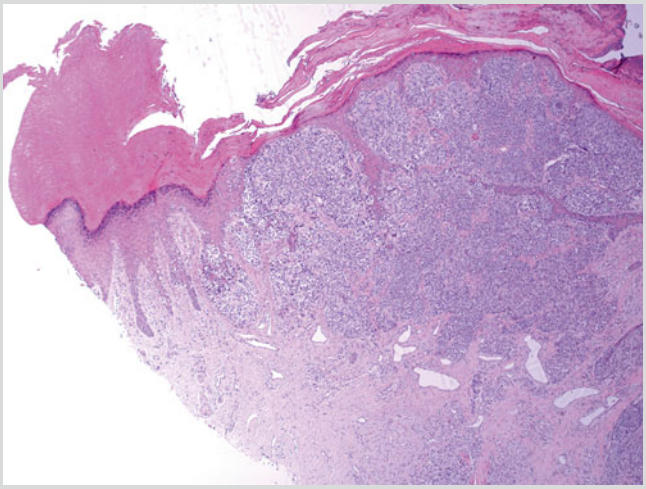

FIGURE 8.2 Histopathology subungual melanoma 4× magnification

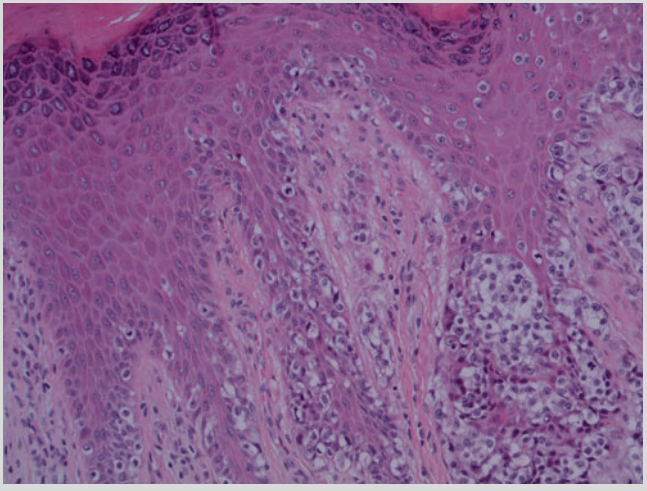

FIGURE 8.3 Histopathology subungual melanoma 20× magnification

Sentinel lymph node biopsy was reported as positive with 'multifocal & nodal deposits of metastatic melanoma with maximum diameter 4 mm'.

Further amputation of the L 4th toe was undertaken together with inguinal lymph node dissection. Two further lymph nodes were positive for metastatic melanoma.

Within 2 months the patient developed multiple small (<5 mm) purple coloured raised lesions on the skin of her dorsal foot. Biopsy confirmed local melanoma deposits suggestive of in-transit **cutaneous metastases**.

Staging CT scan of brain, chest, abdomen & pelvis showed two 2 mm pulmonary nodules and at least three L pelvic lymph nodes the largest 3 cm diameter.

Her current stage is 3B with an expected 57 % 5 year survival.

BRAF mutation testing was negative and she has now been commenced on Ipilimubab.

Discussion

White populations have a much greater risk of developing toe melanoma than Asians or Africans. Contrary to conventional wisdom non-white races overall have a much lower rate of the disease, they are just most likely to develop melanomas in acral locations such as the palmar, plantar surfaces and nail bed [11].

Melanoma of the toe is prevalent at different rates in black populations of America and Africa, getting some authors like Oettlé [12] to suggest that shoe-wearing may reduce the incidence of toe and foot melanoma. However, the following year, Lewis [13] studied several tribes in Uganda and concluded that shoe wearing did not make any difference. More recently, Green undertook a study of 275 melanomas diagnosed on the soles and palms to investigate risk factors and

concluded that sun exposure was a significant risk factor in the development of ALM despite their plantar and nail bed location [14].

The iconic reggae musician, Bob Marley died in 1981 of an acral melanoma and one he had attributed to an injury while playing soccer barefoot. Indeed 23–44 % of patients report direct trauma as causing their subungual melanoma [15, 16]. While the overall incidence of acral melanomas is the same across all races, subungual melanomas represent approximately 20 % in dark-skinned and oriental populations compared to about 2 % of cutaneous melanomas in white populations [16]. Just as squamous cell carcinomas are reported after burns, Möhrle and others feel that in subungual melanoma, trauma is likely to be an etiologcal factor [16].

Does diabetes increase foot melanoma risk? In a case report about a diabetic foot ulcer that turned out to be a melanoma, the authors suggested that 'one of possibilities for the relatively fast growth of acral lentiginous melanoma may point to the diabetes' [17, 18]. However, there has been no causal link established between diabetes and toe melanoma. However, interestingly, Metformin when used in combination with melanoma drugs like bevacizumab shows synergistic effect. Metformin inhibits the growth of most tumor cells, but BRAF-mutant melanoma cells are resistant to metformin in vitro, and metformin even accelerates their growth in vivo. Unexpectedly, drugs used for advanced melanoma like VEGF inhibitors and metformin synergize to suppress growth of BRAF-mutant tumors, revealing that a combination of drugs may be effective in patients [19]. Other authors concluded that Metformin blocks melanoma invasion and metastasis development in AMPK/p53-dependent manner [20]. Therefore more work needs to be done in the realm of melanoma in diabetic patients and some diabetes medications seem to have a role in combination therapy.

Another interesting aspect of foot and toe melanoma is the different genetic mutations involved with acral melanomas when compared with melanomas in other cutaneous sites. Recent studies provide evidence that *acral melanoma is distinct*

from common cutaneous melanoma at the genomic level, and show that the genomic landscapes of *acral and mucosal melanomas are more similar to each other t*han to other subtypes [21]. These findings open the door to more research into managing these acral melanomas differently to cutaneous melanomas. This may also explain the differing mortality levels.

There are two main patterns of nail unit melanoma --longitudinal melanonychia and amelanotic tumours (as in our case here). The first may be associated with alteration of nail plate anatomy in more advanced cases; the latter is almost always associated with nail plate change [22].

However, as we have discussed earlier early diagnosis is key. This need for an early diagnosis and ensuring that lesions are biopsied early led to the development of Clinical Guidelines for the recognition of melanoma of the foot and nail unit [22]. The authors of the guidelines used the CUBED acronym to help identify melanoma of the foot and toe and recommend referral when any two features are noted [22]:

C *Coloured lesions where any part is not skin colour.*
U *Uncertain diagnosis. Any lesion that does not have a definite diagnosis*
B *Bleeding lesions on the foot or under the nail, whether the bleeding is direct bleeding or oozing of fluid. This includes chronic "granulation tissue".*
E *Enlargement or deterioration of a lesion or ulcer despite therapy*
D *Delay in healing of any lesion beyond 2 months.*

Using the CUBED acronym, it is certain that a lesion such as the one we have presented in our case study would be biopsied early. In general, toe melanomas of the nail unit have different genetic attributes when compared with cutaneous melanomas – and given many are amelanotic and appear (as in our case) as an ulcer, dermoscopy is difficult (unless longitudinal melanonychia is present).

As mentioned earlier in a study referred to in this paper, nail melanomas have a 5-years survival in the order of only 51 %. It is best therefore that clinicians and patients both

have a low threshold for diagnosis of nail melanoma and history of trauma and diabetes are viewed within the light of newer research.

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Chapter 9
Revisiting the Halo Graft: Why Does It Heal Faster When Compared to Conventional Split-Skin Grafts?

Sharad P. Paul

Background

The 'halo' graft was first devised by me when I was a plastic surgical registrar at Hutt Hospital, Wellington, New Zealand in 1991. The technique involves harvesting a split skin graft as a 'halo' around the defect and therefore eliminated the need for two surgical sites. I had suggested this technique to my mentor (the late) Max Lovie but we never got around to formally studying the technique. I finally refined it over the years and then formally conducted a clinical trial in 28 patients in 2007/08 when I was a visiting surgical consultant.

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The results were published in 2010 in Dermatologic Surgery [1] and presented at the Nordic Plastic Surgical Congress [2] the same year.

In 2011, Parker studied my halo graft technique in a smaller study of 11 patients in the USA and presented his findings with a paper titled 'Halo grafts: why you don't need to dread skin cancers on the lower leg anymore' [3].

More recently, a team from Queensland, Australia conducted a retrospective study of 68 patients over a 31 month period – they reported a mean healing time for the halo split skin grafts of 4 weeks with a 10 % graft failure rate [4].

The "halo" graft is a useful and versatile technique. Partial-thickness grafts are harvested circumferentially from the annulus area around the defect. The mathematical calculation allows for tailoring this technique to defects of various sizes. It requires minimal equipment, confines the surgical wounds to one site, and speeds up wound healing after skin grafting. Because the graft and donor sites are adjacent, I *only recommend that this technique be used for non-melanoma skin cancers.*

This article reviews the original halo graft study, with two case reports and discusses the reasons why such a simple innovation allows for more rapid healing.

The Halo Graft Surgical Technique

The lesion to be excised is marked out in a circular fashion with the appropriate margins of excision (Fig. 9.1). The annulus area is then marked around the initial circle – the halo graft technique requires that the outer circle be 1.4 times the diameter of the inner circle), with the radius of the outer circle (r) being 1.4 times the radius of the inner circle.

The skin graft is harvested from the 'halo' area i.e., the outer area geometrically called the annulus as shown. I use a No. 22 blade and take shavings of partial thickness skin. The split-skin graft fragments are placed over the recipient defect i.e., the inner circle where the lesion was excised (Fig. 9.2). I dress the graft

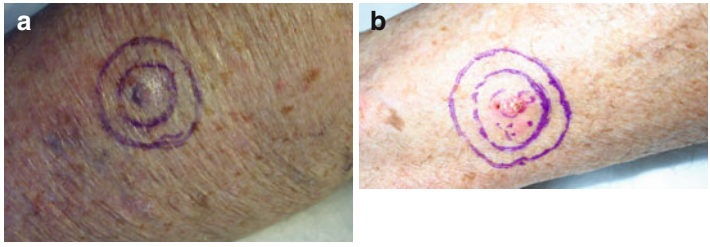

FIGURE 9.1 Preoperative Halo graft markings

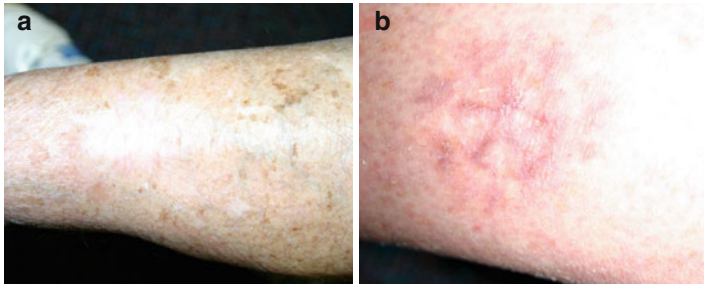

FIGURE 9.2 Halo graft markings postoperatively showing (**a**) minimal scarring or contour defect and (**b**) with less contour defect than a conventional graft

with a foam dressing (Allevyn, Smith & Nephew, Christchurch, New Zealand), which is placed over the whole wound. 2- layer compression bandages are applied using cotton-wool and crepe and *the patient is fully mobilized*. The graft dressing is done at 1 week. The wound is usually completely healed in 2–3 weeks. (If the wound appears inflamed or is potentially infected, I use Allevyn Ag i.e., silver-impregnated Allevyn dressing)

The Geometry

Annulus = A space contained between the circumferences of two circles, one within the other.

If the outer radius is 1.141 times the inner radius, the annulus area becomes 3.14 which equates to π. In other words the outer radius needs to be approximately 1.4 times the inner radius to make the annulus area the same as the area of the inner (recipient) circle.

Case Study 1

A 55-year old female was referred to me with a 2.5 cm BCC on her left leg, overlying the tendo-achilles region. Given the location and orientation of the lesion, primary closure was not feasible. A 'halo' split-skin graft was planned. In this technique the area to be excised is marked out (in this case an approximate 3 cm diameter circle). The outer 'annulus' area was marked at 1.4 times the inner radius i.e., diameter of the outer circle was 4.2 cm and the radius 2.1 cm). Split skin grafts were harvested from the annulus area and laid on the defect like a jigsaw. Dressings were done in the usual manner and the wound was fully healed at 13 days (Figs. 9.1, 9.2, and 9.3). The patient was mobilized with soft cotton-wool and crepe bandages for compression. The wound was kept dry until the first graft dressing at 7 days.

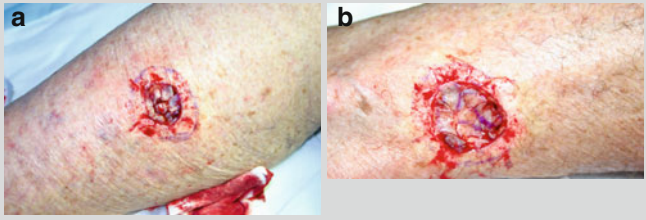

FIGURE 9.3 Halo grafts laid onto the defect

Case Study 2

A 61-year old female was referred to me with a 3.1 cm BCC on her left leg, on the lateral aspect of her calf. Given the location and orientation of the lesion primary closure was not feasible. A 'halo' split-skin graft was planned. In this technique the area to be excised is marked out (in this case an approximate 4 cm diameter circle). The outer 'annulus' area was marked at 1.4 times the inner radius i.e., diameter of the outer circle was 5.6 cm and the radius 2.6 cm). Split skin grafts were harvested from the annulus area and laid on the defect like a jigsaw. Dressings were done in the usual manner and the wound was fully healed at 18 days. Even though the split skin grafts were laid on subcutaneous fat, the wound were fully healed (defined by not needing further dressings) in 18 days (Figs. 9.1b, 9.2b, and 9.3b). The patient was mobilized with soft cotton-wool and crepe bandages for compression. The wound was kept dry until the first graft dressing at 5 days (Table 9.1).

Table 9.1 Halo graft study [1]

Patient no.	Defect diam.(Cms)	NMSC	Male/ female	Final dressing post-op day
1	3.1	BCC	F	17
2	2.7	other	M	16
3	3	BCC	M	17
4	2.5	other	F	13
5	3	SCC	M	21
6	3.1	BCC	F	18
7	4	BCC	M	15
8	3.5	SCC	F	19
9	3.5	SCC	M	17

(continued)

Table 9.1 (continued)

Patient no.	Defect diam.(Cms)	NMSC	Male/ female	Final dressing post-op day
10	4.5	SCC	M	20
11	2.5	SCC	F	14
12	3.9	Other	M	17
13	2.5	BCC	M	16
14	4.5	SCC	F	20
15	2.5	SCC	M	14
16	2.3	BCC	M	14
17	2.5	BCC	F	17
18	2	BCC	M	17
19	2.4	SCC	M	19
20	4.3	SCC	F	20
21	3	SCC	M	17
22	2.7	SCC	F	17
23	4	SCC	M	20
24	4	SCC	F	14
25	2	BCC	F	17
26	4.5	BCC	M	20
27	2.5	SCC	M	14
28	2	SCC	M	16
Mean	3.107142857			17

Total number of patients 28 (11 Female, 17 Male)
Mean size of lower leg defect that was grafted 3.1 cm
Average time of complete epithelialization (defined by no further need for dressings) 17 days post-op

The 'halo' graft is an extremely useful and versatile technique. It requires minimal equipment, confines the surgical wounds to one site and speeds up wound healing following skin grafting. The precise mathematical calculation allows for tailoring this technique to defects of varied sizes.

