Management of Ingrowing Nails

Treatment Scenarios and Practical Tips

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Contents

Chapter 1
Basics

Abstract Performing successful nail surgery requires a comprehensive knowledge of nail anatomy and physiology. Understanding both the vascular and neural pathways supplying the nail complex, the functions and relationship of each component of the nail unit is also essential. The preoperative consultation is mandatory as it allows a detailed evaluation of the patient as well as a full information about the procedure and post operative evolution. The nail surgeon should use adequate instruments for nail surgery and be aware of the techniques and tips allowing an efficient anesthesia with minimal patient discomfort. Post operative procedure includes the proper use of painkillers and wound care. As for any kind of surgery, the operator needs to prevent and handle any complication that may occur during follow-up.

Keywords Nail • Anatomy • Nail instruments • Nail unit anesthesia • Dressings

Surgical Anatomy

Introduction

Before embarking to any nail surgery, a good knowledge of the anatomy of the nail unit is mandatory (Fig. 1.1). It will help to understand how to perform an adequate local anesthesia as well as reasonable procedures at that site and how to deal with post operative bleeding.

The nail apparatus is an integral part of the tip of the digit. All parts are intimately related to each other forming a functional, sensory and cosmetic unit. It is made up of the distal bony phalanx with the joint and synovial membrane, a fibrous network consisting of ligaments, tendons, and connective tissue strings, blood vessels and glomus bodies, nerves and receptors – making it an extremely efficient

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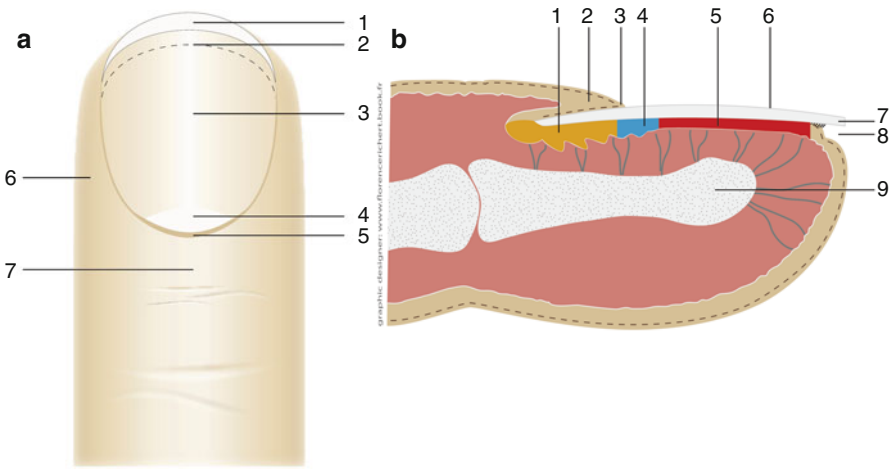

Fig. 1.1 (**a**) Anatomy of the nail apparatus. Upper view. *1* free edge, *2* hyponychium, *3* nail bed. *4* lunula, *5* cuticle, *6* lateral nail fold, *7* proximal nail fold. (**b**) Anatomy of the nail apparatus. Lateral view. *1* proximal nail matrix, *2* proximal nail fold, *3* cuticle, *4* distal nail matrix, *5* nail bed, *6* nail plate, *7* free edge, *8* distal groove, *9* distal phalanx

sensory organ – and the nail unit [1]. The later consists of three different epithelial structures: the nail matrix and the plate, the nail bed that firmly attaches the plate to the underlying connective tissue, the bone and the paronychium (grooves and folds) that act as a frame for the nail plate [2].

Nail Matrix

The nail matrix constitutes the sole germinative structure responsible for the production of the nail plate. It is located on the proximal dorsal aspect of the distal phalanx and just distal to the interphalangeal joint, mostly covered by the proximal nail fold (PNF). The matrix rests on the base of the distal bony phalanx and forms a crescent with posterior inferior concavity (Fig. 1.2); thus, its lateral corners are more proximal than the center. One should bear in mind that on the great toes, both lateral ends of the crescent (also called the lateral horns of the matrix) expand much proximal on the lateral aspect of the phalanx than that of the fingers (Fig. 1.3). The lateral horns may reach to or even beyond the midline of the lateral aspect of the great toe. This anatomical particularity explains why spicules are the most common complication of surgical treatment for ingrown toenail in unskilled hands [3]. The lunula, the most distal part of the nail matrix, is visible as a whitish half-moon shaped structure between the cuticle and the pink nail bed. The lunula is most often only visible on the thumb and middle finger. Pushing back the cuticle renders it visible on other

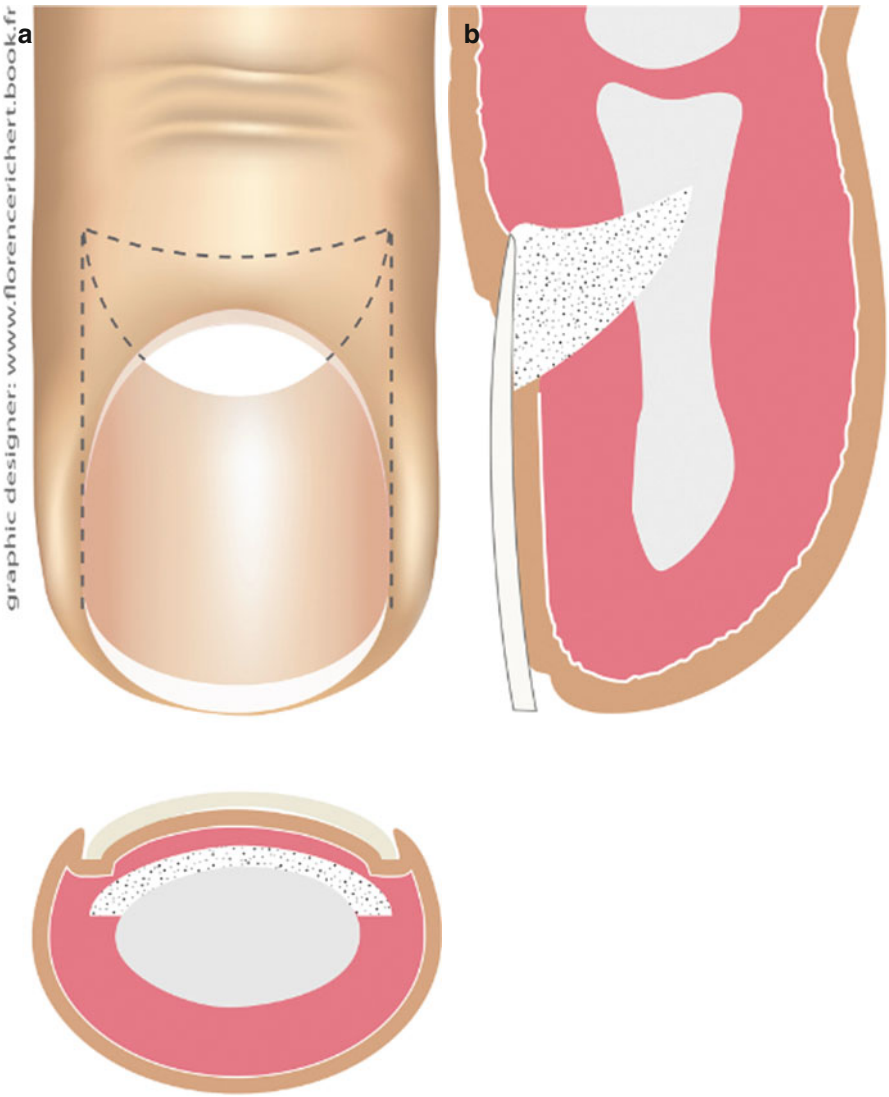

Fig. 1.2 (**a**) Anatomic position of the nail matrix. Upper and transverse view. (**b**) Anatomic position of the nail matrix on the great toenails. Lateral view

fingers and toes. The dermis of the matrix is a relatively loose connective tissue of about 1 mm thick that rests over the very distal fibers of the extensor tendon insertion. There is very little subdermal fat in the matrix [4]. The matrix creates all or most of the nail plate [5]. The proximal portion of the matrix produces the upper third of the nail plate and its distal part the lower two thirds [6] (Fig. 1.4). This has a main issue in nail surgery: removing a part of the distal

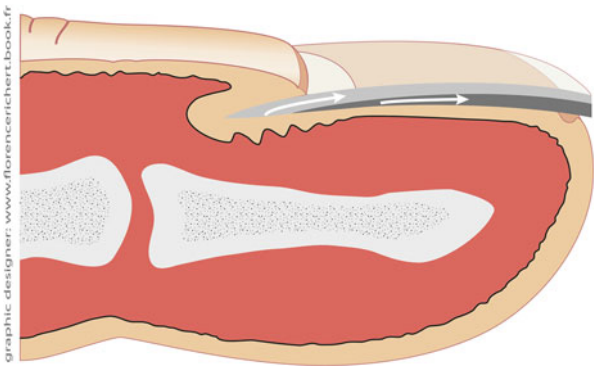

Fig. 1.3 Formation of the nail plate by the matrix: the superficial upper third comes from the proximal matrix, the lower 2/3 from the distal matrix

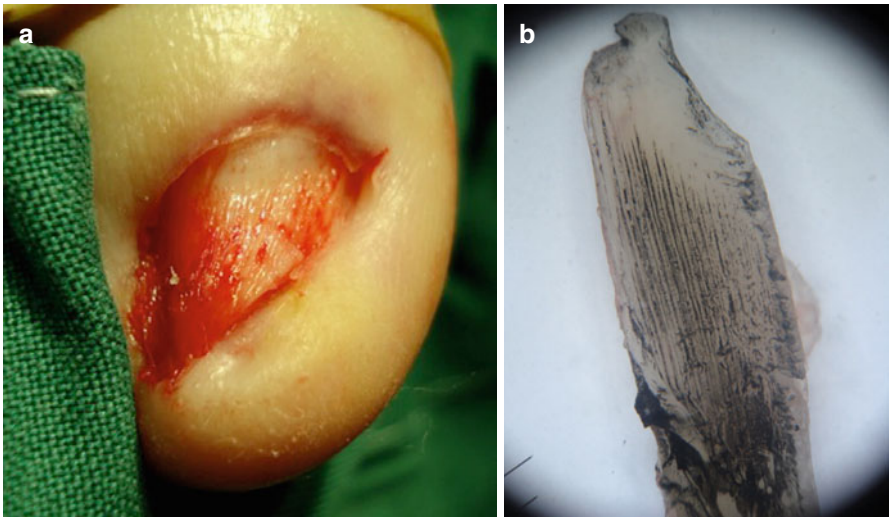

Fig. 1.4 (**a**) Longitudinal rete ridges running on the whole length of the nail bed. (**b**) Undersurface of the nail plate showing the complementary set of ridges (after friction with ink)

matrix (e.g., with a punch) will not lead to nail dystrophy as the defect will be covered by the upper part of the plate synthesized by the proximal matrix. The thickness of the nail plate is proportional to the length of the matrix (thumbnails and great toenails are thicker). The shape of the lunula determines the contour of the free edge [6].

Key Points
The lateral horns of the matrix may extend up and even beyond the midline of the lateral aspect of the great toenail.

Nail Bed

The nail bed (also called sterile matrix by some surgeons as it does not produce any nail substance) is the distal continuation of the nail matrix. It corresponds to the pinkish area that spreads from the distal lunula border till the hyponychium. It very firmly adheres to the nail plate. On the nail bed runs a unique structure that is responsible for its very firm adherence to the plate: longitudinal parallel rete ridges, often very clearly observed after nail avulsion (Fig. 1.4). They integrate and interlock into a complementary set of ridges at the undersurface of the nail plate, which has led to the description of the nail being led up as if on rails [6] (Fig. 1.4b). The nail bed produces a very thin keratin layer, which is just enough to allow the forward movement of the nail plate without shearing off its attachment [4, 7, 8].

Nail Folds

The nail unit is surrounded on three sides by the proximal and lateral nail folds in an inverse "U" shape, constituting the paronychium. The PNF protects and covers the nail matrix and the newly formed nail plate. The proximal nail groove is a pocket formed by the PNF, and its proximal part is called cul-de-sac. Its dorsal surface is made from a skin with a thin dermis and almost no appendages. Some sweat glands are seen in its most proximal portion. The acute angle formed by the free margin of the PNF is essential for the formation of the cuticle. The cuticle is divided into two parts: the true cuticle, attached to the underlying newly formed nail and produced by the deep portion of the ventral surface, and the false cuticle, formed by the horny layers of the dorsal roof and the distal third of the ventral surface of the PNF [4].

The lateral nail folds are connective tissue rolls that progressively flatten from the PNF to the distal tip of the digit. They are often very pronounced in the lesser toes and sometimes in the great toenails rendering some patients prone to develop ingrowing nails. The lateral grooves are longitudinal parallel indentations framing the lateral nail margins and providing an abutment for the nail, for which they have a specialized connective tissue arrangement [6]. Some situations are responsible for the growth of the lateral nail folds, breaking the balance between the nail plate and the nail folds. It may be responsible for ingrowing nails. Tight shoes, hyperhidrosis, genetic predisposition, poor foot hygiene, improper trimming, overweight, diabetes, tuberculosis and syphilis are some examples [9].