Due to the adjacent nature of the graft and donor site, we have only used the technique for non-melanoma skin cancers. The data in this article demonstrate that this technique produces superior results to conventional methods of grafting, improves patient comfort and avoids the need for immobilization of the patient. Further, as taking of the skin graft is from adjacent tissue, the tissue gradient is less leading to a reduced contour defect.

Discussion

A skin graft has long been part of a surgeon's armamentarium. Reverdin first described the use of the pinch graft in 1869 [5]; Ollier's and Thiersch's then demonstrated the application of the split-thickness graft in 1872 and 1886, respectively [6]; and Wolfe's and Krause's described the full-thickness graft in 1875 and 1893, respectively [7]. A partial thickness graft or split-skin graft contains a portion of the dermis and the complete epidermis. The healing process of skin grafts has been well described by Rudolph and Klein [8].

A split-skin graft is more likely to survive on its recipient site because it is more suited to the stage of plasmatic imbibition and revascularization when compared to a full-thickness graft. The thinner split-skin graft contracts less than an intermediate thickness split-skin graft; a full thickness graft hardly exhibits any secondary contracture. Split-skin grafts are more likely to survive in areas with less vascularity such as periosteum or peritenon and are the grafts of choice for the lower limb [9].

The rapid healing of the halo graft led me to research the possible reasons for faster than expected healing. For a start the patient is fully mobilized. Exercise accelerates cutaneous wound healing and decreases wound inflammation and this has been confirmed by studies in mice [10]. Recent studies

have shown that exercise improved cutaneous wound healing in older adults [11]. While the mechanism(s) responsible for this effect was not elucidated, the authors suggested that the acceleration of wound healing could be due to an enhanced neuroendocrine response, and suggested further investigation into this hypothesis and evaluation of pro-inflammatory cytokines in the local wound environment. The authors concluded that a relatively short-term exercise intervention is associated with enhanced rates of wound healing among healthy older adults. Thus, exercise activity may be an important component post-operatively to promote wound healing [11].

Naturally using small split-skin grafts in pieces reduces the metabolic demand for each graft. However, the overall shape of the wound created i.e., inner defect, followed by shallower 'donor' site may also be a factor. When studying mathematical models of ischemic wounds, it is interesting that the authors created a model that mimicked our halo graft with a central 'ischemic' wound surrounded by a shallower wound that was relatively more oxygenated [12]. They found additional benefits of hyperoxia via hyperbaric oxygen (which exercise also helps induce).

There is also reduced morbidity with the avoidance of hospitalization. A survey done of the common practices of surgeons in Australasia found the following [13]: 73.5 % of surgeons reported that at 1 month, skin graft take of >80 % occurred more than 90 % of the time. Most grafts (58.12 %) were perforated. Meshing (22.22 %) and laying the graft as a sheet (19.66 %) were at similar rates. 78.63 % wrapped the limb with bandages only, while 21.37 % would place the limb in a hard splint. 46.15 % of surgeons rested their patients in hospital for between 2 and 7 days.

Interestingly, the circular shape also has further added benefits. Circumferential nature of graft and donor site adds interesting dynamics to the equation. In dermal wounds, the wound opening is closed by epidermal cell migration and granulation tissue contraction. However, in epidermal wounds, it is generally accepted that re-epithelialization is due entirely to epidermal cells at the wound edge moving inwards to close the wound [14].

Further, experimental evidence suggests that a circumferential tension at the wound edge may well be the mechanism underlying epidermal movement, acting like a purse string that pulls the wound edge inwards. The work of Martin and Lewis revealed a thick cable of actin around the epidermal wound margin localized within the leading row of basal cells in circular defects [15].

In conclusion, the 'halo' graft is an extremely useful and versatile technique. It requires minimal equipment, confines the surgical wounds to one site and speeds up wound healing following skin grafting. The precise mathematical calculation allows for tailoring this technique to defects of varied sizes.

Due to the adjacent nature of the graft and donor site, *we have only used (and only recommend) the technique for non-melanoma skin cancers. It would also be common sense to avoid this technique where the entire field is covered with actinic keratosis,* as we sometimes see in severely sun-damaged skin in Australasia. The data in our original study demonstrate that this technique produces superior results to conventional methods of grafting, improves patient comfort and avoids the need for immobilization of the patient. Further, as taking of the skin graft is from adjacent tissue, the tissue gradient is less leading to a reduced contour defect.

A team from Queensland, Australia led by Fietz and Sivyer repeated a clinical trial of halo grafts and concluded thus: The authors of this study agree with Paul that the HSSG (Halo split-skin graft) is a technique that does not require specialized equipment and that it is an economical and effective procedure for managing NMSC (non-melanoma skin cancer) on the leg when SSG (split-skin grafting) is indicated [14]. It can also be used in areas like the scalp (in bald heads) where a split-skin graft is being contemplated.

Key advantages of a halo split-skin graft can be summarized thus:

- Graft taken from 'halo' around defect
- Single site of administration of local anesthesia
- No special instruments or immobilization

- Faster wound healing and reduced contour defect
- Significant less donor-site pain
- No need for hospitalization and reduced morbidity

Interestingly, recurrence of cutaneous squamous cell carcinoma have been reported even at remote limb donor sites [16], therefore any increased concern regarding donor and recipient sites being adjacent in a halo graft may be unfounded.

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Chapter 10
Balloon Cell Nevi and Balloon Cell Melanomas: What Are They?

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Background

Balloon cell nevus was first described by Judalaewitsch [1] over a century ago in 1901. The first detailed case report was in 1935, when Miescher described a balloon cell nevus in a nine-year-old boy [2]. Miescher in this article erroneously hypothesized that a transformation of nevus cells into sebaceous cells produced a balloon cell. It is now known that a balloon cell is a nevocellular nevus [3]. The most common anatomical sites are the head and neck, followed by the trunk and extremities [4]. The significance of the balloon cell formation appears to be due to the degeneration of melanosomes and the progressive vacuolization that results [5]. Many balloon cell nevi resemble benign intradermal

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nevi or other benign lesions and are possibly under-diagnosed as a result. It is important to understand this pathophysiology especially as balloon cell malignant melanoma is known to occur and makes up 0.15 % of all cutaneous melanomas [6]. The article presented here is of two cases that were clinically not diagnosed – the first thought to be an intradermal nevus but turned out to be balloon cell nevus; the second, which resembled a seborrheic keratosis, was a malignant melanoma on biopsy. As in many instances, clinically benign intradermal nevi may not be biopsied, this entity may well be under-diagnosed. Further, as junctional activity has been known to occur over an incompletely removed balloon cell nevus, it may represent a precursor form of a dermal nevus cell [7]. Another notable feature of *this balloon cell melanoma case however, is that it is pigmented* (unlike reported balloon cell melanomas) and *unequivocal balloon cells are seen in the dermo-epidermal junction. This has never been previously reported* and is inconsistent with the previous hypothesis that a balloon cell melanoma is a vertical growth phase melanoma of dermal origin.

Case Reports

Case 1

A 40-year-old white male presented with a lesion on his cheek resembling a typical non-pigmented intradermal nevus. He requested removal as it was interfering with shaving. After this lesion was shave excised, the histology turned out to be a balloon cell nevus. The histological features are described here (Figs. 10.1, 10.2, and 10.3) and the images show balloon cells stained with S100, H & E and Melan A stains (all with 400× magnification)

In contrast to the typical appearance resembling an intradermal nevus in white skin, reports in Asian skin types however indicate that the appearance of a balloon cell nevus tends to be polypoid or pedunculated and more resembling a soft fibroma or papilloma [8].

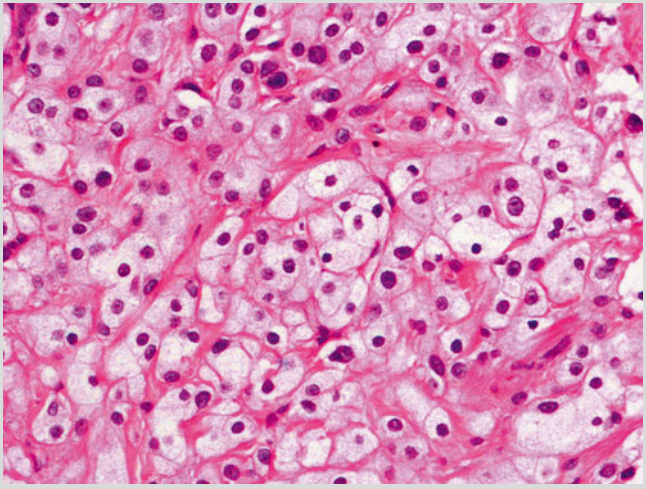

FIGURE 10.1 Clear cell appearance of the melanocytes: H&E, 200× magnification

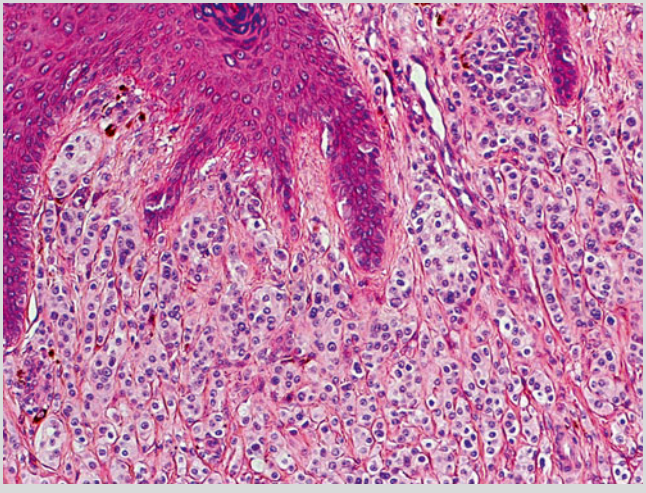

FIGURE 10.2 A transitional area, where conventional melanocytes in the superficial dermis transition into the ballooning melanocytes: H&E, 100× magnification

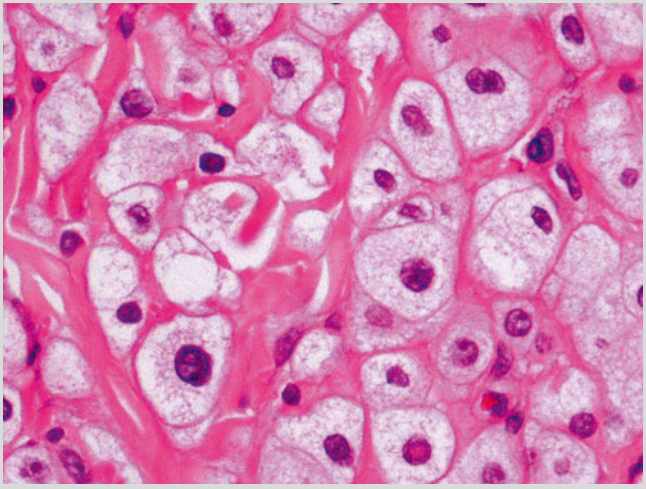

FIGURE 10.3 Classical appearance of the balloon cell nevocytes. Note mild nuclear pleomorphism: H&E, 400× magnification

Histopathological Examination

Balloon cells are characterized by their comparatively large sizes, centrally placed small round nuclei and relatively clear cytoplasm. When transitional nevus cells are evident at the periphery, one can see both balloon cells and nevus cells giving a 'ground glass' appearance [9]. The cytological features of a balloon cell melanoma are similar with the added presence of nuclear pleomorphism, atypia, mitoses and the absence of intervening stroma [10].

Electron Microscopy

Ultramicroscopic examination is especially important in the case of balloon cell nevi. Balloon cells are formed by progressive vacuolization of melanocytes or nevus cells brought about by the enlargement and eventual destruction of melanosomes [11].

Balloooning is essentially large vacuole formation by coalescence of small vacuoles that originate as abnormal melanosomes.

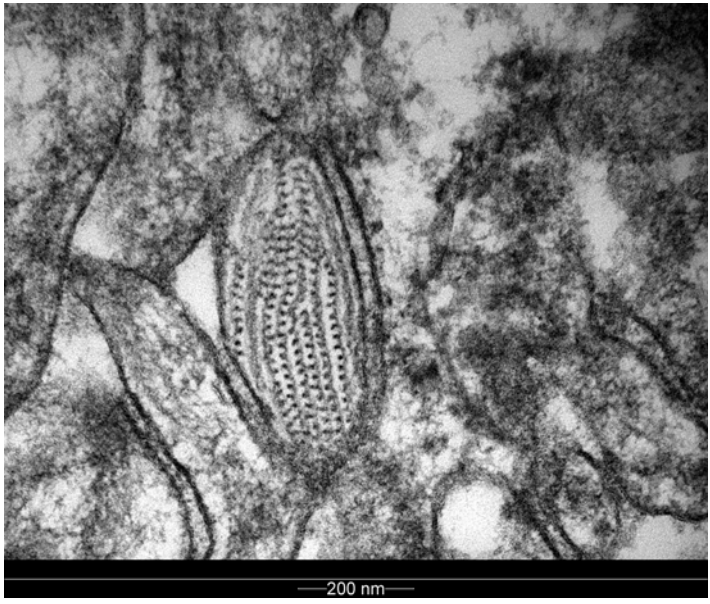

FIGURE 10.4 Normal melanosomes in some of the melanocytes: electron microscopy

Melanosomes in a balloon cell nevus tend to merge and the majority degenerate leaving large cavities. Only a minority still exhibit giant melanosomes. Interestingly, most of these abnormally large melanosomes are not melanized. Melanosomes of intradermal nevus cells are, in contrast, very small and fully melanized [12].

The initial stages of ballooning shows a large number of melanosomes, a well-developed endoplasmic reticulum and frequent mitoses – all pointing to a proliferative rather than a degenerative process. However, such proliferation seems to be a self-regulatory process – where unlimited production of melanosomes continues without accompanying melanization until degeneration of the melanosome i.e., the so called 'ballooning' process. In contrast, human embryonic hair follicles tend to employ phagocytosis as a self-destructive mechanism [13].

The electron microscopic images (Figs. 10.4 and 10.5) show a melanosome and the process of 'ballooning' degeneration quite clearly.

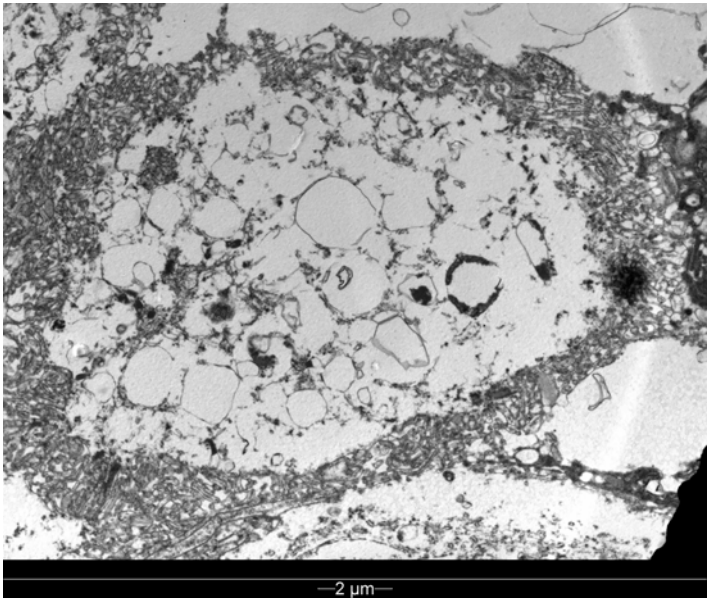

Figure 10.5 Abnormal, disintegrating melanosomes in the balloon cells: electron microscopy

Case 2

A 66-year-old man presented to a primary care skin cancer clinic in Melbourne, Australia requesting a routine skin check. He was not concerned about any particular lesion. There was no personal or family history of melanoma or non-melanoma skin cancers. He had worked outdoors in construction and as a firefighter for over 20 years. He had never used sun beds or used welding equipment. He gave no significant history of recreational sun exposure.

On examination the patient had Fitzpatrick skin type 2 with significant actinic damage to the face, forearms and dorsum of the hands, with multiple solar

lentigines and scattered small actinic keratoses on the temples. A whole body skin examination was undertaken with the aid of a Heine Delta 20 non- polarizing dermatoscope. (Heine Optotechnik, Herrshing, Germany). Digital clinical and dermatoscopic images were taken with a Medicam 800 Fotofinder camera with non-polarizing lens (Fotofinder Systems GmbH, Aichner, Birnbach, Germany), the dermatoscopy images being at 20× magnification. A lesion of concern was found on the right posterior upper arm. It measured 8 mm in diameter and was slightly domed, being raised 2–3 mm from the skin surface and resembled a seborrheic keratosis (Fig. 10.6).

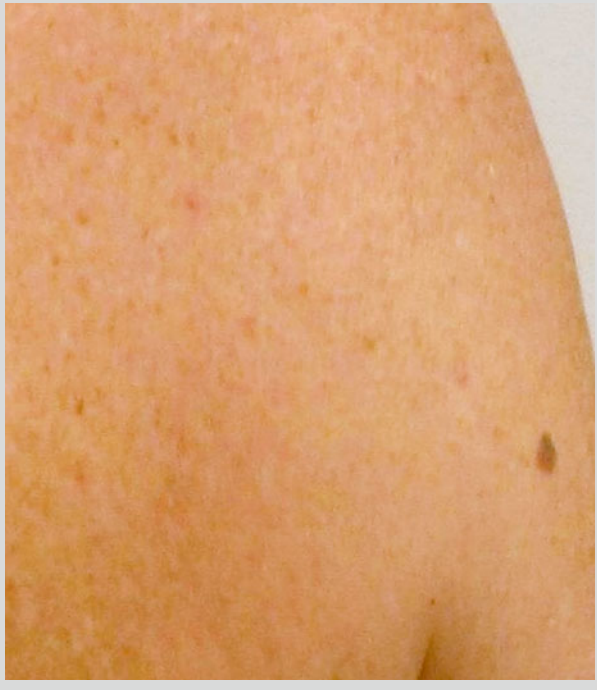

FIGURE 10.6 Right posterior shoulder lesion

Dermatoscopically it was pigmented, and structureless with two colours, blue-grey centrally and brown peripherally, almost symmetrically combined, as well as white reticular lines (inverse or negative network). There was a polymorphous pattern of vessels both linear and and dots (Fig. 10.7). The lesion was quite different dermatoscopically to all the patient's other pigmented skin lesions ('ugly duckling sign') even if appeared a possible seborrheic keratosis clinically. The decision was made to undertake an excisional biopsy on suspicion of melanoma.

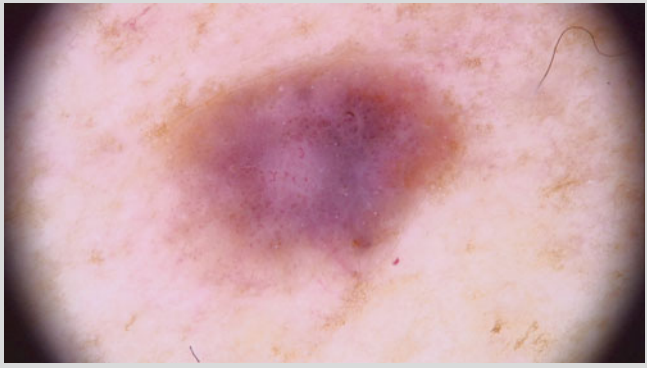

Figure 10.7 Dermatoscopy of right shoulder lesion: balloon cell melanoma

Histopathological Examination

Sections showed a broad, asymmetric nested and single-cell proliferation of severely atypical melanocytes along the dermoepidermal junction, with extension into, and filling the dermis. The junctional component exhibited prominent Pagetoid upward scatter. The dermal component lacked maturation on descent, and extended to a depth of 0.95 mm (Clark level 4). The cells contained hyperchromatic pleomorphic nuclei, and a swollen, ballooned appearance, with abundant

pale granular and/or vacuolated cytoplasm. Virtually all of the cells within the tumor exhibited this appearance, including the epidermal component. There was moderate mitotic activity with 3 mitotic figures seen per mm sq. No ulceration, lymphovascular invasion, perineural invasion, satellitosis, or regression was noted. Excision was complete.

Figure 10.8 Shows a low power 20× photomicrograph. There is a broad, asymmetric proliferation of atypical melanocytes along within the epidermis, and filling the dermis to a depth of 0.95 mm (level 4) Fig. 10.9. 40× magnification photomicrograph of the lesion shows the lesion to consist almost entirely of ballooned melanocytes, including the epidermal component. Extensive Pagetoid scatter is present. The dermal component does not exhibit maturation on descent.

The patient underwent a wider local excision to >10 mm margins (including depth) as per guidelines for managing Stage 1 A melanomas. Sentinel lymph node biopsy was not undertaken.

Discussion

As intradermal nevi are especially common in Celtic skin types, it is possible that balloon cell nevi are under-diagnosed [4]. Further balloon cell nevi tend to have different appearances in white and Asian skin types, making a definitive clinical diagnosis impossible without microscopy. As discussed

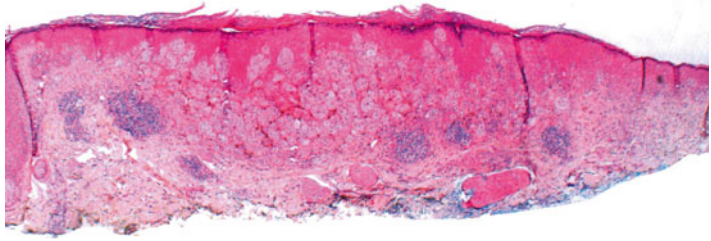

Figure 10.8 Low power (20×) photomicrograph . There is a broad, asymmetric proliferation of atypical melanocytes along within the epidermis, and filling the dermis to a depth of 0.95 mm (level 4)

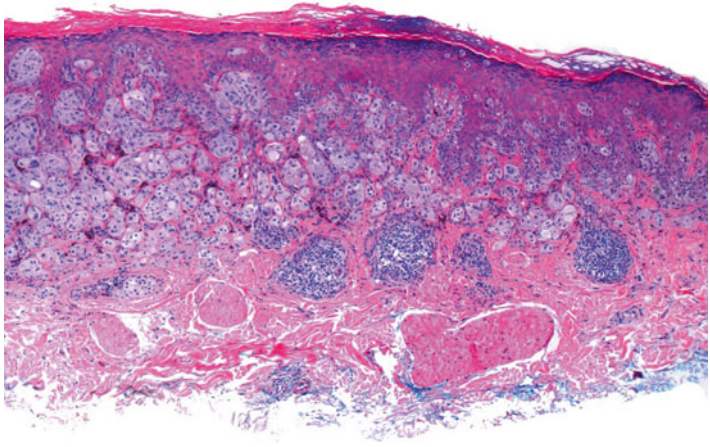

FIGURE 10.9 Photomicrograph 40× shows the lesion to consist almost entirely of ballooned melanocytes, including the epidermal component Extensive Pagetoid scatter is present. The dermal component does not exhibit maturation on descent

earlier, balloon cell nevi are great mimics with many different clinical appearances. Therefore sebaceous, xanthomatous and neurogenic origins have been proposed in the past [2]. There was also a theory that balloon cells were regressive variants of nevus cells confined to children or adolescents [14]. We now know that the ballooning process is a self-destructive degenerative process of melanosomes. The male to female ratio is almost even and most occur in the first three decades of life. While 30 % of balloon cell nevi occur on the head and neck, there are a handful of cases reported of balloon cell nevi on the conjunctiva or iris.

The transformation rate for melanocytc nevi into malignant melanomas is under 0.0005 %. However, melanomas arising in balloon cell nevi are said to make up 0.15 % of all melanomas [15]. The prognosis of balloon cell melanomas correlates with tumor thickness similar to other histological types of malignant melanomas. The preferred method of removal is a complete elliptical excision. However, given many are clinically diagnosed as benign intradermal nevi it is common

for them to have been shaved. Incomplete shave excision can result in a balloon cell nevus recurring as a regular junctional nevus. It is therefore important to understand this 'ballooning' phenomenon as it can prevent erroneous diagnosis as well as avoid undue alarm during such a recurrence occurring. Also understanding of the electron microscopy of these balloon cell nevi helps diagnose balloon cell melanomas and distinguish them from other clear cell carcinomas.

Kao defined balloon cell malignant melanoma as a melanoma composed of more than 50 % foamy cells [6]. The melanoma case presented in this case report complies with this definition. In a review of the literature the various clinical appearances of balloon cell melanomas were characterized as nodular, ulcerated, polypoid and papillomatous, but the common absence of pigmentation was noted. The case presented here is the first *pigmented* balloon cell malignant melanoma ever published.

Balloon cell malignant melanomas have previously been regarded as a vertical growth phase melanoma [16, 17] and as there have been no reported cases of such melanomas with a junctional component of balloon cells, it has been speculated that balloon cell melanomas may have a dermal origin [17]. *The histology in this case however clearly shows a dermo-epidermal junctional component of balloon cells. This has never been previously published* and is inconsistent with the previous dermal origin hypothesis [17].

Metastatic balloon cell melanomas in lymph nodes may be particularly difficult to diagnose because of extensive balloon cell alteration of the melanoma cells. Clear cell morphology should raise the diagnostic possibility of melanomas arising in balloon cell nevi [18].

Given both the balloon cell cases here – of a nevus and a melanoma were picked up more by chance than pre-operative clinical diagnosis, and in clinics routinely dealing with skin cancer, it is likely that both are under-diagnosed. It is important therefore to understand the histology and dermatoscopy and hence these cases have been presented here to broaden awareness as to their occurrence and underlying pathology.

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Chapter 11
Topical Treatment of Skin Cancers and the Risks of 'Fighting Fire with Fire'

Sharad P. Paul

Background

While surgical excision remains the mainstay of managing non-melanoma skin cancers, many authors have published successful topical or non-surgical options for treating non-melanoma skin cancers [1]. A recent review article compared the efficacy of topical 5-fluorouracil (5FU), topical imiquimod 5 % cream, intralesional 5FU, intralesional methotrexate (MTX), intralesional bleomycin, and intralesional interferon (IFN) for non-melanoma skin cancers [2].

5-fluorouracil has been around since the 1960s and it acts as an antimetabolite, interfering with DNA synthesis [3]. Imiquimod was then approved in 1997 for the treatment of genital warts and this nucleoside analogue will be discussed in greater detail in this case study. Diclofenac, an NSAID, acts

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by down regulating cyclooxygenase enzymes and increasing apoptosis. Topical diclofenac 3 % gel in 2.5 % hyaluronic acid (which delivers and retains the drug in the epidermis) is approved by the US Food and Drug Administration for the treatment of actinic keratosis. Diclofenac acts by reducing dysplastic keratinocytes in cancerous lesions, including AKs, by stimulating programmed cell death via COX-2 inhibition and may inhibit angiogenesis [4]. Ingenol mebutate, a macrocyclic diterpene-ester, is a recently marketed natural extract from Euphorbia peplus. The sap of this plant has long been used as a topical traditional remedy for common skin lesions, such as warts and neoplasms – and has a dual action: the induction of rapid cellular death in the treated area, followed by an inflammatory response within days of application, able to eliminate residual cells [5, 6]. Other emerging topical therapies include Piroxicam, Betulinic acid, Resiquimod or calcium/potassium dobesilate [7].

Imiquimod belongs to the class of 1H-imidazo-[4,5-c] quinolones – a group of drugs that was originally developed as nucleoside analogues with the aim to find new potential antiviral agents [8]. Indeed, Imiquimod was first released as treatment for genital warts before its actions against skin cancer were studied. Imiquimod is a relatively small sized molecule (Mr = 240.3). The molecular size, as well as it being hydrophobic, allow it to penetrate the skin epidermal barrier and therefore make it suitable for topical formulations [9]. In many studies Imiquimod has shown itself effective against skin cancers and pre-cancerous lesions, especially basal cell cancers and actinic keratosis [10, 11]. There have also been reports of Imiquimod being used as topical treatment against cutaneous metastases of melanoma and some authors have reported its use as first-line therapy against melanoma in situ [12, 13].

We report a case of an invasive malignant melanoma arising de novo at the specific site of application of Imiquimod (Aldara™ Cream 5 %) for a biopsy-proven superficial BCC. Therefore while Imiquimod has added to our topical armamentarium with respect to skin cancer management,

care must be exercised in prescribing this treatment and it is especially important to follow-up patients regularly.

In recent years, Imiquimod has become widely used as topical treatment for skin cancers. Its tumouricidal activity is based mainly on activating the innate immune system, for which dendritic cells seem primarily responsible. These dendritic cells initiate a tumour-directed cellular immune response [14]. Researchers have noted that dendritic cells respond to much lower concentrations of imiquimod than many other cell types [15]. At higher, but therapeutically relevant concentrations, Imiquimod exerts some pro-apoptotic activity against tumour cells.

Toll-like Receptors (TLR), especially TLR 7 and TLR 8 are important receptors of this innate immune system. It is generally felt that Imiquimod is an agonist of TLRs 7 and 8 [16]. However, while these innate immunity-related actions are well known, there are some findings which cannot be explained easily by TLR-dependent mechanisms – for example Imidazoquinolines like Imiquimod can stimulate the proliferation of B cells in vitro, even in the absence of other immunocytes [17].

However, in recent times Imiquimod has been shown to paradoxically cause tumors, or more precisely tumors have been reported at bodily sites of treatment. In 2006, two cases of invasive SCC arising after treatment of squamous carcinoma-in-situ with 5 % imiquimod cream were reported [18]. While the exact mechanism of tumor-induction by Imiquimod is unclear, presumably it is due to its local alteration and stimulation of an exuberant immune response. Keratoacanthomas have also been reported as arising after treatment with topical Imiquimod [19].

Some authors have used Imiquimod ‘off-label’ and have reported resolution of primary melanoma-in-situ (lentigo maligna) and recurrent lentigo maligna with 5 % Imiquimod cream [20, 21]. Some authors have also noted Imiquimod inhibits melanoma development by promoting pDC cytotoxic functions and impeding tumor vascularization [22], and there have been many reports where researchers have used Imiquimod topically to treat melanoma metastases [23].

In this context, we believe our case report to be noteworthy and worth reporting as in our patient, 5 % Imiquimod was used as topical treatment for a biopsy-proven BCC and the patient ended up developing an invasive melanoma over the site. While, as discussed earlier, keratoacanthomas have been known to develop at the precise site of a treated superficial BCC -- an invasive melanoma arising in this situation is unusual and to our knowledge, not been reported previously. In the case of our patient, the area on his back was marked for treatment, which was then undertaken for 6 weeks with 5 % Imiquimod (Aldara™ cream) with two treatment-free days each week as per usual protocol. At 8 weeks, when the patient was reviewed, he had a complete clearance of the BCC noted earlier; however, he had developed a new pigmented lesion over the site of topical application of Imiquimod which both on dermoscopy and clinical examination was suspicious for melanoma. Histopathological analysis has confirmed this to be an invasive melanoma. While many authors are advocating the use of Imiquimod for melanoma, we would like to present this case, where an invasive melanoma has arisen at the precise site of application of Imiquimod (Aldara™ Cream 5 %) for a superficial BCC.