Hyponychium

The hyponychium is the transition of the nail bed to the digital pulp. It has, like the cuticle, a sealing function. At its most distal part, the nail plate separates from the nail bed. The hyponychial attachment is seen through the nail as the onychodermal band [10, 11].

Nail Plate

The nail plate is synthesized by the matrix. It is composed of compacted keratinized epithelial cells, continuously and exclusively formed by the nail matrix. It is a unique combination of strength and flexibility. The thin dorsal layer of the nail plate (upper third) produced by the proximal matrix, has a smooth shiny surface and is made up of many strongly flattened onychocytes with considerable intercellular adhesion structures. The intermediate layer originates from the distal matrix and is much thicker, but its cells are less flattened than those of the superficial layer. The ventral layer is mainly nail bed (onycholemmal) keratin and has longitudinal ridges that correspond to complementary ridges on the upper aspect of the nail bed. These nail ridges may be best examined using polarized light.

Protection and enhancement of the sensory functions of the fingertip are the most important functions of several of the nail plate. While the toenails are formed over a period of 12–18 months, the fingernails grow continuously on an average of 0.1 mm per day. As well as the toenails, the nails of the shorter fingers grow comparatively slower.

The nail plate is curved transversely and gently curved longitudinally. The curvature may vary inter and intra-individually. In the toes, there is a great variability, and it is a common experience that individuals who have a more pronounced transverse curvature of their toenails tend to have more problems, particularly with ingrowing nails. The longitudinal curvature is probably due to the fact that the proximal matrix proliferates slightly faster than the distal one, which causes the dorsal layer of the nail plate to virtually overgrow the deep one [4]. There is a considerable variation in the shape and size of the fingernails and toenails. The great toe has the biggest nail, then the thumb, middle, index, ring, and little finger. The toenails are rather wider than long. The thumbnail is almost as wide as long, whereas the other fingernails are clearly longer than wide [4].

Vascular Supply

The paired volar digital arteries supply the distal phalanx of the digit. They are divided into the proper artery and a thinner obliquely dorsally running branch, proximal of the distal interphalangeal joint. The latter meets the superficial arcade that mainly derives from the proper artery. Two more subungual arcades derive from the cruciate artery that originates from the merging of the lateral and medial proper arteries. The draining venous system is much less abundant. There are many arteriovenous anastomoses in the distal digit, from simple shunts to the complex glomus bodies. Relatively little is known about the lymphatic drainage of the distal phalanx (Fig. 1.5) [4].

Key Point
Three arcades arising from the proper digital artery irrigate the nail unit

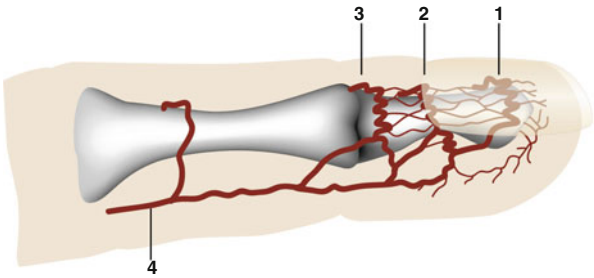

Fig. 1.5 Vascular supply of the nail apparatus. *1* distal subungual arcade, *2* proximal subungual arcade, *3* superficial arcade, *4* proper digital artery

Nerve Supply

The periungual soft tissues are innervated by dorsal branches of paired digital nerves, running at the sides of the flexor tendon and with the dorsal neuro-vascular bundle. These digital nerves divide into three main branches just distal to the distal interphalangeal joint. One branch goes to the nail bed, one to the tip of the digit and the other onto the pulp. There is no unanimity as to which digits have which type of innervation of their tips; it is generally assumed that the index, middle, and ring fingertips get their innervation from the palmar digital nerves whereas the thumb, little finger, as well as the toe tips are innervated by the dorsal nerves [4] (Fig. 1.6).

Key Point
The nail unit receives one branch from the dorsal digital nerve and one ventral branch from the palmar digital nerve.

Skeleton

The skeletal component of the distal phalanx (also known as terminal or ungual phalanges) is made up of the terminal phalangeal bone and the distal interphalangeal joint (synovial joint). The phalanx has a head, a widened proximal base and a tapered shaft (Fig. 1.7). The dorsal surface of the phalanx is convex on cross section, whereas its volar surface is transversely nearly flat. The distal phalanx is slightly concave ventrally along the axis forming the ungual fossa. In the toes, the distal phalanges are similar to those of the hand, but shorter, with flatter shafts, broader bases and more expanded distal ends. The terminal portion of the distal phalanx exhibits a flattened, horseshoes-shaped tuberosity called the processus unguicularis. The shape and the size of the bone largely determine the shape and size of the nail. An abnormal terminal bony phalanx will always result in an abnormal nail [12, 13]. Broader distal phalanx will be associated to wider nail, as in racket nails, and a narrow phalanx will develop a narrow nail.

The joint is laterally stabilized by lateral ligaments (Fig. 1.8) and also by lateral branches of both the extensor and flexor tendons. The flexor and extensor

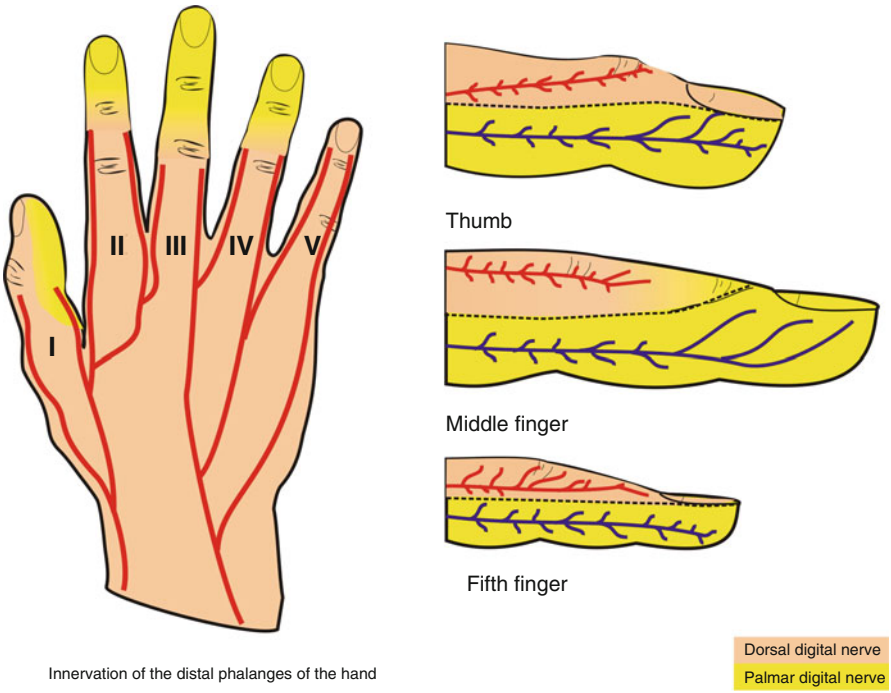

Fig. 1.6 Nerve supply of the nail apparatus

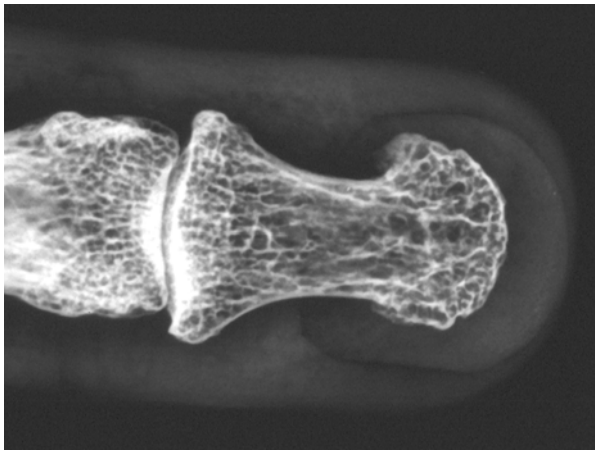

Fig. 1.7 Radiological aspect of the distal phalanx

tendons insert on the ventral and dorsal aspect of the base of the terminal phalanx, respectively. The extensor tendon not only has a bony insertion but also attaches to the nail matrix by a sheet-like superficial lamina, which divides fur-

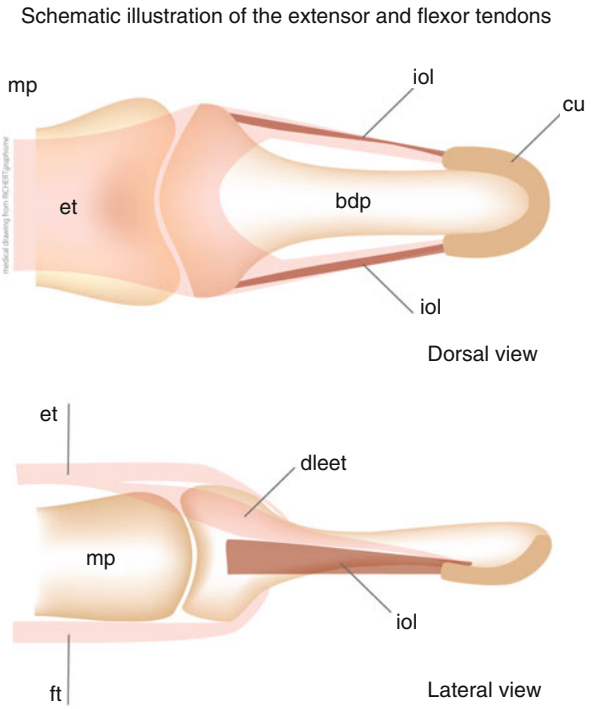

Fig. 1.8 Ligamentary network of the nail apparatus. *bdp* base of the distal phalanx, *cu* corona unguicularis, *dleet* dorso-lateral expansion of the extensor digiti tendon, *et* extensor digiti tendon, *ft* flexor tendon, *iol* interosseous ligament, *mp* middle phalanx

ther into fibers that run along the undersurface of the matrix and into the PNF. The collateral ligaments form dorsal expansions blending into the lateral matrix and nail bed connective tissue [14]. It was thought that hypertrophy of the lateral dorsal expansion in the big toe might be the cause of congenital malalignment of the great toenail [15].

Pre-operative Consultation

General Considerations

A thorough and efficient preoperative evaluation is mandatory for all patients undergoing nail surgery as for any other dermatologic operation. Screening for underlying diseases, especially focusing on any cause of vascular impairment of the extremities (diabetes, Raynaud's disease, smoking, arteriopathy…), current medication and potential allergies (latex, povidone-iodine, antibiotics, pain killers of any type, anesthetics…) should be performed.

Management of common perioperative issues in a proactive and standardized manner, with opportunity to individualize decisions when clinical conditions indicate, is an efficient and optimal approach [16].

Information on the Surgical Procedure

The preoperative consultation should assess all aspects of the planned surgical procedure. Drawings are most eloquent. Surgical complications as well as transitory and permanent nail dystrophy should clearly be reviewed with the patient. Pain is a main concern for patients: they are mostly frightened by the anesthesia. Explanation about the procedure is of great help. If dealing with "needle phobic" patients, do not hesitate to propose anesthetics creams prior to surgery. They should also be reassured about the management of post operative pain and removal of the dressing. Information about possible long-standing post operative dysesthesia should be given. Patients may be offered a flyer containing all pre (Table 1.1) and post operative (Table 1.2) information.

Information on Labour Disruption

It is of utmost importance to try to evaluate as accurately as possible the healing time according to the selected procedure and the impact of the surgery on the patient's professional activity. Remember to inform the patient that the limb has to be elevated for 48 h (it means no driving at all), so people living alone or old patients can make arrangements for accommodation in their daily lives.