Case History

A 60 year old white male presented to our skin cancer center with superficial BCC areas on his mid back. Given he had three to four sBCCs present within a 10 cm area, it was decided to treat these lesions topically using Imiquimod (Aldara™ Cream 5%). A biopsy was undertaken initially to confirm sBCC. We used the standard protocol recommended by the manufacturers i.e., the cream was applied to the affected area once a day at bedtime for five consecutive days per week (Monday to Friday) for 6 weeks. The patient was reviewed at 8 weeks and it was noted that the patient had developed a de novo pigmented lesion over the site

of application of Imiquimod. Given the clinical impression was that of a malignant melanoma, this lesion was excised. The approximate area within which the treatment was undertaken is shown in Fig. 11.1. The image clearly shows the de novo pigmented lesion arising within the field of treatment.

HISTOPATHOLOGY
Specimen:
EXCISION SKIN LESION BACK

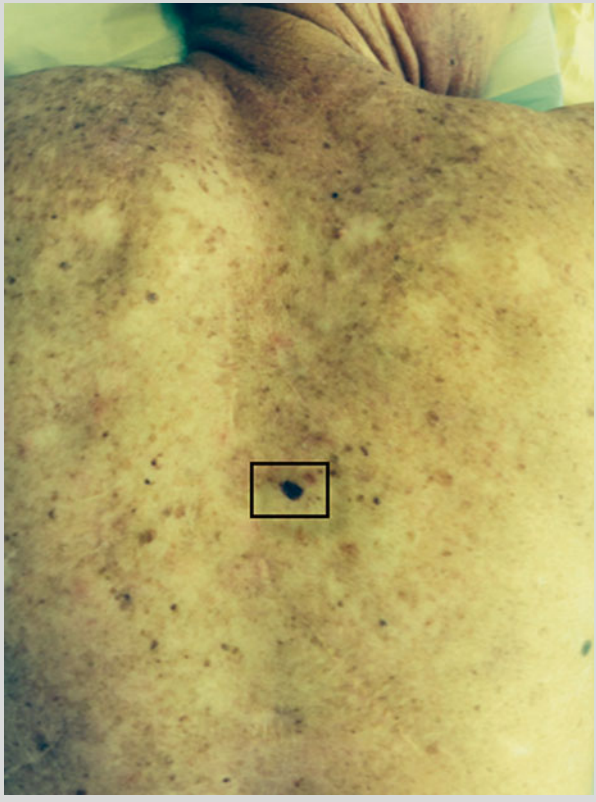

FIGURE 11.1 *Box* shows area of application of Aldara for s BCC

Gross Description:
The specimen consists of a skin ellipse 15 mm × 10 mm ×5 mm bearing a central dark brown irregular lesion approximately 9 mm ×7 mm. 3r 6l
Microscopy:
SYNOPTIC REPORT FOR INVASIVE MALIGNANT MELANOMA
SUMMARY DIAGNOSIS:
INVASIVE MALIGNANT MELANOMA, CLARK LEVEL 3, BRESLOW THICKNESS 0.8 MM, CLOSEST SIDE MARGIN 1.25 MM. OTHER SIDE MARGIN 2.5 MM. CLOSEST DEEP MARGIN 4.1 MM.
Tumor Type: Invasive malignant melanoma arising in an area of melanoma in-situ
Ulceration: Nil
Tumor Infiltrating Lymphocytes: Mild
Regression: Nil
Lymphovascular Invasion: Nil
Perineural Spread/Neurotropism: Nil
Mitotic Rate: 0 per sq mm
Microscopic Satellitosis: Nil
Radial Margin of Excision: Closest side margin 1.25 mm. Other side margin 2.5 mm.
Deep Margin: Closest deep margin 4.1 mm.
Associated Nevus: Nil
The case has also been viewed by Dr F.O. who agrees with the diagnosis. Reported By: Dr. H T. Anatomical Pathologist
Office Data: nl/lm/as
Ordered by: SHARAD PAUL
Observation date: 16-Aug-2014

Histological report is detailed above – which reveals a non-ulcerated tumor of 0.8 mm Breslow thickness, Clark Level 3 invasive melanoma, arising in an area of melanoma-in-situ. A compete skin and lymph node

examination revealed no other abnormalities. After reviewing the histopathology, this patient was managed with a wide local excision with 1 cm margins in keeping with standard guidelines for management of Stage 1A melanoma of skin.

Discussion

Dermatologists, surgeons and skin cancer doctors are faced with an epidemic of skin cancer in Australia and New Zealand. Actinic Keratoses and Squamous Cell Carcinomas share multiple genomic mutations that suggest common origins [24]. It is well known that increases in p53 mutations are seen in sun-damaged skin, AK, and SCC [25]. Given the need to reduce unnecessary surgery as well as associated costs, researchers have turned their focus to topical applications to deal with skin cancer. Some prevailing topical treatments include 5-fluorouracil, diclofenac sodium, topical photodynamic therapy (PDT) with 5-aminolevulinic acid (ALA) Imiquimod and few others discussed earlier.

Given the clinical interest for TLR agonists in metastatic melanoma and indeed skin cancer, it is essential to determine the mechanism of action of Imidazoquinolines such as Imiquimod. Imiquimod has many cellular effects that stimulate Th-1 innate immunity. The drug's effects is mediated after binding to TLR 7, the receptor that is found on dendritic cells and monocytes. TLR-7 is also involved in regulation of cellular apoptosis. Following Imiquimod treatment, 'immunologic memory' is established, and this differentiates this drug from other topical agents [26]. From Imiquimod's early use for genital warts, it was noted that a significant proportion of patients ended up 'non-responders.'

Some authors have been enthusiastic about the 'field clearance' effects of Imiquimod – the concept of lymphatic transport of immune cells and factors with subsequent immu-

nological curing of tumors, not only in the treated area, but also those in 'field' around the treatment site. Akkilic-Materna and colleagues suggest that their observations on the actions of Imiquimod support the concept of lymphatic transport of immune cells and factors with subsequent immunological curing of tumors, not only in the treated area, but also those in the area between the imiquimod application site and the regional lymph nodes – what they term the "lymphatic field clearance" [27] Others have raised concerns about recurrence after Imiquimod use and whether Imiquimod may select more aggressive tumor cells or may just convey a natural course of tumor recurrence as we see with other treatment modalities [28].

Recurrence aside, there have been several reports of Imiquimod triggering keratoacanthomas and indeed infiltrating or aggressive SCC [29]. There has been also a report of a pulmonary embolism occurring after Imiquimod use [30]. The exact mechanism of inducing tumors remains unknown, although the exuberant immunological response is blamed – a sort of fighting 'fire with fire' when utilizing immune-modulating agents that stimulate apoptosis.

There are now several reports that have supported the use of Imiquimod in amelanotic lentigo maligna [31], peri-ocular lentigo maligna [32], facial lentigo maligna [33] and even in large lentigo malignas prior to staged excision [34]. However given the reports of Imiquimod causing aggressive SCC, or in our case, an invasive melanoma arising at the site of topical Imiquimod use, I would like to stress the importance of follow up after Imiquimod use.

Schön and others have discussed that more pleiotrophic antitumoral responses have to be considered when studying imidazoquinolines. They demonstrated that imiquimod is able to act not only as synthetic adjuvant but also as direct inducer of apoptosis for melanoma cells in vitro and in vivo. They concluded that cell death was exerted by apoptosis rather than necrosis and that this pro-apoptotic signal is selectively activated in melanoma cells, but *not* in primary human melanocytes [35].

Of course, in this case report, it is impossible to prove causal effect – other than to say that the melanoma arose at the exact Imiquimod treatment site. However, I believe it is prudent, given this case-study, to undertake ongoing surveillance of patients after Imiquimod use.

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Chapter 12
When a Lipoma Wasn't a Lipoma: A Discussion About Granular Cell Tumors of Skin

Sharad P. Paul and Vladimir Osipov

Background

Granular Cell Tumors, first described by Abrikossoff on the tongue in 1926, are known to occur in skin, connective tissue, breasts, gastro-intestinal and genital tracts – with the head and neck being the commonest region and the tongue the commonest site [1]. They are very rare tumors, and some authors have suggested that they make up around 0.5 % of all soft tissue tumors [2]. Frequent locations are the tongue (40 %), breast (15 %), respiratory tract (10 %), and esophagus

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(2 %) [3]. The tumour can often be multicentric (5–14 % of cases) [3]. These tumors have a higher incidence amongst women and a greater prevalence amongst black people. There has also been a case report of a mother and son – both of whom presented in childhood with multiple granular cell tumors [4].

While the origins of granular cell tumors are often debated and Abrikossoff originally postulated a myogenic origin and termed this a 'myoblastoma', they are now considered to be neoplasms of neural origin, as evidenced immuno-histochemical studies [5]. However, there have been reports of dermal non-neural granular cell tumors in the literature [6].

It is considered difficult by some authors to make a diagnosis of malignancy in these tumors on the basis of cellular pleomorphism, mitotic activity, or ultrastructural findings; macroscopic features such as size greater than 5 cm, rapid growth rate, or invasion of adjacent structures are more likely to suggest malignancy [7]. Most Granular Cell Tumors are benign with a self-limiting growth pattern; however, when they metastasize, the commonest sites are to the regional lymph nodes, lungs or bones [8]. Granular Cell Tumors are rare on the trunk and usually present as a solitary painless mass, with the patient usually noticing a lump [9].

The case we are presenting is that of a young white male aged 27, who presented with a 2-month history of a 2 cm mass on his buttock which was preventing him from sitting down due to pain. Our initial clinical impression of this fibro-fatty mass was initially of a well-circumscribed lipoma or neurofibroma and the differential diagnosis included a cyst. The pain and tenderness to touch were attributed to pressure effects on his sciatic nerve. Given this was a young male patient presenting with a painful dermal/subcutaneous mass, we did not consider a granular cell tumour until histopathological examination, due to this unusual case presentation.

Case History

A 27 year-old white male was referred to our centre by his GP with a lump noted by the referring doctor on the patient's right buttock. The mass was 2 cm in diameter and was felt to be a lipoma clinically. The patient himself was not aware of the lump and had visited his GP only because every time he sat down he felt pain over his buttock region, which was radiating down his leg. This symptom was consistently reproducible and prevented the patient from sitting down on a hard surface like a wooden bench.

The patient was otherwise well with no medical conditions or medications. There was no family history of any malignancy or cutaneous masses or lipomata.

On examination, we felt a well localized an approximately 2 cm soft tissue mass which was clinically located in the deep dermis or the subcutaneous fat. There was no attachment to muscle and no overlying skin changes. Our differential diagnoses included a lipoma or neurofibroma. Given the lesion was well-localized, not greater than 2 cm and not adherent to muscle or deep fascia, we proceeded to excision of the lesion under local anesthesia without imaging.

During the operation, the lesion seemed well localized and intra-operatively appeared to resemble a sebaceous cyst or pilomatrixoma.

Histological reports are detailed below. A compete skin and lymph node examination revealed no other abnormalities. After reviewing the histopathology, this patient was managed with a wide local excision with 1 cm margins.

Histopathological examination:

The tumour was well-circumscribed, spanned the entire dermis and showed broad interface with the underlying adipose tissue. The interface with the epidermis was quite irregular, with prominent epidermal pseudoepitheliomatous hyperplasia (Figs. 12.1 and 12.2).

This feature creates a well-know pitfall that may happen in a limited sample of a granular cell tumour. One can

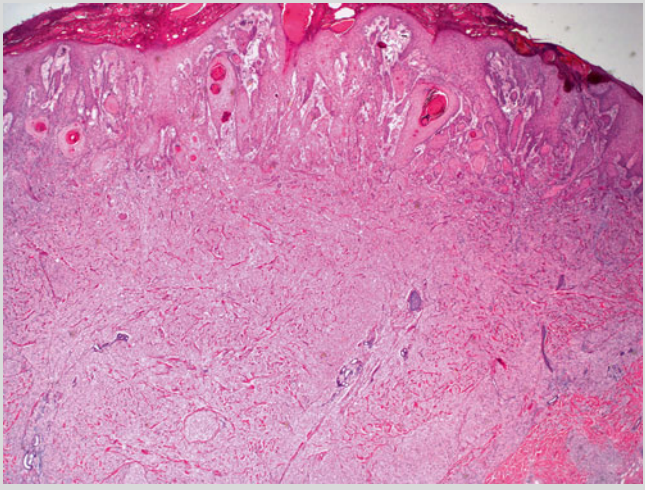

Figure 12.1 H&E, 20× magnification

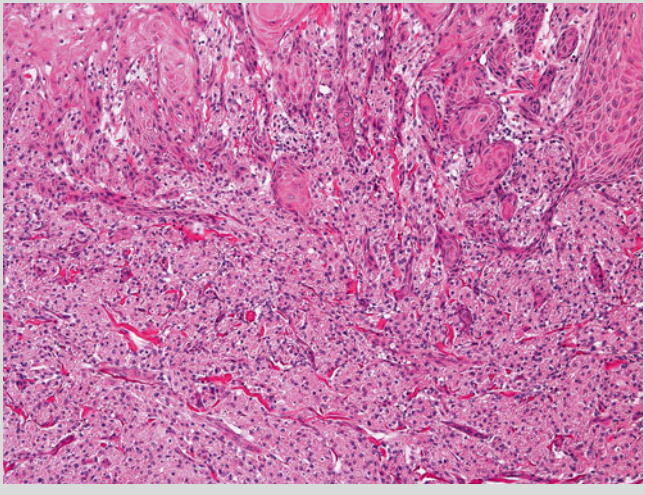

Figure 12.2 H&E, 100× magnification

see how easy a diagnosis of invasive well-differentiated squamous cell carcinoma can be made in a superficial biopsy sample. This can lead to a potentially harmful surgery, especially when the lesion is present in the tongue, which is a common site for Granular Cell Tumors. The tumor cells are quite monomorphous, with small round nuclei and abundant granular eosinophilic cytoplasm (Fig. 12.3). The tumor cells were diffusely positive with S-100 immunohistochemical stain.