Table 1.1 Example of flyer that may be offered to patients as preoperative information

Pre-operative information
Date of surgery:
Time:
Location:
Remove any trace of nail lacquer.
Starting 2 days prior to surgery, bath or shower your finger/toe twice per day and scrub it gently with povidone-iodine soap. Rinse thoroughly and tap dry.
The day of surgery, soak your finger/toe in lukewarm water for 10 minutes, soap it with povidone-iodine, rinse and dry. Apply a dry dressing on top.
Eat normally the day of surgery. Avoid coming with an empty stomach !
Bring sandals with Velcro straps or equivalent to accommodate the post operative bulky dressing. You will not be able to put back your shoe on ! Avoid skinny fit pants to easily remove your pants for night-time without damaging the dressing.
You will not be able to drive back home and your insurance could be considered invalid. You must not travel back home by public transportation. Please make adequate arrangements.
If the doctor prescribed you medication prior to surgery, please follow exact instructions.
Should you have:
Any reason to cancel or post-pone your appointment.
Any new medication prescribed by any doctor.
Excessive pain and/or redness at the site of planned surgery.
Please call the following number:

Table 1.2 Example of flyer that may be offered to patients as post operative information

Post operative information
Date of removal of dressing:
Time:
Location:
1. The administered local anesthesia will last for X hours. In order to avoid any excessive pain, take one pill of paracetamol containing pain killer (drug X, Y, Z, W, **no aspirin**) as soon as you come home, then one pill every 4 hours today, one pill morning, noon and evening tomorrow and the day after tomorrow. If pain relief is not enough add ibuprofen (A, B, C) or naproxen (D, E, F) pain killers.
2. In order to avoid throbbing and any edema that may be responsible for pain, it is mandatory to **keep the limb elevated** (sling for a finger, footstool for a toe) **for 48 hours**.
3. **The dressing will be removed in 48 hours** by the surgeon (or a nurse) at the place and time indicated above. If you are living very far your family doctor may take care of it. Do not forget to bring this sheet with you. Removal of the dressing is not painful. If in any case it sticks to the wound, it will be soaked in lukewarm water until is detaches spontaneously. A much smaller dressing will be placed. You will be able to wear comfortable shoes. Walking is allowed. Avoid sports for 3–4 weeks in order to allow early healing and reduce the chance of infection.
4. **If you had a treatment for ingrowing nail with phenol**, oozing will persist on the lateral side of the nail for up to 6 weeks. This is normal and is not infection. To avoid any scab formation that may impair drainage of the oozing. Gently clean the lateral sulcus with a Qtip or a soft children's toothbrush (new).
5. **The following local cares have to be done strictly**
During 2 weeks: soakings of the finger/toe for 10 minutes in lukewarm water with povidone-iodine soap (red bottle). Tap dry. If you are afraid of touching your nail, use a hair dryer. Apply a line of antiseptic ointment (ointment X, Y, Z, W) on the wound. Cover with sterile dressing.
After 2 weeks: replace the ointment by povidone-iodine solution (yellow bottle) and cover with a plaster until your doctor allows you to have it air-dried.
Should you have:
Any reason to cancel or post-pone your appointment.
Excessive pain, redness, excessive swelling, purulent or smelly discharge, or anything that seems abnormal to you.
Please call the following number:
If out of working hours contact:

Premedication

Premedication is exceptionally prescribed unless with very anxious patients. Short action molecules should be preferred: hydroxyzine, diazepines, orally or sublingually, the latter being quicker. The combination of hydroxyzine 25 mg the night before operation with lorazepam sublingually 1 h prior to surgery is very efficient [17]. Midazolam is favoured by some surgeons as it offers short-acting hypnotic, anxiolytic and anterograde amnestic properties [18].

Antibiotic Prophylaxis

Antibiotic prophylaxis in dermatologic surgery is still debated and data on its use are lacking. Prophylaxis remains however clearly indicated for the prevention of endocarditis and prosthesis infection. Recent prospective studies recommend prophylactic antibiotics only for patients with high-risk cardiac conditions and patients with prosthetic joints at high risk for joint infection [19]. Prophylactic antibiotics are also recommended when the surgical site is infected and for procedures on the lower extremities [19, 20]. All surgery procedures should be performed under full sterile conditions [21].

Discontinuance of Drugs

It is important to list every medication being taken by the patient. This may reveal some underlying disease that the patient forgets to inform the physician as it is a long-standing condition and a medication has been taken for years. But no drugs should be discontinued. Concerning blood thinners and coumarinics, there is no documented data on the increase of severe hemorrhagic complications during continued use perioperatively of blood thinners. This provides a compelling argument to maintain patients on medically necessary blood thinners during cutaneous operation [22, 23]. As surgery for ingrown nail is always performed with a tourniquet, the risk of per operative bleeding is nil. Bleeding may occur post operatively when the tourniquet is removed. Compressive dressing for half an hour with the limb elevated will suffice in most instances. The dressing should be changed afterwards and the wound checked. If bleeding persists, it may be dramatically lessened by the injection of a load of fluid (0.5 mL of buvipacaine i.e.) on the lateral aspect of the digit/toe that will press onto the digital proper artery.

Instrumentation

Very few specific instruments are needed for ingrowing nail surgery:

- An **elevator** is a flat and narrow spatula, designed to avulse the nail atraumatically by gently detaching the nail plate from its bed and from the proximal nail fold. Several elevators are available (Fig. 1.9a, b): the ***Freer*** *septum elevator* (originally an ear-nose-and-throat device) has a round and smooth tip at each extremity with a curved shape adapted to the longitudinal shape of the nail; the ***Lempert*** *elevator* is a narrower variant with a less curved extremity [24]; the ***dura mater elevator*** may also be used, as it has a smooth narrow rounded tip but its long bendable handle makes it not easy to manipulate. Instruments from other specialties may be used: the ***dental spatula*** is shorter, easy to handle, has

an extremity of intermediate size (3 mm), with sharp corners and adapted angle. When none of these instruments is available, a single **jaw of an old thin blunt tipped curved scissors** (curved Metzenbaum ie) may be supportive. The authors favour the ***Locke*** elevator which is very convenient (Fig. 1.10a, b) due to its shape and handiness, that allows precise surgery on both fingers and toenails.

- **Nippers** are of utmost importance for cutting the nail plate. The authors prefer *Straight nail nippers* (Fig. 1.11) that they find the most adequate for cutting a nail of normal thickness: they have sharp straight cutting jaws, thin beveled extremities and a flat undersurface. They allow cutting of the nail without almost no extra lateral onycholysis. For thicker nails, the *dual action nail nipper* (Fig. 1.12) is invaluable: it has nicely adapted beveled jaws and its four hinges will allow cutting the thickest nail plate. The *English nail splitter* (Fig. 1.13) is very unique with its anvil-like lower jaw. Its upper surface slides under the nail plate while the upper jaw has an inferior cutting edge allowing to cut thick nails but it is less handy than the previous ones and the thickness of the lower jaw always induces a lateral onycholysis ahead of the cutting line.

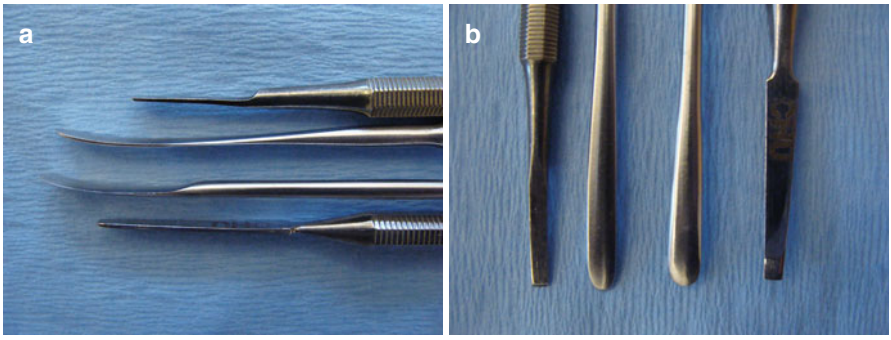

Fig. 1.9 Elevators, (**a**) is lateral and (**b**) front views showing their distal curve, up to down: thin dental spatula, dura mater elevator, Freer elevator, larger dental spatula

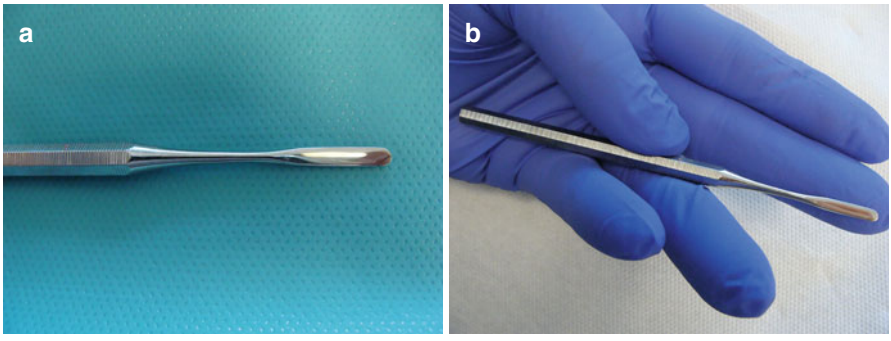

Fig. 1.10 Locke elevator: front view (**a**) and handiness (**b**)

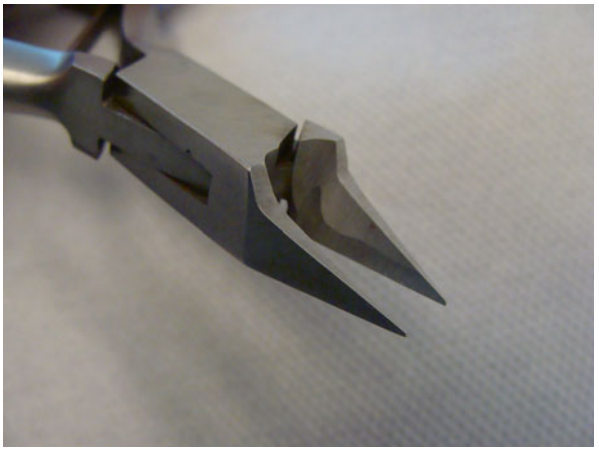

Fig. 1.11 Straight nail nippers. Note the sharp thin bevelled jaws

Fig. 1.12 Dual action nail nippers. Note the four hinges making these nippers very powerful

Fig. 1.13 English nail splitters. Note the anvil-like lower jaw

- A **tourniquet** is always required, as the surgical field needs to remain bloodless in all instances, especially when performing matrix cauterization. Several options are available:
  - The Penrose drain (Fig. 1.14) is the most widely used. It is wrapped around the base of the digit and its two ends are clamped together with a sturdy hemostat. This is especially adapted for toenail surgery. It has been shown that this technique delivers high and unreliable pressure [25] and is not recommended for digits.
  - An alternative is to use a tourniquet made from a piece of glove finger cut at both extremities. Rolled onto the finger, it provides exsanguination (Fig. 1.15). It is easily available and suitable for both toe and fingernail surgery but the main risk is to forget to remove it after the surgery, leading to a potentially dramatic ischemia of the involved finger. Several tips may be used to increase its visibility: the use of a colored piece glove or the application of a sturdy hemostat on the tourniquet [26].
  - For fingernail or even for toenail surgery, it is best to use a sterile glove, half a size smaller than the adequate size. After anesthesia and full disinfection of the hand or foot with plain alcohol, the surgeon places the glove in full aseptic conditions. The top of concerned glove fingertip is cut off and rolled back to the base of the proximal phalanx (Fig. 1.16). This technique exsanguinates the digit and delivers a reliable pressure under 500 mmHg. The remainder of the glove will serve as a sterile field. It also provides the safest tourniquet technique, as the whole glove cannot be forgotten at the end of the procedure. If a too large glove has been used or if the glove fingertip has been too largely cut, the plastic ring rolled at the base of the finger may not be tight enough and bleeding may still occur. In such instances, the pressure from the plastic ring may be increased using a hemostat that is hold in place by folding back the most proximal part of the glove [27] (Fig. 1.17). This procedure may dramatically increase the pressure and should be avoided. It may be applied for very few minutes, for example during chemical cauterization of the matrix in a

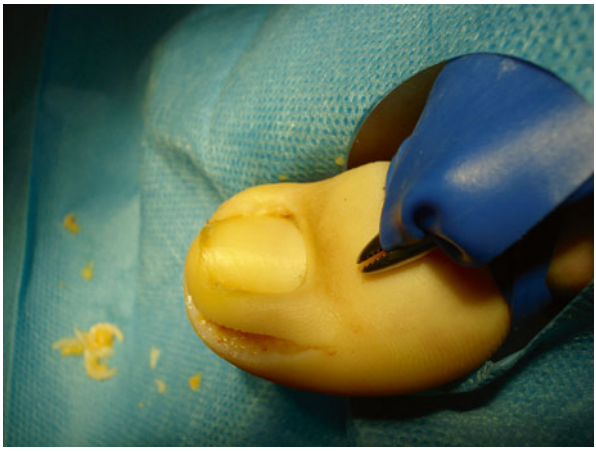

Fig. 1.14 Penrose drain

Fig. 1.15 Tourniquet made from a piece of glove finger cut at both extremities

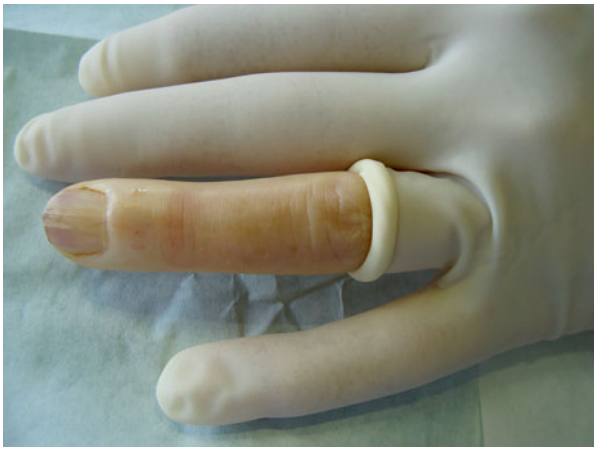

Fig. 1.16 The glove tourniquet, ensuring finger exsanguination and sterile field. This is mostly adapted for fingernail surgery

bloodless field. For the same reason, tunable zip-ties that have been proposed as digital tourniquets should not be used [28] (Fig. 1.18).

– T-Ring® is a single use tourniquet which has the great advantage to first exsanguinate the finger/toe and to provide a safe and controlled pressure of 160 mmHg (Fig. 1.19). Autoclavable pediatric tourniquets, used for blood collection may also be used but without any control of the delivered pressure (Fig. 1.20).