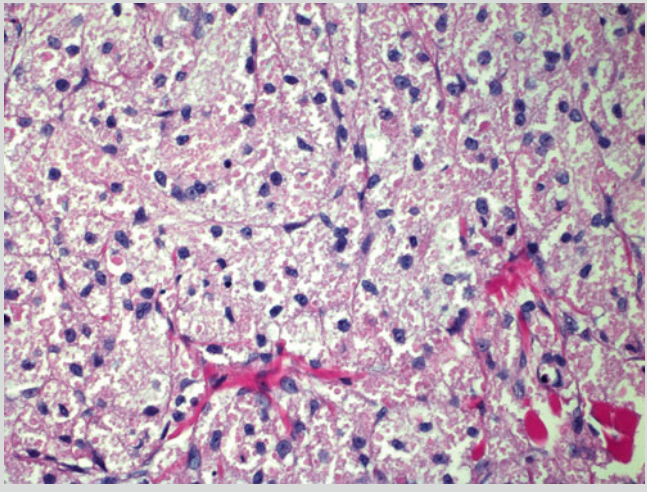

Figure 12.3 H&E, 400× magnification

Discussion

Granular Cell Tumors are uncommon and when they occur they are most common on the head and neck. Surgical excision is the treatment of choice. The recurrence rate for Granular Cell Tumors has been reported at 2 %, when local

wide excision has been undertaken [10]. Most Granular Cell Tumors can be easily managed by wide local excision; however, in cosmetically sensitive areas where tissue preservation is paramount – such as the penis, Mohs Micrographic Surgery has been used [11]. Our patient was unusual, given it was the symptomatic nature of the lesion that led to the diagnosis – the patient was unable to sit due to buttock pain which resulted in the initial referral, and the impression during surgery was of a cyst, neurofibroma or a pilomatrixoma. A survey of buttock tumors suggested that when pain is present, it is usually due to cyst formation in old haematomas, and pain along the course of the sciatic nerve and its branches was present in 40 % of the cases [12].

Granular Cell Tumors are usually painless masses in the head, neck or extremities and hence in our patient, the diagnosis was only made subsequently upon histological examination. It is interesting that as far as Granular Cell Tumors are concerned, when malignant cases are reported (in 1–2 %), the most common site is the soft tissue of the thigh, rather than the head and neck area. [13] The malignant versions of Granular Cell Tumors are more common in African-American females, and the mean age range of patient with malignant tumors is similar to the benign group i.e. 30–50 years. The treatment of choice is wide complete local excision, as was performed in our patient. The recurrence rate after incomplete excision results in a recurrence rate of 21–50 % [14]. This case report suggests that Granular Cell Tumors must be considered in the differential diagnoses of lipomas. Several authors have mistaken them for lipomas. Approximately 5 % of GCT occur in the gastrointestinal tract, with predilection for the esophagus. Due to the similarity in endoscopic appearance, some gastroenterologists [15] suggest granular cell tumors may often be mistaken for lipomas and are perhaps more common than the reported literature suggests.

While they are rare, they are commoner in blacks and show a slight female preponderance. Usually presenting as solitary and painless masses, less than 10 % are multiple, and fewer than 3 % of tumors show features of malignancy. Mean

age is 40–60 years. An interesting report noted a 45-year-old man with a single, firm, painless and mobile cutaneous nodule 2 cm in size on his right arm. This was excised and the histology confirmed as a granular cell tumour [16]. However, the authors in this case noted a strange occurrence. Four years after the initial diagnosis, the patient presented with enlarging subcutaneous nodules on the trunk, left arm and left buttock, associated with a drop in hemoglobin.

A nodule was surgically removed from the left buttock, and this time the histopathological examination revealed a granular cell tumour with malignant features. The authors caution that in benign cutaneous granular cell tumors, as our case was, recurrences can occur many years after the original diagnosis. Therefore long-term follow up is important. This recurrence may involve malignant transformation and also involve gastrointestinal organs besides the skin [16]. Indeed authors have reported granular cell tumors as 'incidental findings' when haemorrhoids have been removed and histological analysis has been done [17]. There is also a report of a *cutaneous* granular cell tumor of skin of the arm diagnosed on fine needle aspiration cytology, which the clinicians had felt was a possible dermatofibroma [18]. The authors in this case comment that while in most cases the cytological features are distinctive enough, soft tissue sarcomas need to be excluded. As they note, sarcomas typically show prominent nucleoli, multinucleated cells, and the characteristic rhomboid crystals. The absence of cross-striations and glycogen distinguishes a granular cell tumour from a rhabdomyoma while the absence of lipid droplets excludes a lipoma-variant such as a hibernoma [18].

And recently, in a large multi-centre study of 119 cases of granular cell tumors of skin, the authors studied the propensity of vascular invasion and other invasive features in granular cell tumors of the skin – and noted that infiltration of arrector pili muscle occurred in 23 % and perineural spread in 66 % of cases. While vascular invasion occurred in 23 % of cases, no intraluminal embolus was found. Therefore vascular invasion of granular cell tumors of the skin consists of an infiltration of

the subendothelial layers, without intraluminal cells, and is not necessarily a marker of adverse prognosis [19].

Just as authors earlier mistook a granular cell tumour for a dermatofibroma, there is a paper where the lesion was initially diagnosed clinically as a dermatofibrosarcoma or a spontaneous keloid only to end up as granular cell tumour of skin on histological examination [20]. Granular cell tumors should therefore be included in the differential diagnosis of scar-like lesions, 'keloidal lesions' or lesions suspected of being lipomata. These tumors should be removed completely and patients then examined regularly to detect new tumors given the risk of both new tumors and later occurrence of malignancy.

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Chapter 13
How Small Is Small for a Melanoma?

Sharad P. Paul

Background

Melanoma is the second most common cancer in men aged 30–49 years and the fourth most common cancer in men aged 50–59 [1]. For women, it is the most common cancer in women aged 25–29 and second only to breast cancer in women aged 30–35 years [2]. Australia and New Zealand record the highest rates of melanoma in the world [3], >55/100,000 people due to high UV indices and largely Celtic populations. Early detection of a melanoma is the best way to reduce mortality – the 10-year survival rate has been reported as high as 99.5 % for early melanomas <0.76 mm thick, but is only 48 % for lesions >3 mm thick [4].

Earlier detection is probably the reason for the reduction in mortality from about 60 % for those diagnosed in 1960 to about

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11 % for those diagnosed 45 years later [5]. Educational and public health campaigns have no doubt helped raise awareness, help self-detection and bring down the mortality rate [6]. The ABCD (asymmetry, border irregularity, color variegation, diameter >6 mm) acronym was created in 1985 to help people recognize early melanomas and differentiate them from benign pigmented lesions [4]. The addition of E, for 'evolving,' to the acronym ABCD is intended to heighten awareness of the diagnostic importance of change, which has been recognized for many years [7]. In the 'rules' of the ABCD acronym, E criterion must coexist with at least one of the other criteria of the ABCD acronym.

Part of the problem with these criteria is that the evolution (E) aspect has been applied particularly to nevi with both medical and lay populations obsessed with screening nevi. However, we know that most melanomas *do not arise* in pre-existing nevi [8] – in one of the most detailed studies that looked to answer this question, it was found that when superficial spreading melanomas were analysed by level, the presence of a nevus varied from 31.3 % of level I melanomas to 21.3 % of level IV melanomas. When thickness was measured, an associated nevus was found in 27.0 % of superficial spreading melanomas less than 1.0 mm thick, and 14.8 % of melanomas with a thickness of 1.0 mm or greater [8]. However, one interesting yet unexplained finding has been that patients presenting with a melanoma arising in a pre-existing naevus had a greater Breslow thickness despite presenting sooner than those with de novo melanomas [9].

The second issue with the 'diameter' (D) aspect is that it raised an erroneous expectation that melanomas need to be at least 6 mm in diameter. One study conducted in Australia suggested that 31.1 % of melanomas were <6 mm in diameter [10]. One of the clinically concerning things about these small-diameter melanomas is the finding that melanomas ≤6 mm display many of these same histo-pathological atypia as larger melanomas [11].

While dermatoscopy has really helped the diagnosis of melanoma, the ABCD rule of dermatoscopy may not be as useful in the identification of small melanomas, as there is

insufficient inter-observer agreement in evaluating the presence of each of the criteria in lesions ≤5 mm [12]. To further complicate matters, studies have shown that dermatoscopy did not improve diagnostic performance for lesions ≤6 mm in diameter, even for those trained in dermatoscopy [13]. This brings us to the question – with regard to melanomas how small is small? Does the ABCD criteria not apply to small melanomas? How can one diagnose small melanomas? We present a case of a tiny <2 mm pigmented lesion that turned out to be a melanoma.

Interestingly, in 1987, Schmoeckel and Braun-Falco even suggested that pigmented lesions under 5 mm cannot be considered melanomas as clinical and histological features only became apparent when lesions enlarged beyond 5 mm size [14]. Then, as mentioned earlier, a large retrospective study from the Sydney Melanoma Unit concluded that 31.1 % of lesions were 6 mm or less in diameter [10]. A few years later, a paper presented a series of invasive small-diameter melanomas, debating if the 'D' should be removed from the ABCD acronym [15]. Recently, a case report reviewed the dermatoscopy and dermatopathology findings of a tiny invasive melanoma in a 38-year-old patient who had >100 nevi – with the smallest diameter ever of a reported melanoma of 1.6 mm [16].

In this case report I am presenting a 2 mm melanoma-in-situ presenting as a solitary de novo lesion in a 60-year-old patient with no previous history of melanoma or multiple nevi – illustrating the fact that when it comes to a melanoma, size does not matter and very tiny 2 mm lesions can also be melanomas. Perhaps, tiny melanomas ≤2 mm need to be termed 'micromelanomas'!

The presentation here is unusual because of the age (60), and clinical presentation of this lesion not being clinically different to the patient's other nevi. Further this patient had <5 nevi other overall. This lesion did not look particularly sinister on clinical examination with the naked eye. The dermatoscopic and histological aspects are reviewed in the context of this clinical case and the associated literature of small-diameter melanomas.

Case History
A 60-year old lady (Caucasian, Fitzpatrick Type 2 skin) presented for a screening skin examination with no previous family history or significant personal medical history of skin cancer. On examination she had a very small 2 mm pigmented lesion on her R forearm (Fig. 13.1). She had not been aware of this lesion given its tiny size. She had very few nevi (<5) and all other nevi appeared equally pigmented and around 2 mm in diameter. None of them appeared particularly dark on clinical examination.

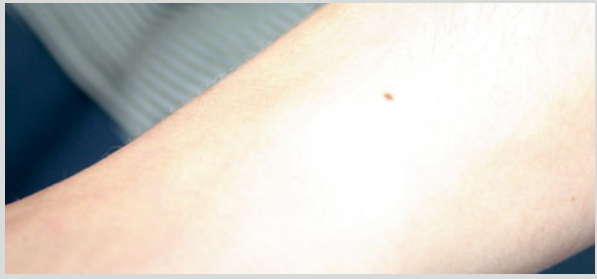

Fig. 13.1 Small 2 mm pigmented lesion on forearm

Dermatoscopy

On examination with a dermatoscope (Heine Delta 20 dermatoscope, manufactured by Heine, Optotechnic GmbH, Herrsching, Germany), the lesion being discussed had no obvious melanin network, but it had asymmetry of color; further the blueness suggested that is was probably both melanocytic and atypical (Fig. 13.2). As we discussed earlier, small melanomas are not only missed by the ABCD rule, but der-

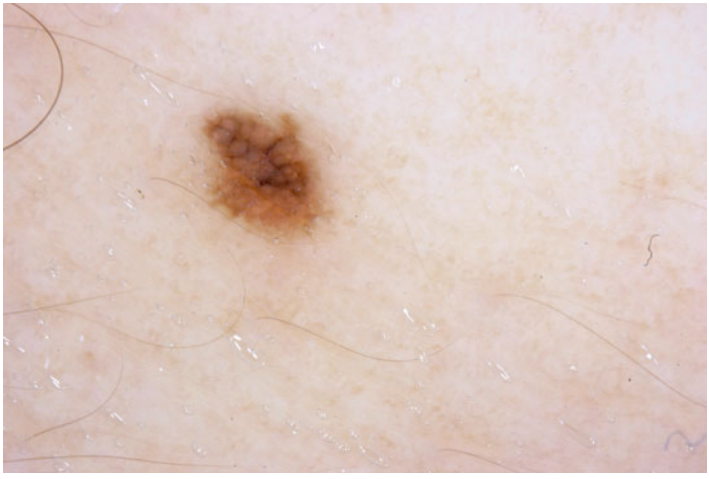

Fig. 13.2 Dermatoscopy

matoscopy is notoriously difficult, with most dermatoscopic algorithms not being useful.

Looking for 'Chaos and Clues' in dermatoscopy has been described as an extremely useful method [17]. In this method 'chaos' is defined as the presence of asymmetry in structure or color. In the presence of 'chaos' one looks for any of the following eight clues:

1. Thick reticular lines
2. Grey or blue structures of any kind
3. Pseudopods or radial lines at the periphery
4. Black dots in the periphery
5. Eccentric structure-less area of any color
6. Polymorphous vascular pattern
7. White lines
8. Parallel lines on ridges

In the case being described here, the lesion exhibited 'chaos' (asymmetry of color or structure) and also a 'clue'

(grey or blue structure of any kind). Therefore excision biopsy was done. Interestingly, this lady had very few (<5) nevi and none of the other equally small and pigmented nevi exhibited any asymmetry.

In dermatoscopy, most two-step algorithms commonly recommended were established to differentiate melanocytic from non-melanocytic lesions as a first step. However, using a 'chaos and clues' method helps us differentiate malignant from benign lesions first – by looking for chaos over symmetry. In comparing these methods, Kittler and others commented that looking for chaos and clues is preferable over other methods – given that the first step of the traditional dermatoscopic 2-step algorithm, if applied consistently, has a low specificity especially in patients with severely sun-damaged skin, as is often found in Australasia [18].

Histopathology

Argenziano and others suggest that small melanomas need more stringent criteria and a 'consensus approach' to diagnosis among examining pathologists, as there is no gold standard. In their study they suggest that severe cytologic atypia represents a useful clue in differentiating small melanomas from small dysplastic nevi [19].

Sections here show superficial sun-damaged skin bearing a small proliferation of atypical melanocytes showing pagetoid scatter to the granular layer along with trans-epidermal elimination of melanin pigment. Superficial dermis shows melanophages and there is no dermal invasion. The appearance is suggestive of a melanoma in-situ because of the combination of cytologic atypia and epidermal invasion (Figs. 13.3, 13.4, and 13.5). Figure 13.3 shows the biopsy specimen; Fig. 13.4 shows atypical hyperchromatic melanocytes singly and in nests and Fig. 13.5 shows transepidermal (pagetoid) invasion.

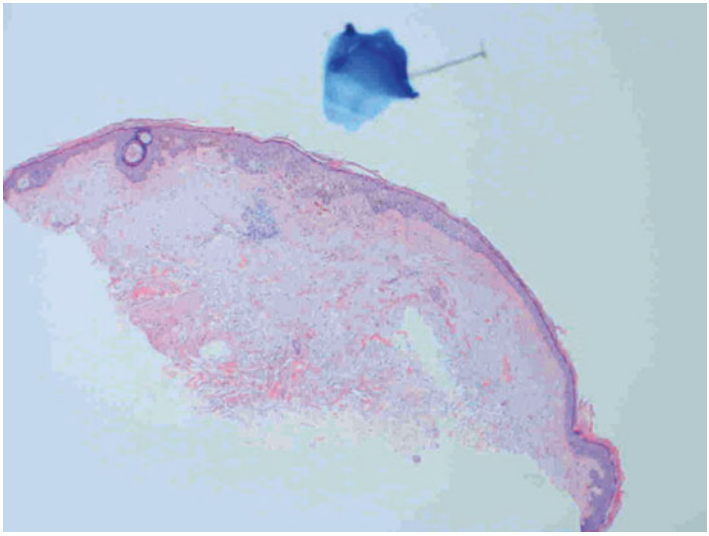

Fig. 13.3 2-mm pigmented skin lesion

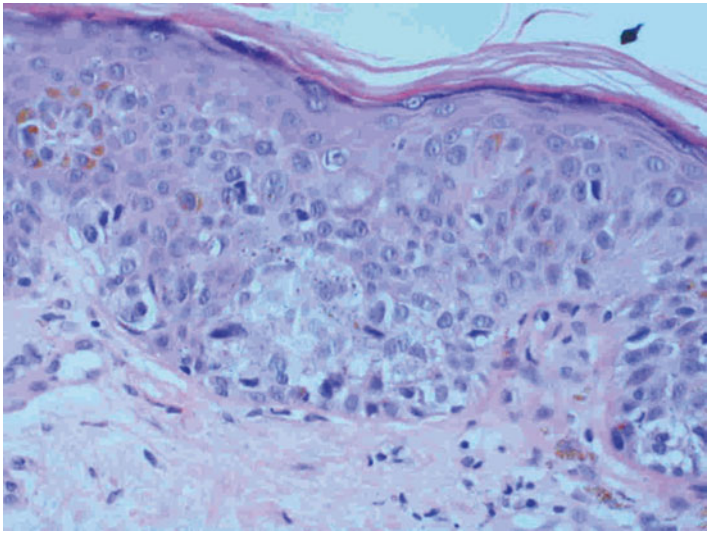

Fig. 13.4 Atypical hyperchromatic melanocytes singly and in nests

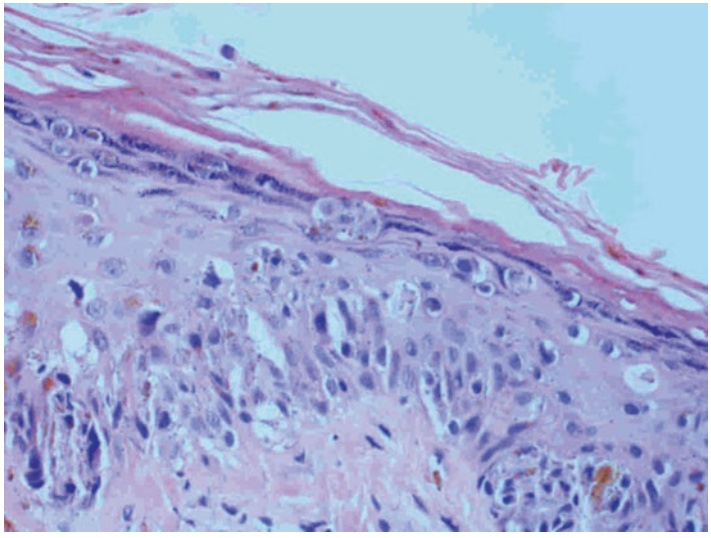

Fig. 13.5 Transepidermal pagetoid invasion

Discussion

Tiny melanomas ('micromelanomas', the term suggested by the author) as discussed earlier, naturally will not fit the ABCD acronym. In a study of pigmented lesions 3–6 mm in diameter, the authors showed that clinical criteria for diagnosing melanoma are not as reliable in the diagnosis of pigmented lesions of less than 6 mm diameter [20]. In this case of a tiny pigmented lesion of 2 mm diameter, the unusual features were the absence of several nevi, which is usually the case in other reported cases. In this situation, this was the only nevus that exhibited any chaos and therefore using the 'chaos and clues' algorithm proved decisive. The lesion turned out to be a melanoma-in-situ and was managed by wide surgical excision to ensure 5 mm margins all around.

In conclusion, melanomas under 2 mm are being increasingly reported and given the minute size, the ABCD screening acronym becomes redundant. Further, traditional dermatoscopic diagnostic methods often fail, and the 'chaos and clues'

algorithm may be the best method to follow while performing dermatoscopy. In previously reported small-diameter melanomas, the lesions were noted to be darker than other nevi (the so-called 'ugly duckling' sign) [21]. Further, patients usually had dysplastic nevus syndrome with >100 nevi. Our patient exhibited neither of the above clinical features and hence this case was considered noteworthy. The lesion was one of 4 nevi and all appeared similar to the naked eye and not particularly abnormal. However, when all the nevi were examined using a dermatoscope, this particular lesion proved significant when using the 'chaos and clues' method of dermatoscopy; histology confirmed features of a melanoma-in-situ. Therefore, this case serves to illustrate that when it comes to melanoma, small-diameter may indeed mean ≤2 mm.

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Chapter 14
Multiple Basal Cell Carcinomas and Superficial Radiotherapy (SRT)

Robert A. Norman

Patient History

The patient is a 56-year-old male with a history of basal cell carcinoma on his back, scalp and face. He was scheduled for an initial evaluation of the skin lesions and the patient stated that over the past year the lesions were increasing in size and he had been experiencing bleeding, crustiness and scaliness in these areas. The patient had no past treatments. Upon biopsy, multiple lesions were diagnosed as basal cell carcinoma.

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Patient Management

The patient presented with a 10 mm diameter lesion on his mid upper back, a crusty and scaly 10 mm diameter lesion on his upper scalp and a 3.0 × 2.0 mm lesion on the right hairline (forehead). The treatment options discussed with the patient were wide local excision and superficial radiation therapy (SRT). The patient opted for superficial radiation therapy as treatment for his lesions.

Treatment Parameters for the Upper Middle Back Lesion

The upper mid back clinical lesion was identified and circled. A 5–7 mm border was drawn around the lesion. The tumor depth was estimated to be <5 mm. A 0.762 mm thick led shield was utilized over a 2 cm field and placed over the lesion and extended field. Superficial radiotherapy was administered with a 3 cm cone for 15 treatments of 300 cGy at 70 kVp, 10 ma. Treatments were delivered Monday through Friday for three weeks, for a total dose of 4500 cGy (Figs. 14.1 and 14.2).

Treatment Parameters for the Upper Scalp Lesion

The upper scalp lesion was identified and circled. A 5–7 mm border was drawn around the lesion. The tumor depth was estimated to be <5 mm. A 0.762 mm thick led shield was utilized over a 2 cm field and placed over the lesion and extended field. Superficial radiotherapy was administered with a 3 cm cone for 15 treatments of 300 cGy at 70 kVp, 10 ma. Treatments were delivered Monday through Friday for three weeks, for a total dose of 4500 cGy (Figs. 14.3, 14.4, and 14.5).

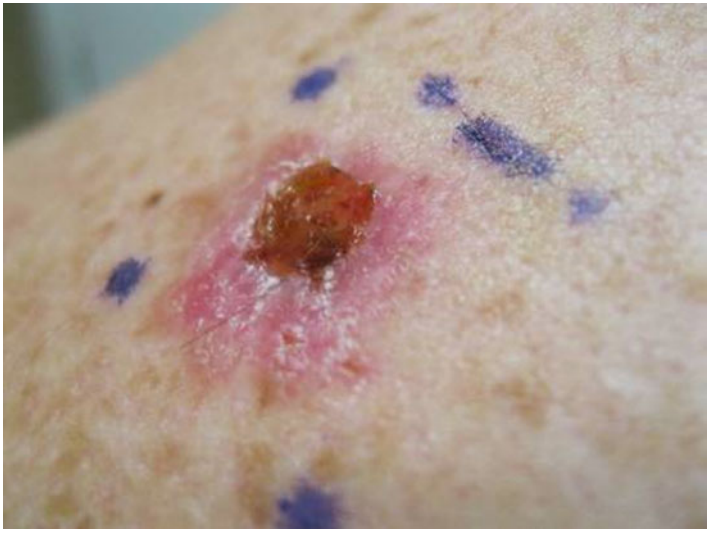

Fig. 14.1 Patient outcome on his mid upper back lesion – first day of treatment

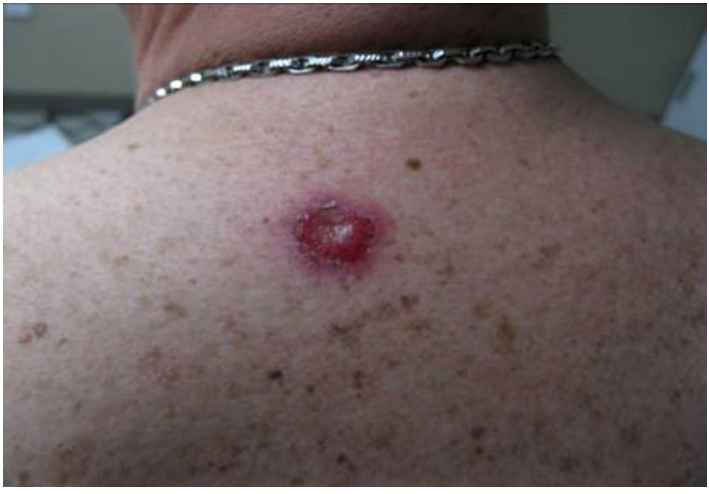

Fig. 14.2 Patient outcome on his mid upper back lesion – tenth day of treatment

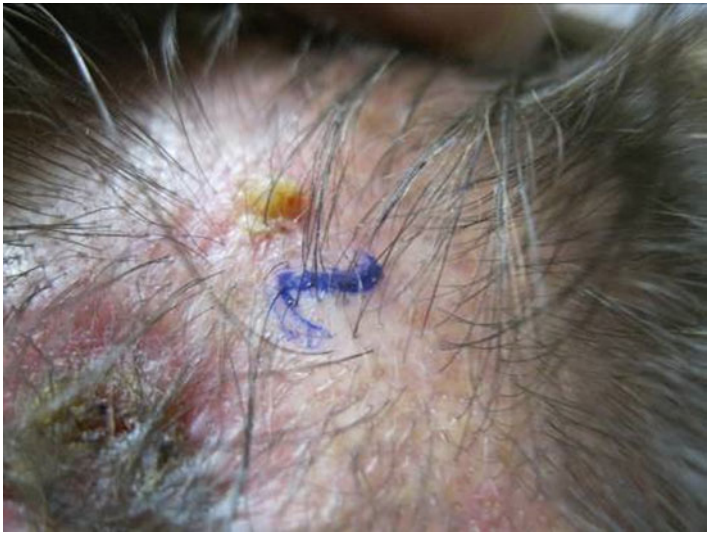

Fig. 14.3 Patient outcome on his upper scalp lesion – first day of treatment

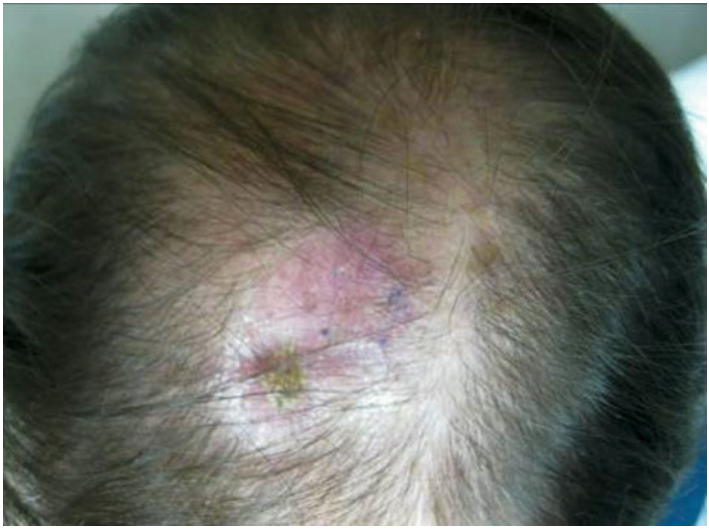

Fig. 14.4 Patient outcome on his upper scalp lesion – tenth day of treatment

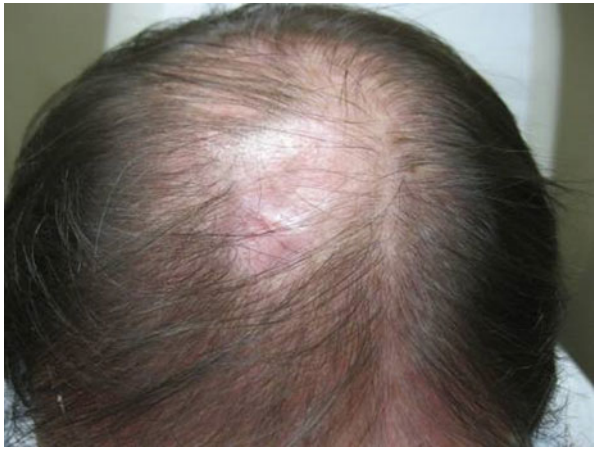

Fig. 14.5 Patient outcome on his upper scalp lesion – 4 weeks after treatment

Treatment Parameters for the Right Hairline (Forehead) Lesion

The right hairline (forehead) lesion was identified and circled. A 5–7 mm border was drawn around the lesion. The tumor depth was estimated to be <5 mm. A 0.762 mm thick led shield was utilized over a 2.0 × 3.0 cm field and placed over the lesion and extended field. Superficial radiotherapy was administered with a 4 cm cone for 15 treatments of 300 cGy at 70 kVp, 10 ma. Treatments were delivered Monday through Friday for three weeks, for a total dose of 4500 cGy (Figs. 14.6, 14.7, and 14.8).

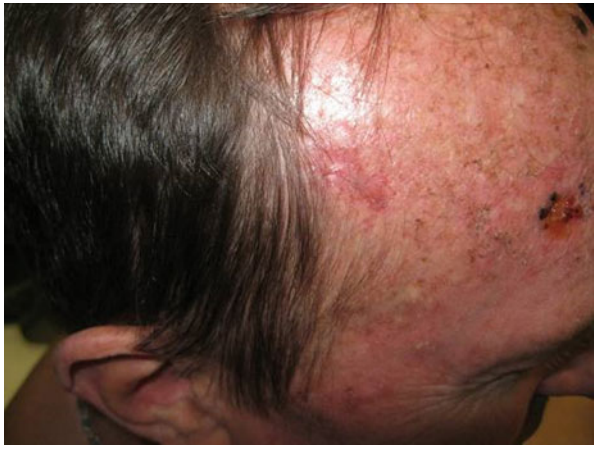

Fig. 14.6 Patient outcome on his right hairline (forehead) lesion – first day of treatment

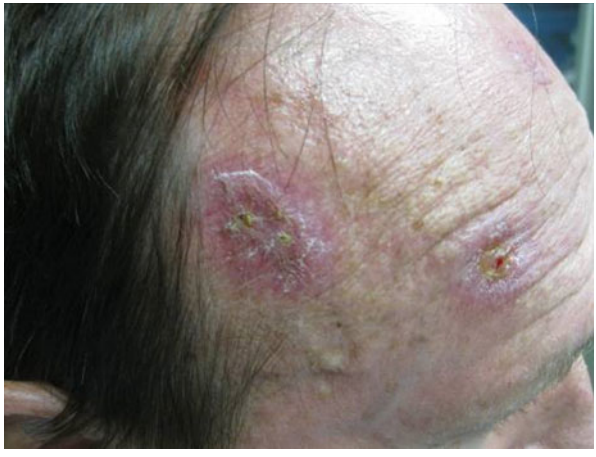

Fig. 14.7 Patient outcome on his right hairline (forehead) lesion – tenth day of treatment

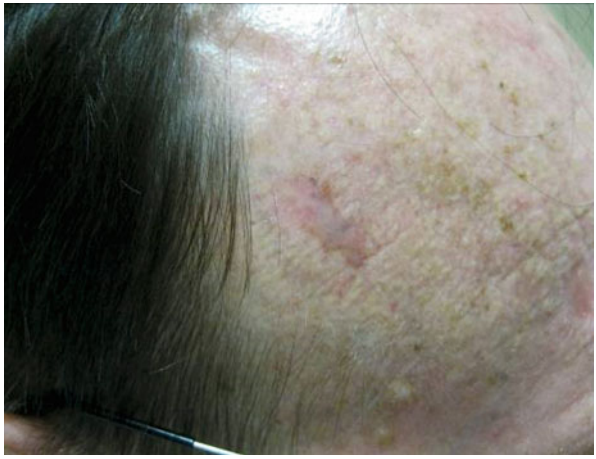

Fig. 14.8 Patient outcome on his right hairline (forehead) lesion – 4 weeks after treatment

Conclusion

The patient tolerated the treatment with minimal side effects. The treated areas experienced erythema and mild desquamation during treatment. The patient had very successful cosmetic and clinical results and was able to avoid surgery. SRT is a viable and effective choice for many non-melanoma skin cancers.