The **basic ingrowing nail surgery tray**, required to perform **partial chemical matricectomy** (Fig. 1.21) should include the following:

- Tourniquet
- Elevator
- Nail nippers
- Curette

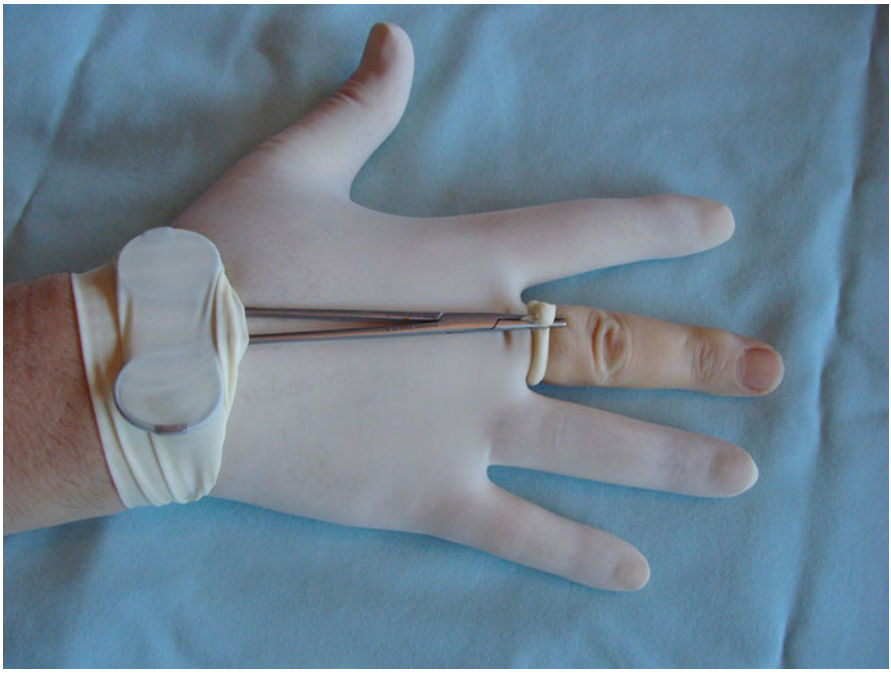

Fig. 1.17 The glove tourniquet with increased pressure: this procedure should be strictly limited to a few minutes. This may be useful in patients under blood thinners

Fig. 1.18 The zip-tie tourniquet. This device is not recommended

The **full ingrowing nail surgery tray** required to perform surgery on periungual soft tissues (Fig. 1.22) should include the instruments of the basic ingrowing nail surgery tray plus:

- *Bard-Parker* blade holder, with blades n° 15 or 15 C
- Fine Adson toothed 2×1 forceps

Fig. 1.19 T-ring tourniquet. This device provides an ideal compression (Courtesy N. Jellinek, Providence, USA)

Fig. 1.20 Pediatric multicoloured tourniquet

- Fine curved scissors, *Iris* or *Graddle* type for undermining
- Needle holder, with serrated jaws, for holding larger needles (4/0 and over) for suturing the skin and through the nail

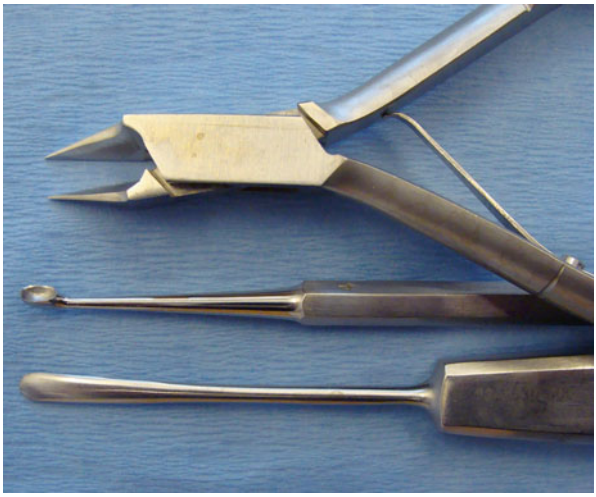

Fig. 1.21 Basic ingrowing nail surgery tray

Fig. 1.22 Full ingrowing nail surgery tray

- Suture cutting scissors (the cheapest heavy straight scissors will do).
- Sturdy straight hemostat, at least two. They are very useful to grasp thick nails for avulsion. Prefer those with serrated jaws without teeth at their extremity. One hemostat may be used for holding the tourniquet.

- Curette, excavator type (*Besnier* lupus or *Volkmann* curettes), fenestrated or not, for removing pyogenic granulomas…
- Fluted probe. This instrument is useful especially for the deroofing of the lateral nail fold in harpoon nail.
- Non absorbable 3/0 and 4/0 sutures
- Absorbable 4/0 and 5/0 sutures

Many varieties of instruments are available, providing an overwhelming number of choices both in quality in cost of surgical instruments. Most practitioners will develop their own likes and dislikes for some instruments during their practice. Choosing the right instrument for one's hand size and type of procedure to be performed is crucial for efficient procedures [29].

Disinfection of the Surgical Field

Feet are prone to bacterial contamination. It has been demonstrated that infection rates are higher following orthopaedic procedures on the foot and ankle as compared with procedures involving other areas of the body. The difficulty of eliminating bacteria from the forefoot prior to surgery has been documented. Several studies compared the efficacy of povidone-iodine, chlorhexidine, alcohol, combination of them and their application with bristles or sponge. Culture swabs were obtained from different locations: web spaces, nail folds, toe surfaces. The better reduction in bacterial carriage was obtained with alcohol scrub + alcohol paint with bristle (only 12 % of positive cultures in the nail folds) [30] and chlorhexidine scrub plus isopropyl alcohol paint (38 % of positive cultures in the nail folds) [31]. All other combinations had a positive culture rate over 70 %. Recently, footbath with chlorhexidine gluconate (Hibitane®), 20 min before surgery, was recommended as it significantly reduced the intraoperative and post operative bacterial counts [32]. Brushing the nail does not decrease bacterial number [33]. Another study mentions that incorporation of alcohol and povidone-iodine into the preoperative nail preparation may help reducing the bacterial load [34]. The most disturbing finding in these studies is that the nail remains contaminated after any of the preoperative nail preparation method studied. This suggests that all efforts to reduce the bacterial load should be used [15] and that plain alcohol acts as a major factor for that.

Anesthesia

Most people are more often more apprehensive about the needle stick than the procedure itself. This is why the preoperative consultation should assess all aspects of the procedure in order to have the patient fully reassured. If excessive anxiety is noticed, premedication should be prescribed. Another option is the use of topical anesthetics (see section "Pre-operative Consultation").

A good knowledge of the nerve anatomy of the digits (see section "Surgical Anatomy"), as well as of the techniques of anesthesia of the nail unit, are a prerequisite to ensure a comfortable nail surgery both for the patient and surgeon.

Paired palmar and plantar nerves lie at the sides of the flexor tendon sheath and proper digital arteries. These digital nerves divide into three main branches just distal to the distal interphalangeal joint. One branch goes to the nail bed, one to the tip of the digit and the other onto the pulp (Fig. 1.6) [35]. The aim of the procedure is to block the dorsal and the ventral branches to obtain a complete numbing of the digit/toe.

Checking for any history of allergy to lidocaine or bupivacaine or parabens (contained in both as preservative) is part of the preoperative consultation. Local anesthetics may be contraindicated in patients with cardiac disease such as heart block [36].

Anesthetic Products

- *Plain lidocaine 1 or 2 %* is the reference local anesthetic. Plain 2 % should be preferred as it seems slightly more efficient [24].
- *Lidocaine with epinephrine* has been shown to be safe for digital anesthesia, but there remains a very deeply ingrained resistance to its use for digital anesthesia. It is widely thought that this will lead to irreversible digital artery vasospasm [37]. Multiple studies involving thousands of patients support the premise that the use of lidocaine with epinephrine is safe in the digits [37–42]. All cases of digital gangrene after anesthetic block occurred more than 50 years ago when the surgeon or the nurse manually added epinephrine to the local anesthetic, in erroneous concentrations. There have been no case reports of digital gangrene using commercial lidocaine with epinephrine since its introduction in 1948 [38]. A study using duplex scanner and Doppler probe measured actual changes of digital artery flow consecutive to digital block with 2 % lidocaine with epinephrine: a dramatic decrease of 50 % of the arterial flow was noted after 5 min but returned to normal by 60 min [39]. As the temporary vasoconstrictor effect is reversible, the threat of complication from vasoconstrictor-induced ischemia is theoretical [40]. The use of lidocaine with epinephrine has clear advantages such as quicker onset, fewer reinforcement doses, less need for special maneuvers to stop bleeding, and longer total time of post operative analgesia [41]. However, a very recent publication from the Cochrane Group showed that there are only limited data available and that evidence is insufficient to recommend use or avoidance of adrenaline in digital nerve blocks according the published data. The evidence provided in this review indicates that addition of adrenaline to lidocaine may prolong the duration of anaesthesia and reduce the risk of bleeding during surgery, although the quality of the evidence is low. They conclude that large prospective trials are required [43]. This comforts the ideas of the authors who believe that lidocaine with epinephrine is of little interest for performing nail surgery [42], on the contrary of some others [44]. Most surgical nail procedures require a completely bloodless

field that is only achieved when using a tourniquet and not with an adrenalin containing anesthetic. Moreover, if bleeding occurs when the tourniquet is removed, the surgeon can check the cause and act on it. If the bleeding occurs when the patient is back home, this might be much more troublesome.

- *Bupivacaine 0.5 %* acts for 8 h [45]. Injecting 0.5–1 mL of bupivacaine immediately post operatively as a distal digital block will first act as a chemical tourniquet – the volume load pressing on the digital proper arteries will stop any post operative bleeding – and second, will ensure a very comfortable post operative for the patient.
- *Ropivacaine* has the same quick onset as lidocaine but provides a better post operative pain relief (up to 9 h) [46, 47] and is less cardiotoxic than bupivacaine [48]. Pain at infiltration depends on concentration: pain occurs over 5 mg/mL. Mean time to regain full sensation is over 7 h for 2 mg/mL. Ropivacaine appears to produce vasoconstriction at low dosages [49]. For all these reasons, the authors use rovipacaine 2 mg/mL in routine with very comfortable anesthesia and post operative for our nail surgery patients. We restrict the use of this anesthetic for patients without any history of vasospastic disease, diabetes mellitus, Raynaud's disease, heavy tobacco use, etc.

Material

- *Luer-Lock syringes or dental syringes* (Fig. 1.23) are mandatory for any type of anesthesia at the nail apparatus, as these are high resistance injections (weak dilatation of tissues). Their screw-on system, on which needles are tightly secured, avoids their detachment under high pressure.
- *Very thin needles (30 G)* will decrease pain from puncture. Their size will also limit the anesthetic flow, inducing a very slowly progressive swelling of the soft tissues. It is common for the physician to spend more time injecting the anesthetic than performing the surgical procedure. The pain from injection is clearly linked to the speed of injection [50].
- *Needleless injection systems* for digital blocks has been proposed for "needle phobic" and young patients. This is nothing different than a disposable DermoJet. The liquid is delivered in an aerosol form subcutaneously to a depth of 5–8 mm, fanning out on maximum penetration to a width of 8–10 mm. This technique is not reliable since it requires in all patients an additional anesthetic administration of 3 mL to achieve adequate anesthesia of the tip of the toe [51].

Techniques of Injection

It is best to have patients in a reclining position during the administration of anesthesia in the event a vasovagal episode occurs. It is judicious to inform the patient when the needle stick is about to occur to avoid a dangerous reflex jerk [52].

Fig. 1.23 Luer-Lock and dental syringes

- *Proximal Digital Block*. The term "ring block" should be abandoned as it suggests injection of anesthetic all around the base of the finger. This historical technique induces constriction of the blood flow through a tourniquet of fluid at the base of the proximal phalanx. It should not be performed anymore. The proximal digital block is the updated and adequate procedure of this type of anesthesia. With the patient's hand pronated, the needle punctures the skin in the midline of the lateral aspect of the proximal phalanx, with an angle of 45° from the proximal bony phalanx, 1 cm distal to the interdigital web. The needle is pushed until bone contact, where 1.5–2 mL of anesthetic is deposited to numb the digital nerve. The procedure is then repeated on the opposite side of the digit to complete the block. A complete block is usually achieved in 10–15 min, sometimes more.
- *Distal Digital Block* (Fig. 1.24a). This is the most useful in routine nail surgery as it acts immediately. The injection site is at a point about 1 cm proximal and lateral to the junction of the proximal nail fold and the lateral nail fold. By directing the needle at a 45° angle directed distal down to the bone, about 0.5 mL of anesthetic is slowly deposited. Resistance to injection suggests that the needle tip has penetrated some fibrous tissue such as ligament

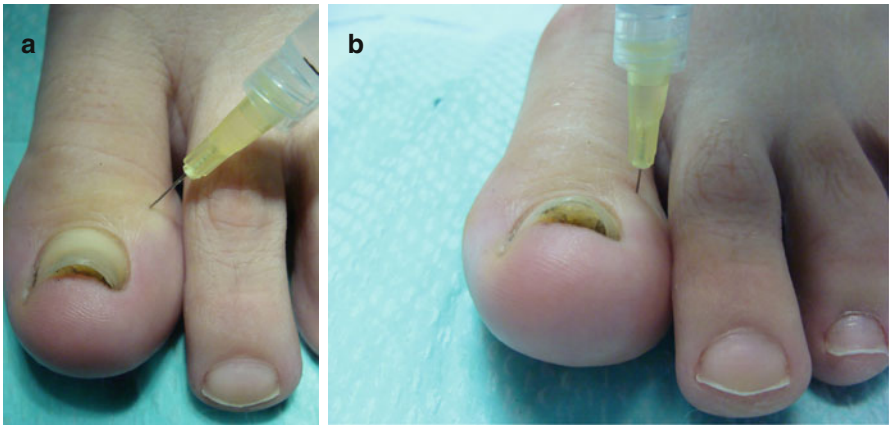

Fig. 1.24 Distal digital block

Fig. 1.25 Position of the finger of the surgeon evaluating the dilation from the anesthetic into the pulp

or the periosteum. Careful withdrawal of the needle will result in a free flow. Blanching of the lateral part of the lunula is often noticed. This injection will anesthetize the dorsal nerve. The needle is then slightly withdrawn and set back upright and pushed downwards skimming the lateral aspect of the bony phalanx, until the ventral pulp. Another 0.5 mL of anesthetic is injected at that place (Fig. 1.24b). The surgeon's index, placed under the pulp feels the tip of the needle and the progressive dilation from the anesthetic (Fig. 1.25).

- *Distal wing block.* This is indeed a periungual block. The first step of the procedure is identical to the one of the distal digital block: the needle is inserted about 1 cm proximal and lateral to the junction of the proximal nail fold and the lateral nail fold, at a 45° angle, down to the bone and about 0.5 mL of anesthetic is slowly injected. The needle is then withdrawn and pushed distally into the lateral nail fold, where some more anesthetic is deposited. Injections are repeated several times at the previously anesthetized site whilst progressing up to the tip of

Fig. 1.26 (**a**) Scheme of a "wing block". A more adequate term would be "periungual block". (**b**) Bending of the needle for insertion into the whole length of the lateral nail fold, will limit repeated punctures

the digit (Fig. 1.26a). The needle may be bent at 120° to facilitate the injection within the whole length of the lateral fold, limiting the number of punctures (Fig. 1.26b). The infusion and bleaching of the lateral nail fold resembles a wing as it progresses distally [53]. This will provide anesthesia of half of the nail apparatus. For complete anesthesia, the procedure should be repeated on the opposite side. The procedure requires about 1.5 mL/side. When finished the entire digital tip appears swollen and white.

- *Matricial, hyponychial and transthecal blocks* are not useful in the surgery of ingrowing toenails.

Key Points

- Take your time. Injecting very slowly is the key to a painless anesthesia.
- Talk to the patient (« talkesthesia »).
- Learn the time of action from your anesthetic and type of block. Let your patient rest in a room and do something else in the meantime.
- Check the efficacy of your anesthesia before embarking on surgery. Do probing with some sharp instrument on both anesthetized and non-anesthetized areas: complete numbness of the anesthetized area will fully reassure the patient

Tips for Reducing Pain

– ***from the needle prick:***

- Use very *thin needles* (30 G)
- The use of *EMLA cream* under occlusive, at least 1 h prior to the local anesthesia, will alleviate the pain caused by needle insertion [54] but not the one from the dilation and deposition of the local anaesthetic [55].
- Ice packs, topical cryogen spray, cold air… may reduce the discomfort from the prick [53]
- *Pressure and vibration* at the expected site of injection for several minutes (around 5 min), may minimize the concurrent pain from the needle prick [56]. This is particularly helpful in children and needle phobic patients.

– ***from infusion of the anesthetic****:*

- Inject extremely slowly, thus performing a very progressive swelling of the soft tissues: the subungual space is limited and non-expendable.
- Lidocaine is acid. Its alkalinisation (one volume of bicarbonate for nine volume of lidocaine) reduces pain during infusion [57]. Addition of too much sodium bicarbonate will result in a milky solution secondary to flocculation. This may impair the flow through the needle that may even become obstructed.
- Keeping the anesthetic out of the fridge, at body temperature will render the infusion less painful.

Complications and Management

– ***from the anesthetic***:

- Epinephrine and rovipacaine should not be used in patients with vasospastic, thrombotic or extreme medical conditions (Fig. 1.27).

Fig. 1.27 Necrosis and the distal tip of the toe in a patient with extreme vasospastic conditions that received accidentally lidocaine with epinephrine

Fig. 1.28 Partial necrosis of the lateral fold in a diabetic patient after a wing block

- Prolonged ischemia may be reversed with nitroglycerin ointment or phentolamine too injection [58].
- Adding too much bicarbonate to buffer the lidocaine has been associated with necrosis [59].

– ***from the technique****:*

- ***Proximal digital block****:* Complications are rare, but the major drawback is the potential hazard of injury to the digital neurovascular bundles, including direct trauma and spasm [60]. Ignorance of the delay between anesthesia and surgery often leads to infusion of a large volume of anesthetic from repeated injections. This load of liquid may impair the venous and lymphatic blood flow and induce a painful oedema at the operating site.
- ***Distal digital block/Wing block*****:** Complications are exceptional. Local necrosis may be encountered in exceptional instances, mostly on one lateral nail fold (Fig. 1.28). This may result from a local vasospasm in patients with impaired blood supply of the limb, diabetes or under blood thinners. As this condition is very painful, except in case of severe polyneuropathy, prescribe potent pain killers and check the wound at regular intervals. To avoid discomfort from retraction of the crust, keep the area humid with greasy antiseptic occlusive dressings. The necrosis will be eliminated in 4–6 weeks and will leave no scar.

Dressings

For ingrown nail surgery, post operative dressings must have three main properties: non adherent, absorbent and perfectly fixed. Adapted footwear is a must (Fig. 1.29).

Fig. 1.29 Adequate footwear after toenail surgery

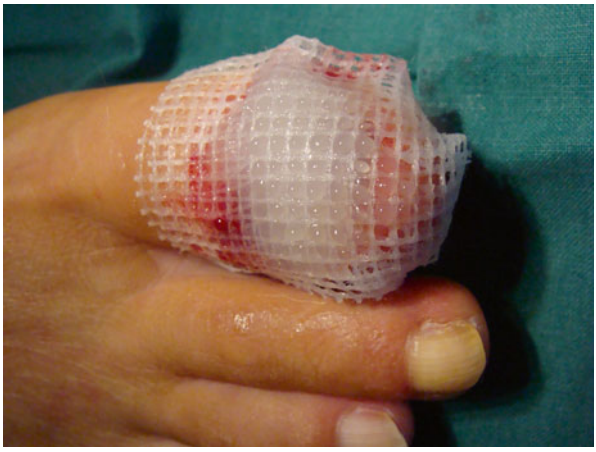

Fig. 1.30 Greasy dressing with non-adherent gauze

Non Adherent Dressing

Applying large amounts of ointment (possibly containing antiseptics) covered with non adherent dressing such as petrolatum coated gauze (Tulle gras®, Bactigras®, Adaptic®, Jelonet®) possibly added with antiseptics (Betadine Tulle®, Fucidin Tulle®) will protect the wound from drying and will allow an easy and painless removal (Fig. 1.30). Telfa® may be another option. A new category of dressing appeared on the market that is well adapted to nail surgery. It consists of a porous, semi-transparent, low-adherent, flexible polyamide net coated with soft silicone (Mepitel®). It is not absorbent, but contains apertures of approximately 1 mm in diameter that allow the passage of exudate into a secondary absorbent dressing [61].

Absorbent Dressing

As post operative bleeding may be noticeable, a bulky dressing made of two or three loose layers of mesh gauze, on top of the non adherent dressings, will absorb bleeding and offer padding against trauma. Bleeding is limited with the elevation of the limb for 48 h.

Securing the Dressing

A bandage will hold together the bulky dressing. Tubular gauze or net may be used but control of the pressure on the dressing is impossible. A narrow elastic bandage (4–5 cm) is a more flexible form of dressing as it may apply more precise pressure over the wound. They are applied in a U shaped fashion in order to avoid any tourniquet like effect. The last layers may be circular and will include wrapping around the ankle to fully secure the dressing (Fig. 1.29). This should afford light compression that does not compromise blood flow [18].

Post Operative Management

Post operative management has mainly two issues: pain control, dressing replacement together with instructions on how to do proper home care.

Pain Control

Pain control relies on two points: elevation of the leg and pain killers.

- *Elevation of the leg:*
  Elevation at the hip level, meaning horizontally, using a footstool, suffices. This will reduce throbbing and facilitate healing. It will avoid edema at the surgical site that may be responsible for pain and may pull on the sutures, if any. The duration of elevation of the limb is of 2 days, equal to the inflammatory reaction after surgery.
- *Pain killers:*
  According to the type of surgery, pain will last from several hours to several days after cessation of the anesthesia. The surgeon should accurately determine the degree of pain of his surgery in order to adapt the post operative analgesia. Some procedures are less painful than others (see Table 1.2, page 11).

Post operative pain management starts first with adequate anesthesia (see above). Long lasting anesthetics (bupivacaine, ropivacaine) (up to 8 h) are a must for painful surgery.

If only no to mild pain is expected, paracetamol 500 mg every 4 h on the first day then 3/d on the second day will suffice. Patients may be instructed to add anti-inflammatory agents such as ibuprofen, naproxen or meloxicam if needed. Although there is a caution against nonsteroidal anti-inflammatory drugs in nail surgery in a US guideline [62], the authors have found them useful, as other authors [63], with no effect on post operative bleeding. Most patients usually need analgesia for the first day and drop the treatment afterwards.

If moderate pain is planned, combination of paracetamol and codeine works nicely.

If severe pain is expected, mild opoids narcotic analgesics (tramadol, naloxone associated with tilidine) should be prescribed and precise posology and side-effects explained.

In case of an anxious patient with low pain tolerance, it is judicious to always add a prescription of a stronger analgesic to reassure the patient. In almost every case, the patient will not have to use it.

Dressing Removal and Replacement

Patients fear pain from sticky dressings that are abruptly pulled out. This is why the dressing should be adapted to nail surgery (see above). In most instances, sticking to the wound is unusual, even if there is almost always some bleeding into the dressing. The dressing is removed on the second day post surgery. Sometimes early removal is necessary after 24 h if bleeding is severe, because the impregnated gauze of the bulky dressing dries off and become stiff and may cause unpleasant or painful compression. If left in place too long, such dry and hard dressings may induce superficial erosion on the skin of the proximal and/or lateral nail folds [64]

Fig. 1.31 Skin erosion from a dressing left too long on site that dried out

Fig. 1.32 Splitting of a large commercial plaster to adapt to the shape of the toe

(Fig. 1.31). In case of adherence, never try to pull, but soak the dressing in lukewarm water until it detaches spontaneously.

The patient, or one relative, should see the way the new dressings is done in order to be able to reproduce it properly at home. This teaching phase is very important to ensure a smooth and optimal healing. Cares will depend on the type of surgery. In most instances, the dressing should be renewed twice per day for the first days. A large plaster, half split in four on its length, will cover easily a great toe or a finger (Fig. 1.32). Greasy antiseptic ointment should be applied for the first 2 weeks to avoid the wound to dry. Then, application of povidone iodine solution twice a day until healing is complete. A plaster should cover the wound at all times to avoid any contamination.

Follow-up

Follow-up is mandatory to check the absence of any recurrence. As the nail grows very slowly on the great toenail, it seems logical to check the patient after 3 months to be sure that the regrowth is adequate and not inducing any ingrowing process. The patient should be informed that if anything goes strange (pain, swelling, redness, oozing…) he should call the surgeon for a check.

Post operative long-term dysesthesia is common and may be observed in up to half of the patients. There is no clear explanation for this phenomenon up to now [65].

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Chapter 2
Definition – Pathogenesis
Risk Factors – Classification – Scoring

Abstract There is still a debate about the cause of ingrowing toenails: is it the nail plate itself, the soft tissues or both that are at fault? There are few real risk factors that may promote ingrowing toenails, mainly nail abnormalities like too wide or transverse overcurved nails. Ingrowing is precipitated by improper nail cutting in most instances. The best way to classify ingrowing nails is from their location: lateral, distal or proximal. Each of these categories has different subtypes. Several severity index scoring may help the clinician to find the best treatment plan.

Keywords Ingrowing nails • Etiology • Risk factors • Scoring • Classification • Lateral ingrowing • Distal ingrowing • Proximal ingrowing • Retronychia • Harpoon nail • Pincer nail • Plicated nail • Omega nail • Juvenile ingrowing nail

Definition

Nail ingrowing results from a painful conflict between the nail plate and the surrounding soft tissues.

Pathogenesis

There is still a debate about the cause of ingrowing toenails. Some are convinced that the nail is responsible for the condition and thus will intervene on the plate itself, others are prone to the idea that the periungual soft tissues are at fault and favour a surgical procedure on them. Trying to know which, from the plate or the soft tissue is at fault, is similar to guessing which came first, the chicken or the egg.