Chapter 15
Adenocystic Carcinoma

Lisa M. Diaz and Robert A. Norman

Presentation

A 39-year-old Caucasian male presented to the dermatology clinic with the chief complaint of an enlarging growth on his right heel (Fig. 15.1). Based on its clinical appearance, pyogenic granuloma was at the top of the differential. A biopsy was taken and sent to pathology for examination.

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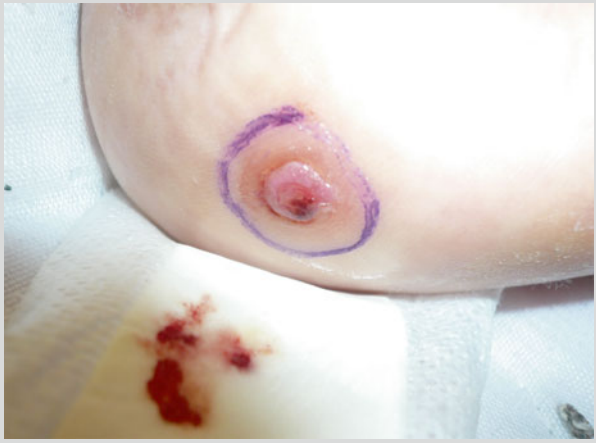

FIGURE 15.1 39-year-old Caucasian male with a pink, ulcerated nodule on the right heel

Differential Diagnosis

Pyogenic granuloma
Basal cell carcinoma
Melanoma
Metastatic carcinoma
Angiosarcoma
Atypical fibroxanthoma
Spitz nevus
Adenocystic carcinoma
Squamous cell carcinoma

Biopsy Results "Suggestive of adenocystic carcinoma."

Diagnosis Adenocystic carcinoma

Microscopic Feature

The classic findings of cutaneous adenocystic carcinoma (ACC) occur in the deep dermis and are characterized by basaloid cells in islands that form cribriform patterns and tubular structures (Fig. 15.2). Multiple cystic spaces can be seen containing mucin that stains positively with hyaluronic acid (Figs. 15.3 and 15.4). Perineural invasion is observed in most cases. The lumina of the tubular structures have prominent basement membrane material that is PAS positive and diastase-resistant [1–3].

Unlike the similarly appearing adenoid basal cell carcinoma, ACC typically does not have a connection to the overlying epidermis or adnexal structures. This separation is a helpful clue for pathologists when making the diagnosis, as oftentimes these two can be difficult to differentiate. Immunohistochemical studies demonstrate that cutaneous ACC stains positively for S-100, epithelial membrane antigen

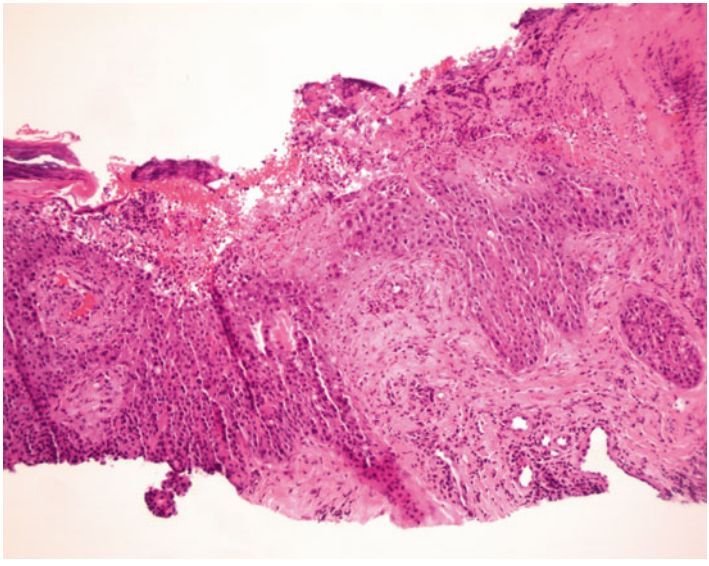

FIGURE. 15.2 H&E, 40×. Low magnification view shows an ulcerated epidermis with underlying nests of tumor

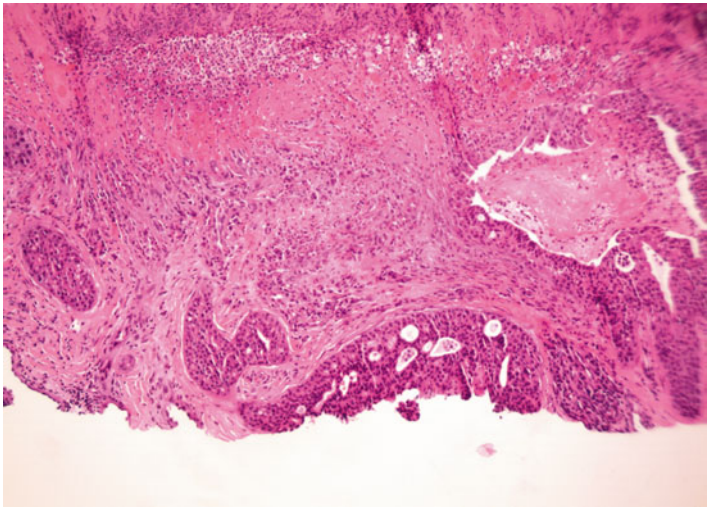

FIGURE 15.3 H&E, 40×. The tumor is invasive and extends into the deep dermis

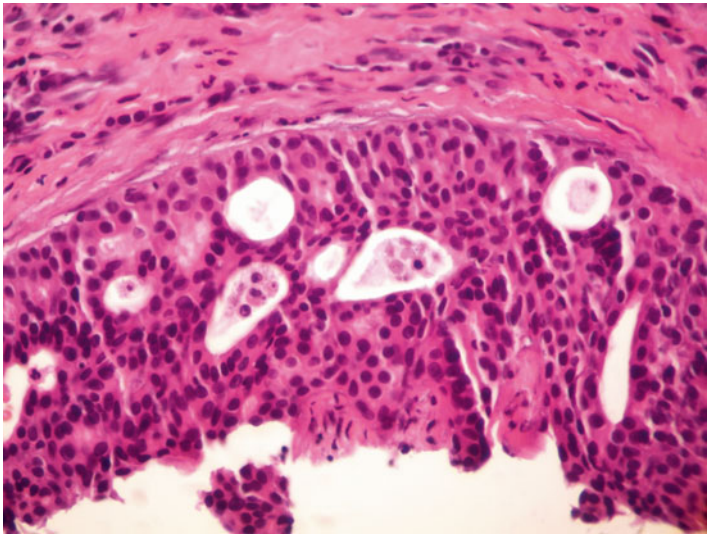

FIGURE 15.4 H&E, 400×. A close up of a basaloid nest which contains scattered round, cystic spaces (cookie cutter pattern)

(EMA), and is occasionally positive for carcinoembryonic antigen (CEA) [1–3].

Discussion

Adenocystic or adenoid cystic carcinoma is a rare, aggressive carcinoma. There are approximately fifty cases published in the literature [4]. It typically arises from the major or minor salivary glands but may also arise primarily from an extra-salivary gland site like the skin, external auditory canal, respiratory tract, esophagus, breast or prostate [3].

Primary cutaneous ACC presents clinically as a firm, slow-growing nodule or tumor with poorly defined borders. Although usually asymptomatic, some patients may complain of pruritus, tenderness, or alopecia. The average age of those affected by cutaneous ACC is 59 with 57 % of cases involving male patients. Approximately 41 % of cutaneous ACC occurs on the scalp. Other areas commonly affected include the chest, abdomen, back, eyelids, and perineum [5].

Salivary ACC is more aggressive than cutaneous SCC with greater rates of local destruction, recurrence and late metastasis [6]. The lungs and lymph nodes are the primary sites of metastasis. Although cutaneous SCC is more indolent than salivary ACC, it does have a high incidence of local recurrence. One study with an average follow up time of 58 months calculated the local recurrence rate to be 44 % after wide excisional surgery [5]. Another study calculated the recurrence rate to be 50 % [7]. Some authors argue that this high recurrence rate is a consequence of the carcinoma's tendency of discontinuous perineural invasion or "skip areas" that lead to high rates of false negative reports upon histological examination [3, 7]. In one study, approximately 76 % of the cases demonstrated perineural invasion [5]. For this reason, some authors believe that Mohs micrographic surgery is a better treatment option than the customary wide local excision with histologically clear margins.

As mentioned, treatment for cutaneous ACC has traditionally consisted of wide local surgical excisions with histologically proven negative margins. While some authors debate the benefit of Mohs micrographic surgery, all agree that patients diagnosed with cutaneous ACC must have lifelong follow up for possible recurrence later on. One study described a recurrence of cutaneous ACC 35 years after initial treatment [5]. Furthermore, once a patient has been diagnosed with cutaneous ACC, it is recommended that a work up be performed to rule out the possibility of metastatic primary salivary gland ACC. This can be done with a thorough physical exam as well as CT imaging of the head and neck, chest and abdomen.

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Chapter 16
Sebaceous Carcinoma

Lisa M. Diaz and Robert A. Norman

Presentation
An 82-year-old Caucasian male with a past medical history significant for Hepatitis C, squamous cell carcinoma, basal cell carcinoma, and actinic keratosis presented with the chief complaint of a growth on his right neck. A $2.5 \times 3.5 \times 0.5$ cm non-tender, ulcerated erythematous nodule was noted on the lateral aspect of the right neck (Fig. 16.1). A biopsy of the nodule was taken and sent to pathology for examination.

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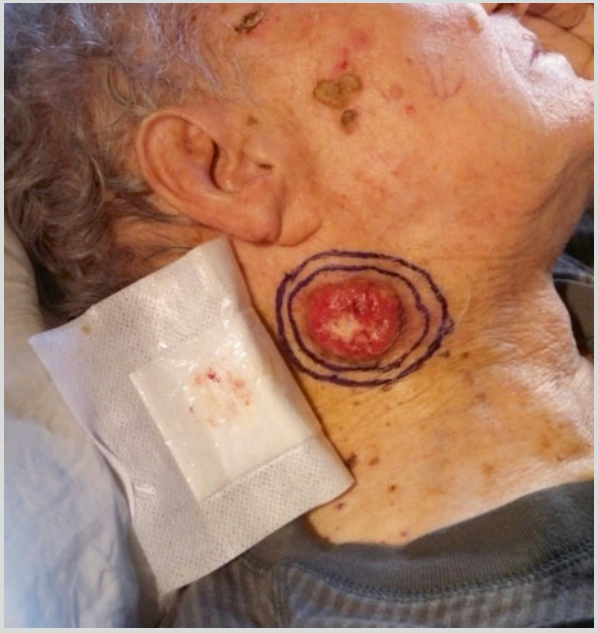

FIGURE 16.1 Elderly Caucasian male with large eroded lesion on the neck

Differential Diagnosis

Basal cell carcinoma
Squamous cell carcinoma
Amelanotic melanoma
Keratoacanthoma
Sebaceous carcinoma
Merkel cell tumor

Biopsy Results Sebaceous carcinoma: lesion extends to the deep margin.

Diagnosis Sebaceous carcinoma

Microscopic Features

Under the microscope, sebaceous carcinoma appears as irregular lobular arrangements of cells of various sizes and with varying levels of differentiation. Wolfe et al. categorized sebaceous carcinomas based on their grade of differentiation. Well-differentiated cells with foamy cytoplasm were categorized as Grade 1 (Fig. 16.2) [1]. Undifferentiated cells with little cytoplasm were categorized as Grade 4. Nuclear atypia is observed with oval nuclei, prominent nucleoli, and high mitotic rates [2]. Sebaceous carcinoma classically demonstrates intra-epithelial or Pagetoid spread.

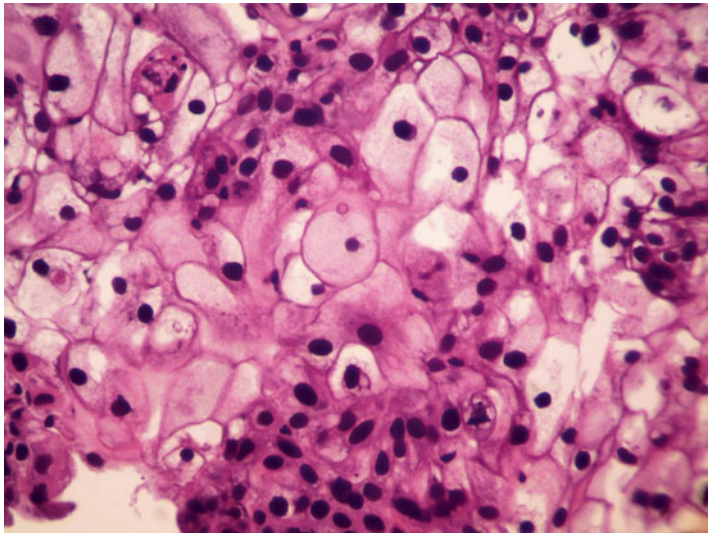

FIGURE 16.2 H&E. 400× magnification. Sheets of tumor cells with highly variable shapes and sizes. Some have a foamy cytoplasm while others have scanty eosinophilic cytoplasm. There is also variability of the nuclei

Immunohistochemical staining of sebaceous carcinoma reveals the following positive markers: epithelial membrane antigen (EMA), androgen receptor (AR), CA15-3, and ADP. Markers that are usually negative include: S100, Ber-EP4, and carcinoembryonic antigen (CEA) [2, 3].

Discussion

Sebaceous carcinoma is a rare and extremely aggressive tumor. There are approximately 200 cases reported in the literature. In the past, these tumors have been divided into periocular and extraocular cases. The majority of sebaceous carcinomas, approximately 75 %, occur around the orbit. They arise from the Meibomian glands, Zeis glands, and the sebaceous glands of the eyebrow [2]. They are found more commonly on the upper eyebrow area. Sebaceous carcinomas found on both the upper and lower eyelids portend a poor prognosis [4]. Sebaceous carcinomas are often seen in Muir-Torre syndrome, so it is important to screen patients so that this diagnosis can be ruled out.

Although often reported around the orbit, sebaceous carcinomas may occur anywhere on the body. Most published cases have been reported on the face, scalp, neck, trunk, and upper limbs. In 2009, Dasgupta et al. conducted a retrospective review of 1,349 cases of sebaceous carcinomas. This review challenged previously accepted knowledge regarding sebaceous carcinomas. It was once thought that sebaceous carcinomas affected middle-aged Asian females more often than any other population. However, this study demonstrated that Caucasians were the predominantly affected population comprising 86.2 % of the cases. Only 5.5 % of those affected were of Asian or Pacific Islander ancestry. The median age of diagnosis was 72 and approximately 54 % of subjects were male [4].

A sebaceous carcinoma typically presents as a slow-growing, firm nodule. It can easily be mistaken for other more common dermatological or ophthalmological conditions, which can lead

to a delay in diagnosis. When benign, sebaceous carcinomas are managed with wide excisional surgery. Sebaceous carcinomas that are malignant are more difficult to treat. In these cases, surgery is performed for local disease and radiation or chemotherapy is used for recurrent or metastatic disease [5, 6].

Dasgupta and colleagues calculated the overall survival rate at 5 and 10 years to be 71.1 and 45.9 %, respectively. In their study, the cause of death was attributable to cancer in 31 % of the cases. Furthermore, they determined that there was no significant difference in overall survival rates in periorbital versus extraorbital cases [4]. These findings were contrary to the findings in previously published data in which studies contained smaller sample sizes. Indicators of poor prognosis include: poorly differentiated cells, multicentric tumors, pagetoid spread, involvement of regional lymph nodes, symptoms for more than 6 months, tumor size greater than 10 mm, and vascular, lymphatic, and orbital invasion [5].

The patient presented in this case underwent eight sessions of superficial radiation treatment.

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Chapter 17
Metastatic Cutaneous Adenocarcinoma

Lisa M. Diaz and Robert A. Norman

Presentation
A 98-year-old Caucasian female with a past medical history significant for breast cancer, squamous cell carcinoma, basal cell carcinoma, and actinic keratosis presented to the dermatology clinic with the complaint of a 1.5×0.8 cm erythematous plaque on her right chest. A shave biopsy was performed and sent to pathology for examination.

Differential Diagnosis

Basal cell carcinoma
Squamous cell carcinoma
Metastatic cutaneous adenocarcinoma
Melanoma

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Biopsy Results "Multiple groups of atypical cells with duct formation. Some cells contain mucin goblets. The CEA is positive while the CK5/6 and CK20 are negative. These findings support a metastatic lesion. Given the patient's history of breast carcinoma, this most likely represents a recurrence."

Diagnosis Metastatic cutaneous adenocarcinoma

Microscopic Features

Metastatic breast adenocarcinomas usually consist of round, discrete tumor lobules in the mid to deep dermis demarcated by a Grenz zone (Fig. 17.1). Neoplastic cells may also be present in the lymphatics or blood vessels. The cells typi-

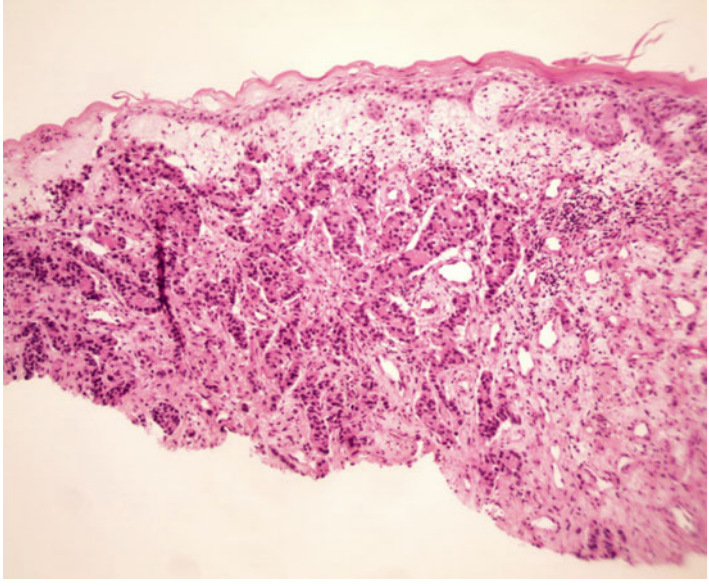

FIGURE 17.1 H&E 25×. Low magnification shows tumor filling the upper dermis

cally resemble the primary tumor. However, various patterns may be observed, examples of which include: a single-line of cells infiltrating the collagen, dense sheets of cells, or glandular clusters of cells with mucin or glycogen (Fig. 17.2). Immunostains are typically positive for CK7 and CEA (Fig. 17.3).

Discussion

The overall incidence of cutaneous metastasis from any type of visceral malignancy is 5.4 % [1]. However, breast cancer is the most frequently encountered cutaneous metastasis carcinoma and has an even higher rate of cutaneous presentation. One study showed that of 7518 patients with visceral malig-

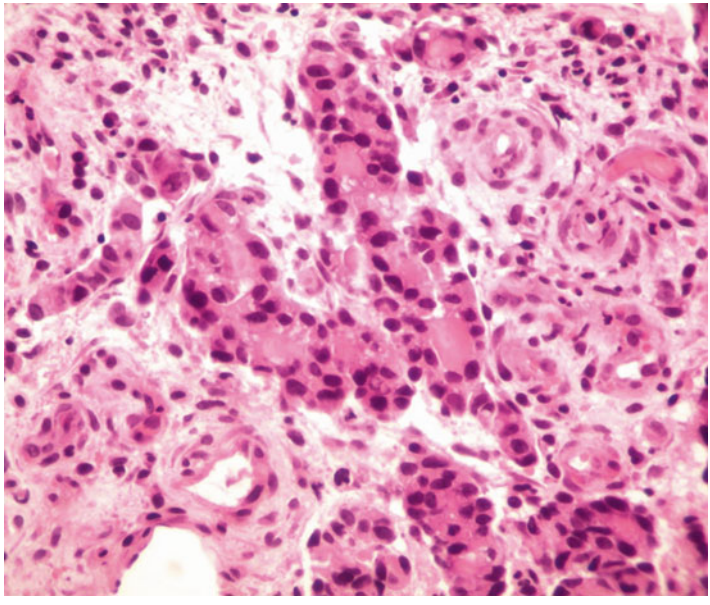

FIGURE 17.2 H&E, 400× magnification. Chords and tumor nests are visible. Some nests show duct formation where tumor cells are lined along the edge with a central fluid-filled space

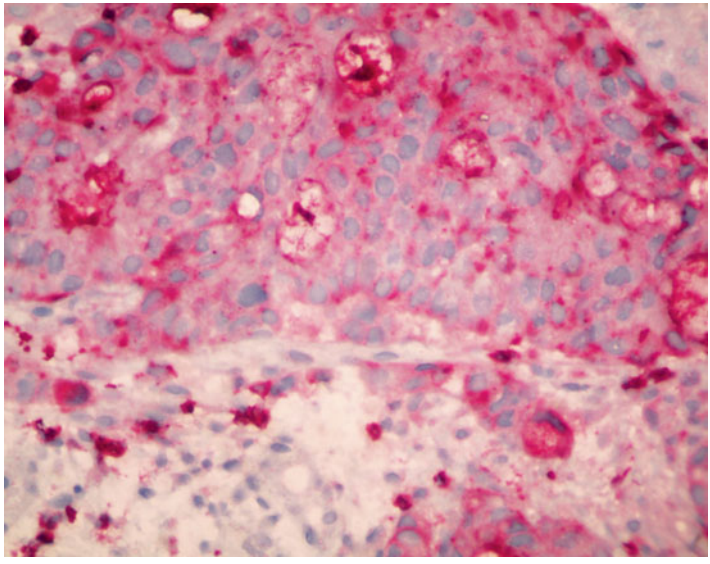

FIGURE 17.3 CEA 400×. Positive staining of the tumor cells portend an adenomatous origin

nancies, approximately 26.5 % of females with breast cancer were found to have cutaneous metastasis [2]. On average, these cutaneous signs appear 5 years after the initial diagnosis and treatment for the breast cancer [3].

Most clinical presentations of cutaneous metastatic breast cancer are acute in onset and nodular in appearance. A retrospective review conducted by Mordenti et al. determined that 80 % presented as skin papules or nodules, 11 % as telangiectatic carcinomas, 3 % as erysipeloid carcinomas, another 3 % as "en cuirasse", 2 % as alopecia neoplastica, and 0.8 % presented in a zosteriform fashion [4]. Unique to metastatic cutaneous breast carcinomas are the erysipeloid and "en cuirasse" presentations. The erysipeloid carcinomas present as an expanding, erythematous patch or plaque. The "en cuirasse" version presents as a hard, leathery, morphea-like indurated plaque that covers the chest, much like the armor breastplate from which its name is derived [3].

Typically these hallmark inflammatory skin changes begin 10 weeks before the diagnosis of cutaneous metastasis is made. Patients may complain of symptoms like increased warmth, erythema, edema, pruritus, and nipple retraction. The most frequent areas of involvement are the chest, abdomen, and back. The appearance of cutaneous metastatic carcinoma portends a poor diagnosis. Most patients will die of disease within 3–6 months. By this time, the focus of treatment is delaying progressive disease, minimizing bothersome symptoms, and maintaining the quality of life for the patient [5].

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Chapter 18
Zosteriform Cutaneous Metastasis

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Presentation

A 49-year-old Caucasian male was seen by the dermatologist in the setting of a skilled nursing facility. He complained of a painless rash on his left upper arm. His left shoulder and left upper arm were noted to have erythematous papules and vesicles in a dermatomal distribution.

The patient was unable to provide any further history so his caretaker was consulted. The caretaker reported that the patient had a history of cancer in his left shoulder that had been treated with radiation therapy. He now had lymphedema in that arm as a result. The patient had been diagnosed with herpes zoster in the recent past and was treated with acyclovir with some improvement. The patient was restarted on acyclovir and a shave biopsy was taken and sent to pathology for examination and to rule out a herpes zoster infection.

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Differential Diagnosis

Herpes zoster
Contact dermatitis
Eczema
Cellulitis
Cutaneous metastases

Biopsy Results "Sections show multiple nests of atypical cells that are positive for CK7 but negative for CK20 and MART1 (Fig. 18.1). These findings are consistent with a metastatic carcinoma. The differential can include a lung primary. Clinical correlation is recommended."

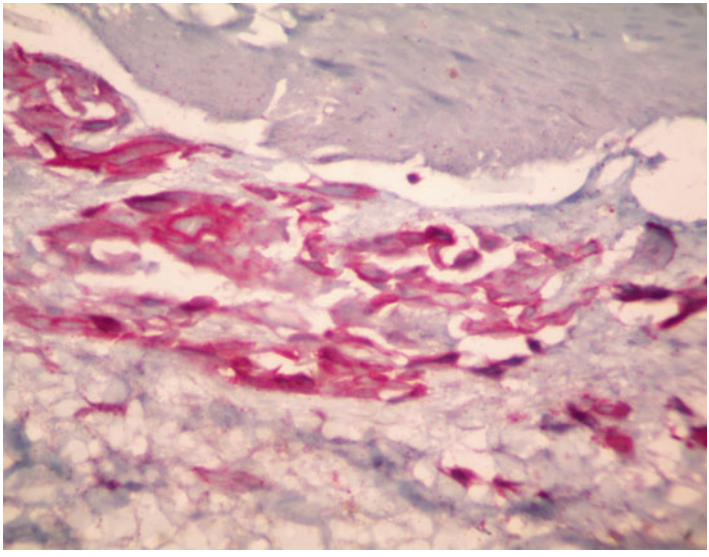

FIGURE 18.1 40× magnification. CK7 positive staining of the cytoplasm

Diagnosis Cutaneous metastatic carcinoma, the source is most likely a primary lung cancer.

Microscopic Features

Metastases are typically categorized broadly as adenocarcinoma, squamous cell carcinoma or undifferentiated carcinomas [1]. The neoplastic cells are usually found in the mid to deep dermis but may also be found in the subcutaneous tissue (Fig. 18.2). The cells tend to demonstrate patterns that resemble the primary source of the tumor. Some patterns that are

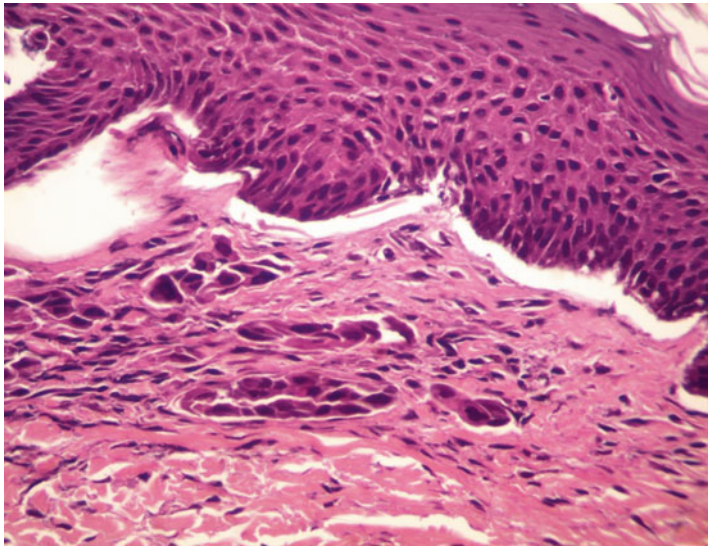

FIGURE 18.2 H&E, 40× magnification. Multiple nests and single cells are found just under the epidermis. These cells show marked variability with irregularly-shaped nuclei

commonly observed include: nodular growths of tumor cells with scanty intervening stroma, strands or rows of cells infiltrating a fibrotic dermis, dense sheets of cells, or malignant glandular clusters of eosinophilic cells containing mucin or glycogen. Some of the cells may demonstrate epidermotropism by abutting the epidermis. Lymphatic invasion and diffuse, intralymphatic tumor emboli may be seen [1, 2].

Discussion

Cutaneous metastases are not commonly seen in dermatology offices and occur in 0.6–10.4 % of all patients with cancer [3]. Therefore, if a patient does not provide a history of cancer, it is easy for this diagnosis to be missed. Cutaneous manifestations of metastases can present in various ways, some of which may resemble other common dermatological diagnoses. One study showed that in 45 % of cases of biopsied cutaneous metastases, the diagnosis was missed altogether [2].

There are cases reported in the literature of cutaneous metastases presenting as a rash, melanoma, basal cell carcinoma, keratoacanthoma, subcutaneous nodules, hidradenitis suppurativa, herpes zoster, vascular tumors, and epidermal inclusion cysts. The sites most commonly involved in descending order include the upper trunk, abdomen, head (especially the scalp), and the neck. Metastatic lung cancers were noted to present most commonly on the head, neck and upper trunk. Metastases to the extremities are extremely uncommon [2–5].

A retrospective review performed by Sariya and colleagues found that 86 % of patients who presented with cutaneous findings were found to have Stage 4 cancer. Of those patients, 76 % succumbed to the disease in an average of 9.4 months. Therefore, cutaneous metastases in most often a late finding in advanced disease states. The same retrospective study showed that the average time between diagnosis of primary cancer and the development of cutaneous findings was approximately 36 months. By that point, the majority of patients had disease progression to Stage 3 or greater [2].

Cases describing zosteriform cutaneous metastases from a primary lung tumor are exceedingly rare. Even more rare is the location of the metastasis on the upper extremity [6]. The cause of the unique zosteriform presentation has not been adequately explained. One author surmised that the mechanism for the zosteriform, band-like presentation was a result of the "retrograde flow of lymph after obstruction by cancer cells" [6]. Other authors hypothesize that the tumor cells spread from the cutaneous lymph nodes to the sensory nerves where they reach the dorsal root ganglia [3, 7, 8].

Metastatic neoplastic cells may present in a myriad of forms, often making it difficult to diagnose correctly. For this reason, obtaining an accurate medical history is paramount. Although cutaneous metastasis are rare, it is important for physicians to always be suspicious of this diagnosis in their patients with a history of cancer. One study showed that in 12 % cases, the cutaneous findings were the first sign of an occult cancer [2].

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