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The painful conflict between the plate and the periungual soft tissues may result from:

An Epidermal Breakage in the Lateral Nail Sulcus

Constant pressure from the nail plate against the soft tissues in a narrow shoe, especially if the nail is cut short, may push up the distal pulp, resulting in a painful distal corner. To alleviate discomfort, the patient starts to dig with nail clippers in the lateral nail fold and is unable to clip the most lateral and deep part of the plate, leaving thus a spur (Fig. 2.1). The latter will grow distally and run through the epidermis of the lateral sulcus leading to pain, inflammation, pyogenic granuloma and even infection. The same etiology is responsible for ingrowing toenails observed in teenagers who tear off their nails, softened by the humidity from sneakers: the nail is torn in a lateral motion very deep in the lateral sulcus. This phenomenon may be worse in some patients as transverse curvature and nail plate width vary inter- and intra-individually, particularly in the toes. It is not rare to observe patients in which the lateral border of the nail plate curves to reach to or even beyond the midline of the lateral aspect of the big toe [1]. Those individuals with more pronounced transverse curvature of their toenails tend to be more prone to developing ingrowing nails. This type of ingrowing is mostly an acute and painful phenomenon.

A Pinching of the Subungual Soft Tissues (Pincer Nail)

This occurs subsequently to bony alterations of the underlying phalanx. The matrix is firmly attached to the bone. Widening of the distal interphalangeal joint (either from osteoarthritis, or trauma or surgery) will lead to a narrowing and elevation of the distal part of the plate to which the bed remains attached. This can be demonstrated easily with a paper model and is confirmed if complete avulsion is performed (Fig. 2.2). The result is a distorted distal nail bed that is pinched between the two lateral edges of the plate (Fig. 2.3). With time, the constant pulling of the distal

Fig. 2.1 Pressing down the lateral fold may exhibit the spur left by incomplete clipping of the lateral nail plate

Fig. 2.2 Rear view of an avulsed pincer nail. Note the enlarged base and the narrower distal tip

Fig. 2.3 Painful pincer nail on distal pressure

part of the bed may result in a traction osteophyte visible on X-rays [2] (Fig. 2.4). Pain will develop progressively over time, impeding footwear, and sometimes bed sheet contact becomes unbearable.

A Swelling of the Periungual Tissue

Swelling of the periungual tissue may be observed physiologically in infants (Fig. 2.5), where surgery is contra-indicated, as abstention, or sometimes conservative treatments, may lead to complete resolution within a few months [3]. In adulthood, swelling of the periungual soft tissues is secondary to chronic ingrowing,

Fig. 2.4 X-rays, lateral view. Note the distal hyperostosis, responsible for the pain

Fig. 2.5 Prominent hypertrophic medial folds in a toddler

enhanced by cutting the nails very short in the distal corners, without inducing any acute reaction. This chronic inflammation generates a fibrosis, giving rise to peripheral fibrous sausages in which the nail sinks and disappears (Fig. 2.6). Distal embedding results from the loss of counter-pressure exerted by the plate on the distal pulp. It occurs after a nail loss either from trauma or surgery. It is an acute painful condition presenting with a distal inflammatory extremity into which the distal edge of the newly regrown nail impacts.

Risk Factors

Risk factors predisposing to the development of ingrown toenails include anatomic and behavioural mechanisms.

Fig. 2.6 Chronic ingrowing. The plate is sinking into distal and lateral fibrous soft tissues

Nail Abnormalities

Some experts suggest that wider nail folds and thinner, flatter nails increase the risk of ingrown toenails [4], but this remains unproven. This type corresponds indeed to the so-called trapezoidal nails. A case control study with 46 patients found no difference in the anatomic shape of toenails in patients with and without ingrown toenails [5]. In older individuals, the natural aging process causes toenails to thicken, making them more difficult to cut and the associated osteoarthritis promotes pincer nails, which are more inclined to exert pressure in the lateral grooves.

Forefoot Abnormalities

A study showed that in the majority of subjects with onychocryptosis, only a discrete anatomical predisposition existed and that the other factors may act only as triggers in the development of the condition [4]. A more recent study failed to demonstrate any abnormality in the forefoot alignment in patients with symptomatic ingrowing toenails [6].

Genetic Predisposition

Without any strict evidence basis, it is thought that there is a genetic predisposition and family history [4]. The latter may be behavioural and linked to the familial transmission of an inadequate way of clipping nails.

Fig. 2.7 Congenital malalignment of the great toenail. There is no ingrowing. The plate has a triangular shape from constant rubbing against the shoe and/or the adjacent toe

Congenital malalignment of the great toenails is very often incorporated as a congenital form of ingrowing toenail. For the authors, this condition is indeed a congenital disorder but it should not be included into ingrowing conditions. The nail plate is mainly laterally deviated, has an oyster-shell like aspect and is detached from its bed. From the loss of adequate counterpressure from the plate and, as the nail has a tendency toward curvilinear breakage, a distal nail wall may form. Constant rubbing against the latter may give rise to a triangular shape of the nail (Fig. 2.7). Parents bring their child because they are worried about the cosmetic appearance of their great toenail, never because of onychalgia.

Trauma

Repetitive trauma from buffeting of the toes against the tip of the shoe during running or playing sports (some sports are more at risk than others, especially the ones with successive abrupt starts and stops), or inadvertent trauma (stubbing the toe against a chair i.e.) may be inciting factors.

Systemic Diseases

Diabetes may promote ingrowing toenail from the associated polyneuropathy that render the foot insensitive and from the retinopathy that impairs sight and favours inadequate clipping. Obesity, thyroid, cardiac, and renal disorders that may predispose to lower extremity edema can also increase the likelihood of developing an ingrowing toenail [7].

Improper Nail Cutting

In adolescence, feet often perspire more, enhanced by sneakers, causing the skin and nails to become soft, resulting in easy splitting. Teenagers have the tendency to play with their soften nails and tear them off. This produces nail spicules that can pierce the lateral skin.

Transverse curvature and nail plate width vary inter- and intra-individually, particularly in the toes. Those individuals with more pronounced transverse curvature of their toenails tend to be more prone to developing ingrowing nails. If the nail is cut accidentally too short, the distal pulp may lift up, resulting in a painful distal corner, aggravated by pressure from footwear. To alleviate discomfort the patient starts to dig with nail clippers in the lateral nail fold and is unable to clip the most lateral and deep part of the plate, leaving thus a spur that will in time pierce the skin of the lateral groove.

In older persons, inadequate nail trimming can become a chronic problem caused by their reduced ability to care for their nails secondary to reduced mobility or impaired vision.

Classification and Clinical Features

Baran classified ingrowing toenails in different categories long ago, suggesting that each type may benefit from a specific treatment [8]. Several classifications may be proposed according either to the age of arising of from the location of the ingrowing. The latter has the favour of the authors.

Lateral Ingrowing Without Modification of the Curvature of the Plate

Trapezoidal Nail

Trapezoidal nails are a congenital nail dystrophy where the nail plate, too wide for its bed, appears to widen distally as its proximal part remains hidden by the proximal portion of the lateral nail folds (Fig. 2.8). The nail plate may look too wide for its bed, but in fact it is the junction proximal nail fold – lateral nail fold that is at fault,

Fig. 2.8 Trapezoidal nail. The distal part of the plate appears wider than its base

Fig. 2.9 Ingrowing of a trapezoidal nail. This is quite uncommon. Patients mainly complain from discomfort but the trapezoidal nail rarely gets ingrown

as it is too medial. The condition is always symmetrical and affects both great toenails. Unlike racquet thumbs, no bony alteration is associated. This affection would only be a curiosity if the imbalance between the width of the nail plate and that of the nail bed would not promote distal lateral onychocryptosis in some patients (Fig. 2.9), the distal borders of the nail plate pushing laterally on the nail folds. In time, this may promote the arising of a distal lateral hypertrophic lip.

The trapezoidal appearance of the nail may appear "too masculine" by some women seeking a cosmetic surgical cure [9].

Juvenile Ingrowing Toenail

Juvenile ingrowing toenail is the most common type of IT and as its name says, occurs mainly in adolescents. It is mainly precipitated by improper trimming. The distal lateral corners of the nail plate, when cut obliquely, leave a spicule that grows into the lateral nail groove piercing the epidermis with subsequent inflammation,

Fig. 2.10 The so-called "juvenile ingrowing" toenail that associates inflammation and pyogenic granuloma, precipitated by oblique cutting of the corners of the plate

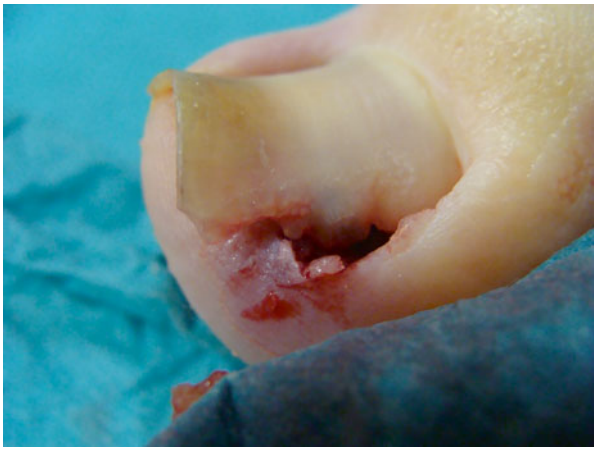

Fig. 2.11 Curettage of the pyogenic granuloma reveals that the lateral edge of the plate is serrated and acts as a saw in the lateral fold

granulation tissue, infection (Fig. 2.10) and if this process is recurrent, an induration of the lateral nail fold appears [7] (Fig. 2.6).

Hyperhidrosis is promoted by wearing sneakers all day. With this constant humidity, the lateral border of the plate tends to crumble, with resulting indentations that will apply a "saw-like" effect on the lateral fold (Fig. 2.11).

Another common cause is tearing off the softened nails. This will result exactly as an improper nail trimming.

Hypertrophic Soft Tissues in Teenagers and Adults

Chronic ingrowing, with or without history of surgery, progressively evolves towards hypertrophy of the soft tissues constantly inflamed by the onychocryptosis. This hypertrophy may enormously vary in size from a focal hypertrophic lip

Fig. 2.12 Moderate hypertrophy of the lateral nail fold from ingrowing nail

Fig. 2.13 Exuberant hypertrophic lateral nail wall

(Fig. 2.12) to exuberant exophytic tissues covering a large part of the nail plate (Fig. 2.13). This mass is not granulation tissue but fibrous tissue, a bit similar to what would be observed in an early cheloid. Amazingly, at this stage, even with a prominent hypertrophy of the surrounding tissues, pain is not the rule. However, oozing is constant. Contamination with anaerobics is frequent and leads to evil smelling. This clinical feature is commonly mistaken with infection and most often oral antibiotics are prescribed.

Lateral Ingrowing with Modification of the Curvature of the Plate

Tile Nail

This type is more common in young persons, and is characterized by a transverse overcurvature where the lateral nail edges remain parallel [10]. Clinically it is considered less severe than other types, without serious symptoms (Fig. 2.14).

Plicated Nail

The plicated nail is a variety of transverse overcurvature [2]. The surface of the plate is flat or exhibits a moderate convexity while one or both lateral margins are sharply bent at 90°, forming vertical sides (Fig. 2.15). Most of the time, this affection is asymptomatic, unless pressure is applied on the nail, inducing a painful conflict between the angled nail and the underlying soft tissue. In some rare instances, there might be an epidermal breakage within the lateral groove, resulting in a painful inflammatory flare. Surgical treatment to alleviate discomfort remains exceptional [11].

Pincer Nail

Pincer nail is defined by a transverse overcurvature increasing from proximal to distal part of the nail plate, pinching the nail bed. It is more frequent in adults on toes, and pain is very variable. Even in the presence of a very discrete transverse overcurvature, pain may be exquisite. A typical clinical sign is the pain triggered at night by the weight of the sheets.

Fig. 2.14 Tile nail

Fig. 2.15 Plicated nail

Fig. 2.16 Hereditary pincer nails. The great toenail is deviated laterally and the lesser toenails medially

Pincer nail can be due to hereditary or acquired factors. Hereditary overcurvature is symmetric in the most part of the cases and there is a positive history family. The nails of big toes exhibit a lateral deviation while the lesser toes show medial deviation (Fig. 2.16) [2]. Acquired transverse overcurvature on toes or digits is not symmetric and may be mainly due to improper footwear but also to other causes such as psoriasis [2], nail tumours such as subungual exostosis, myxoid cyst or implantation cyst [12], onychomycosis [13], trauma, nail avulsion etc. On fingers, it is associated with degenerative osteoarthritis [2], drug intake [14, 15] (Fig. 2.17) or gastrointestinal neoplasia [16]. It has been proven with X-rays and MRI [2] that the enlargement of the distal phalanx, mainly due to osteoarthritis but also to any other cause, will flatten the curvature of proximal nail plate and consequently the curvature increases distally [2] (Figs. 2.18 and 2.19). This motion is easily

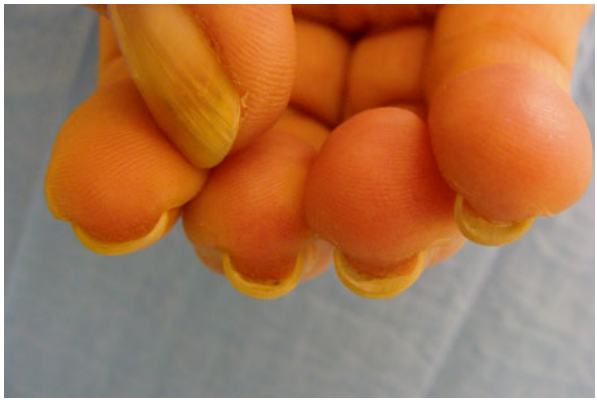

Fig. 2.17 Acquired pincer fingernails due to pamidronate

Fig. 2.18 Pincer nail with clear narrowing of the distal plate

understandable with a paper model. The distally more pronounced overcurvature exerts traction on the nail bed, which is transduced to the bone by the ligament-like fibers fixing the nail unit to the tip of the terminal phalanx. This eventually results in a traction osteophyte, which is also often seen on radiographs and MRI [13] (Fig. 2.4).

Morphologically there are three clinical types: the "common" pincer nail (also called trumpet nail or omega deformity), the tile-shaped nail, and the plicated nail (see below). The most frequently seen type is the trumpet nail deformity with the overcurvature increasing along the axis from proximal to distal. The lateral plate margins may with time virtually roll in, sometimes even

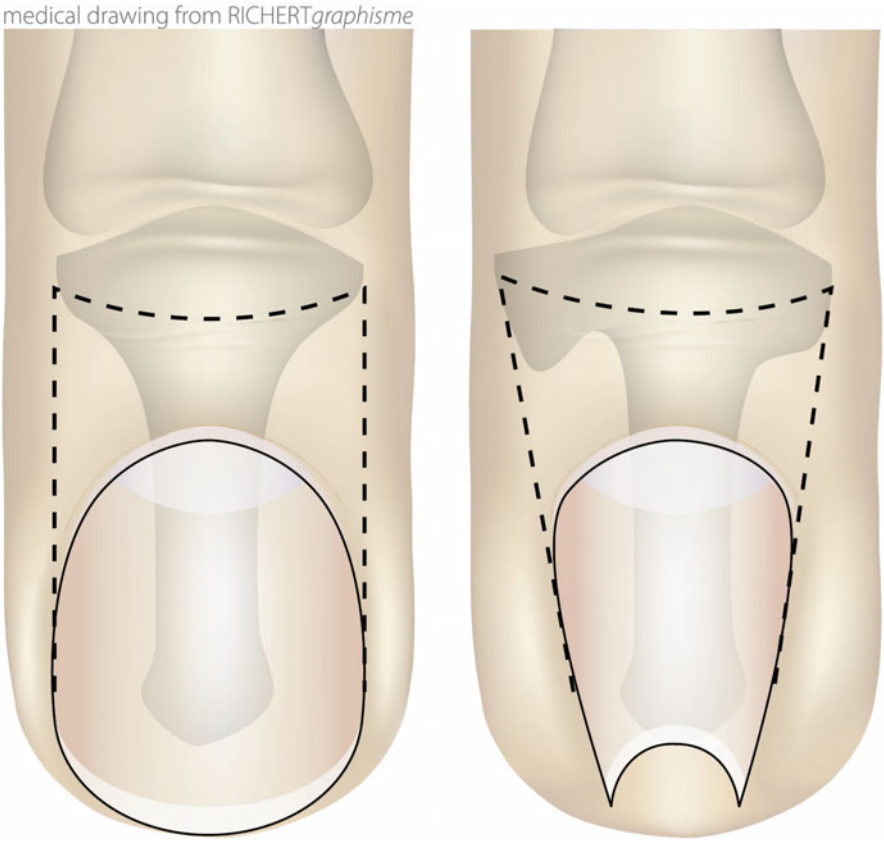

Fig. 2.19 Scheme explaining the origin of pincer nail: enlargement of the base the distal phalanx due to osteoarthritis flattens the curvature of proximal nail plate and subsequently increases the curvature of the plate distally

forming a tube (circumferential nail see above). The nail bed becomes pinched, shrinks in its transverse diameter, and is lifted up distally by the continuous traction exerted on the distal dorsal tuft. The lateral plate margins may eventually break through the epidermis and produce granulation tissue mimicking an ingrown toenail [13]

Circumferential Nail (Also Called Trumpet Nails)

In this peculiar form, the two lateral edges of the nail have joined distally, giving rise to a circumferential nail [17]. It appears as a tube that may be empty (Fig. 2.20) of filled with keratin material (Fig. 2.21). This form is surprisingly not painful as there is no more ingrowing into the lateral nail folds. However, pressure from the shoe on thickened nail is painful, impairs with footwear and prompts patients to seek medical advice.

Fig. 2.20 Trumpet nail, densely filled with keratin

Fig. 2.21 Trumpet nail, tube-like appearance

Distal Ingrowing

Anterior Embedding

It occurs when the distal edge of the nail unit mounds up forming a distal wall that interferes with the growth of the nail plate (Fig. 2.22). Normally the nail plate counteracts the forces produced by the plantar portion of the hallux during walking. When the nail plate is absent this counterpressure does not exist anymore and consequently the flesh of distal toe heaps up [18].

With time, a hyperkeratosis can appear at the distal edge of the newly growing nail (Fig. 2.22) [19], aggravating the condition. This is a protection from the distal wall against the new stubbing plate. A traction osteophyte, resulting from the heaping up of the distal pulp, may be seen on X-ray at the distal dorsal extremity of the distal phalanx [19]. In some instances, it might be translucent as it is made of

Fig. 2.22 Distal embedding occurring several months after traumatic nail loss. Note the hyperkeratotic edge

fibrocartilaginous tissue. This condition is acquired (after nail avulsion or nail shedding). It is far more frequent on the great toenails from the body weight resting on them and enhancing the condition.

Proximal Ingrowing

Retronychia

The term retronychia, coined in 1999 by de Berker and Rendall [20], derives from the word "retro", latin for backwards and the greek term "onychia", meaning nail. It is characterized by a triad associating: arrest of the growth of the nail plate, proximal paronychia and xanthonychia. The most probable etiology is distal trauma from footwear that pushes the nail back and upwards, so that the proximal margin is above the leading edge of the newly forming nail. As this new nail grows forward, it fails to push the old nail plate distally, but passes beneath it and pushes the old nail further upwards. For some reason the distal edge of the nail plate adheres very firmly to its bed and does not move forward. The newly formed nail grows beneath the old one and gets stuck again distally. Another new nail may grow again beneath the former one and so on. This lifts up the proximal nail fold that becomes inflamed and irritated from the proximal stacked thin sharp nails, resulting in paronychia [21] (Fig. 2.23). With time, a pyogenic granuloma may develop under the proximal nail fold (Fig. 2.24) and the oozing will induce a yellowish discoloration. Another clue for the diagnosis is the shortening of the distal nail bed due to the excessive pressure of the distal plate onto the bed and the lifting of the proximal part of the plate from the successive superposed nails (Fig. 2.25) [22].

It is probably an underestimated condition that mostly affects adults, but may also occur in children, adolescents and young adults [23]. It affects mostly women (>80 %) and the great toenails (>90 %). This confirms the probable role of poorly

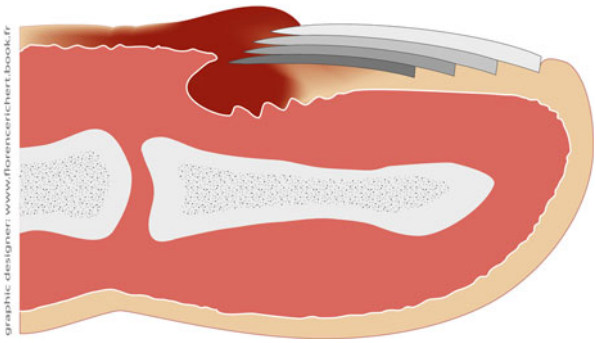

Fig. 2.23 Scheme explaining the origin of harpoon nail. As for some reason the nail gets stuck distally, several newly formed nail plates grow beneath the old one lifting up the proximal nail fold that becomes inflamed and irritated from the proximal stacked thin sharp nails, resulting in paronychia

Fig. 2.24 Typical retronychia with pyogenic granuloma under the proximal nail fold

fitting or narrow footwear for the women cases, but sports where running plays a major role may explain the cases in men. Fingernails may be affected but in this case it always follows an acute injury such as trauma, burns, arthritis, and acute paronychia.

Lateral and Distal Ingrowing

Harpoon Nail

The harpoon nail is a recently described variant of ingrowing toenail, where a spur skewers the distal lateral nail sulcus (Fig. 2.26) [24]. The origin is most probably a constitutional transverse overcurvature responsible for a painful distal corner, which the patient attempts to relieve by clipping the nail into the lateral folds, without reaching the most lateral and deep part of the plate, thus leaving a lateral spur. In some cases, the spur will grow distally and run through the disto-lateral wall to

Fig. 2.25 Shortening of the nail bed is also a clue for diagnosing retronychia. Compare the two great toenails

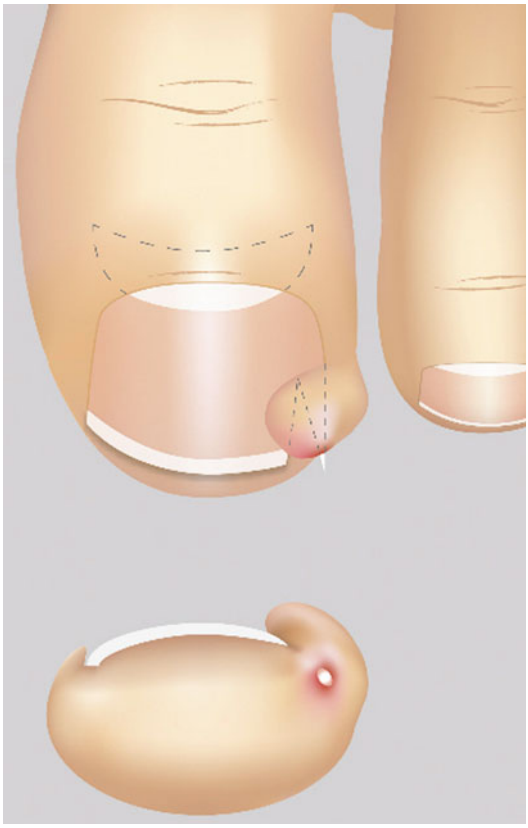

Fig. 2.26 Scheme explaining the origin of harpoon nail: the spur left from incomplete nail trimming grows distally and runs through the distal lateral wall to finally emerge at the hyponychium

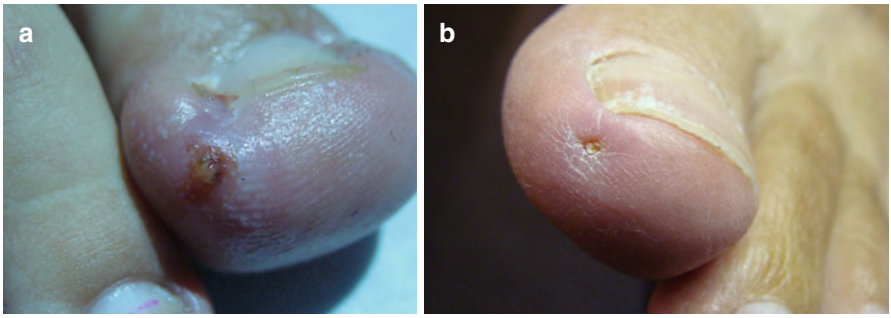

Fig. 2.27 (**a**) Harpoon nail, acute form (**b**) Harpoon nail, chronic form

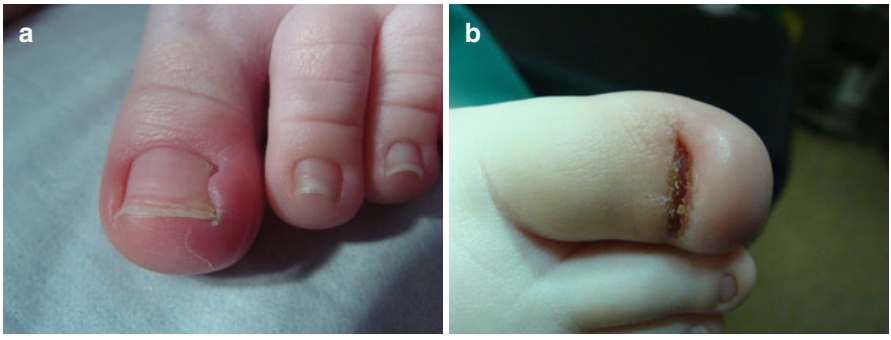

Fig. 2.28 (**a**) Lateral hypertrophic nail fold in a child, very common variant (**b**) Complete covering of the nail plate from a hypertrophic distal wall

finally emerge at the hyponychium, appearing as an erythematous and oozing, sometimes crusted papule in the acute form (Fig. 2.27a). In absence of treatment, the canal containing the spur epithelializes and the inflammation disappears, leading to the chronic form (Fig. 2.27b).

Hypertrophic Lateral and Distal Lip in Infants

Congenital hypertrophy of the lateral nail folds was reported as the most common nail alteration (2.5 %) on a series of 250 toddlers [25]. It mainly happens in big toenails, and manifests as a hypertrophic lip that partially covers the nail plate. The lateral, the medial, the distal or several folds may be involved (Figs. 2.5 and 2.28a–c). The condition may be present at birth or develops shortly thereafter. It has been attributed to an asynchronism between the growth of the nail plate and that of the soft tissues [26].

It is frequently associated with inflammation and moderate to severe pain due to an ingrown nail. The child refuses to wear shoes or socks. The only series on the

follow-up of patients demonstrates a spontaneous or partial improvement in 40 %, no improvement in 30 % and worsening in 30 % of cases [3].

Staging (Severity Index)

The idea for a simple classification is based primarily on the severity and presentation of initial clinical findings. This may guide the clinician to find the best treatment plan. This also may end in an algorithm for the treatment of ingrowing toenail.

Five different severity indexes have been published up to now. They are all based on the same main criteria: erythema, infection, swelling, oozing, hypertrophy of the lateral fold, granulation tissue and pain [27–30], except one which takes care of the shape of the nail plate [31]. The latest classification adds lateral onycholysis as a criteria [30]. Tables 2.1, 2.2, 2.3, 2.4, and 2.5 summarize the different severity indexes.

Staging should be practical and guide the surgeon. For this reason, the authors favour the Heifetz severity index which gives an easy clue for the treatment: for stage I, conservative measures are the first choice treatment, for stage II, procedures narrowing of the nail (including the nail matrix, with or without labiectomy) are recommended and for stage III debulking of the hypertrophic soft tissues should be preferred.

Table 2.1 HEIFETZ severity scoring

Stages	**HEIFETZ** severity index
I	Slight erythema and swelling of the nail grooves in the nail bed (Fig. 2.29a)
II	Presence of an acute infection and suppuration (Fig. 2.29b)
III	Chronic infection, formation of granulation tissue in the nail grooves and hypertrophy of the surrounding tissues (Fig. 2.29c)

Table 2.2 FROST severity scoring

Stages	**FROST** severity index
I	Nails have spurs formation in the lateral nail fold
II	The nail are concave
III	Soft tissue hypertrophy

Table 2.3 MOZENA severity scoring

Stages	**MOZENA** severity index
I	Inflammatory stage: Erythema, mild edema and pain on pressure. The nail is normal
IIa	Infectious stage: Increased pain, oozing and infection, swelling of the lateral fold that extend on the lateral nail <3 mm
IIb	ditto IIa with swelling of the lateral fold that extend on the lateral >3 mm
III	Hypertrophic stage: Granulation tissue and lateral fold extend widely over the lateral nail plate

Table 2.4 MARTINEZ-NOVA severity scoring

Stages	**MARTINEZ NOVA** severity index
I	Inflammatory stage: Erythema, mild edema and pain on pressure. The nail is normal
IIa	Infectious stage: Increased pain, oozing and infection, swelling of the lateral fold that extend on the lateral nail <3 mm
IIb	ditto IIa with swelling of the lateral fold that extend on the lateral >3 mm
III	Hypertrophic stage: Granulation tissue and lateral fold extend widely over the lateral nail plate
IV	Serious hypertrophic stage with chronic deformity of the toenail involving the two lateral and distal folds covering a wide part of the plate

Table 2.5 KLINE severity index

Stages	**KLINE** severity index
I	Local irritation stage: Local irritation of the nail fold without gross infection or granulation tissue, with or without history of onychocryptosis
II	Infectious stage: Infection of the nail border with pus and/or granulation tissue, without history of onychocryptosis
III	Infection of the nail border with the history of more than one episode of onychocryptosis to the affected nail border
IV	Infective onychocryptosis with partial onycholysis of a single nail border
V	Infective onychocryptosis with partial or complete onycholysis of the nail plate and/or nail border involving both nail borders

Fig. 2.29 (**a**) Ingrowing toenail, Heifetz stage I (**b**) Ingrowing toenail, Heifetz stage 2 (**c**) Ingrowing toenail, Heifetz stage 3

However, one should remember that different approaches are always possible in each type and that the surgeon should use the one he considers to be the most adapted to the patient according to his age group, his medical history and his professional activities. He should also decide which technique would suit best according to his/her skills. Sometimes, several types of procedures may be performed on the same ingrowing toenail to obtain best results.

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Chapter 3
Conservative Treatment

Abstract A large number of conservative treatments for ingrown toenails have been described, such as compression, massage of the nail folds, taping, acrylic nails and nail bracing. All of them may help in the treatment of ingrown nails, especially in mild cases and in children. These treatments are lengthy and, when inappropriate, associated with a high recurrence rate.

Keywords Ingrowing nail • Conservative • Nail brace • Taping • Dental floss • Gutter splint • Acrylic resin

Although surgical treatments for ingrown nails have high cure rates, achieve rapid cure, the patient usually fears these techniques. For this reason, a large number of patients will try conservative treatments before seeking surgical advice.

Conservative procedures improve the condition very progressively over weeks and months and may restrict daily activities for a variable period of time. They are mainly indicated when the ingrowing nail is moderate and results from a transitory alteration of the nail plate (improper nail clipping, nail loss…) or when the nail unit has not reached its definitive shape (infants and young children) [1]. Another reason to choose a conservative treatment is severe health alterations (severe vascular impairment of the extremities and uncontrolled diabetes) [2], and the inability to perform post operative care during the healing period [3].

In most cases, conservative treatments are performed in an office without specific equipment or at home and thus are less prone to induce complications compared to surgery.

B. Richert et al., *Management of Ingrowing Nails*,
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Fig 3.1 Hypertrophy of the medial nail folds in a 1 year-old boy

Fig 3.2 Seven years later without any treatment

Abstention

Abstention is an option in very mild cases, especially in newborns, when the lateral hypertrophy of the nail folds is moderate and tends spontaneously to regress over time. It may be difficult to convince the parents not to embark on surgery but to have a wait and see attitude (Figs. 3.1 and 3.2). In children, conservative treatments and antimicrobial ointments, associated or not with systemic antibiotics, give better results than in adults [4].

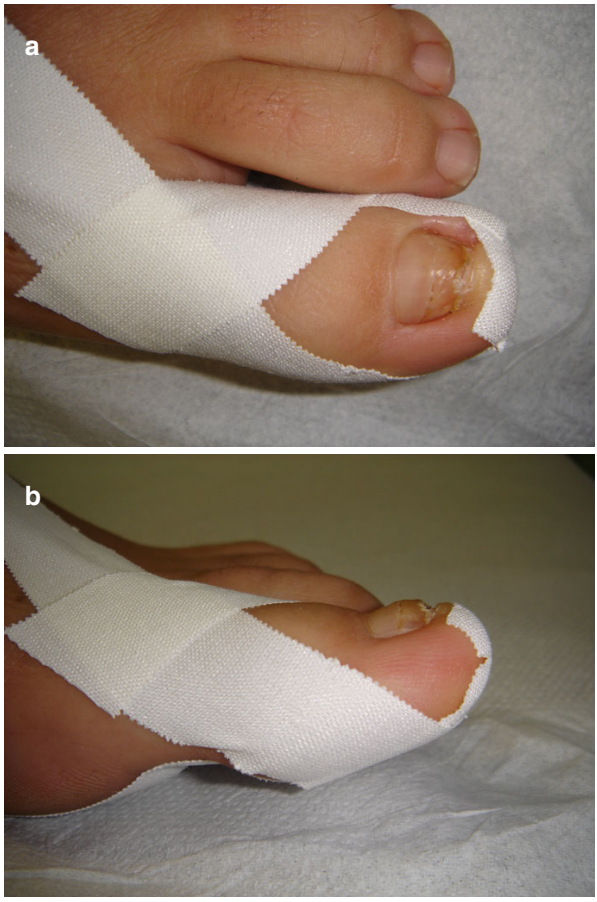

Fig 3.3 (**a**) Lateral and distal ingrowing in a teenager following traumatic nail loss (**b**) Taping laterally and distally

Taping

This technique was first described by Nishioka et al. [5] and later by other authors [3, 6, 7]

Indications

- Mild cases of ingrowing nails (Heifetz 1), any type (lateral, distal, both), on the toenails or fingernails (Fig. 3.3).
- When surgical procedure is not straightaway indicated.

Expectations

- Pulling out enough the lateral nail fold from the offending nail plate to cancel the plate – soft tissue conflict.

Fig 3.4 (**a**) Hypertrophic lateral nail fold in an infant. The black discoloration results from a previous treatment with silver nitrate (**b**): After taping. Note how the lateral fold is pulled away from the plate, taking the black discoloration as a landmark

Material

- Elastic tape (Anchor tape)
- Medical liquid adhesive (e.g. Mastisol®), acetone

Procedure

- The skin of the nail folds and pulp are cleaned up with acetone and adhesive medical liquid (Mastisol®) may be applied to improve the adherence of the tape to the skin.
- An elastic strip of tape, approximately 1.5–2 cm wide and 5 cm long, is pressed onto the offending lateral fold as close as possible to the nail. Once secured on the skin, the band is pulled down and away from the nail, in an oblique and proximal direction over the pulp of the toe without impairing the joint movement and avoiding a circular constriction of the toe.
- A second tape is applied over the beginning of the first one to fix it and exert even more pull on the distal nail fold.
- Several bands may be applied. For bilateral ingrowing, the procedure is repeated on the other side.
- For distal ingrowing (excellent choice for distal embedding following nail loss) the tape is anchored on the distal bed and pulled downwards (Fig. 3.4).

Key Point

- The first limiting factor of this method is being able to achieve a proper taping procedure, meaning that this skill has to be perfectly taught to the patient to have a chance to reach good results.
- Another difficulty is to make sure that the dressing will perfectly adhere to the skin, which can be impeded by transpiration, very common in teenagers, or a large granulation tissue rendering the area wet. Acetone and/or Mastisol® are

therefore mandatory for a better adhesion. If the latter cannot be achieved, another method should be selected.

Post Op Care

- The tape must be changed at least every day, more often twice a day, especially if it gets wet. The pull has to be preserved in any case 24 h a day.

Evolution

- Pain relief occurs rapidly in 2–6 days thanks to the suppression of the conflict between the plate and the lateral fold. A total improvement may be seen after at least 4 weeks, depending on the severity of the affection.

Complications

- Contact dermatitis due to the tape glue (Fig. 3.5)

Author's Point of View

- This technique is indeed suitable in patients who experience a transitory and mildly painful ingrowing nail, such as: improper nail clipping, accidental nail fracture, mild distal embedding after traumatic or surgical avulsion. In these transient cases, taping should be attempted, coupled to the application of steroid cream. Educating the patient is the main issue.
- Duration of this method may appear long for the patient but it allows an easy and stress-free healing.

Acrylic Nails

Acrylic artificial nail (sculptured nail) was described and often used by some Japanese authors [8, 9]. Self-curing formable acrylic resin used in sculptured nails is made by mixing together acrylic powder (acrylic ester polymer) with acrylic liquid (acrylic ester monomer), which can be quickly molded during polymerization

Fig 3.5 Contact allergy to the glue from the adhesive tape

into acrylic artificial nails (sculptured nails) for use as prosthesis and also as a suitable fixation for gutter splints [8].

Alternative false nails include preformed plastic nails and nail gels. Preformed plastic nails (plastic tips, press-on-nails), made of thermoplastic resin ABS (Acrylnitrile Butadiene Styrene) can be used. They are stuck onto the nail surface with cyanoacrylate glue. They can be stuck on the distal half nail to elongate the length of the plate and can be used as a template to support an artificial coating (light-cured gel). Nails gels represent another option to build up a false nail, are made up of a mixture of acrylic monomers and polymers directly provided by the manufacturer. There are mainly two types of gels: acrylic light cured gels and ethyl cyanoacrylate gels. Contrary to acrylic nails, gel nails do not require the use of methacrylic acid as primer, are odourless and easy to apply but they cannot be removed with acetone [9, 10].

Indications

- It is best indicated in distal ingrowing varieties, in order to exert a counter pressure that has disappeared from the nail loss, allowing the distal pulp to heap up.
- Distal-lateral moderate forms secondary to improper nail clipping (oblique trimming of the corners of the plate): the false nail plate applies the necessary pressure in order to prevent the raising of the pulpous or lateral folds soft tissues. Once the natural nail plate has regained a complete adequate shape, the acrylic nail may be removed.

Expectations

- Keeping the normal anatomy of nail unit until full complete nail regrowth
- Covering and protecting the underlying tissues from an upward pressure.

Material

- Acrylic powder (acrylic ester polymer)
- Acrylic liquid (acrylic ester monomer)
- Primer
- Nail template (i.e., negative film)
- Coarse nail file

Procedure

- The nail plate surface is pumiced, disinfected and a metalized paperboard template is placed on and around the natural nail to frame the new nail.
- A primer (methacrylic acid) is painted onto the natural nail. The « primer » acts as a double-sided tape, as it sticks both to the nail and the acrylic. Following this, several layers of the acrylic paste that has just been blended, are applied.
- After hardening at room temperature, which occurs rapidly, the template is removed and the artificial nail is shaped, pumiced, and buffed [9, 10].

Key Point

- The room should be adequately ventilated during the procedure.
- The sculptured nail should be thick enough not to easily fracture and to exert a sufficient counter pressure, but also not too long, in order to impede a lever arm effect that would tear out the nail in case of accidental trauma.

Post Op Care

- Intensive practice of sports should be discouraged
- The false nail should be handled by the podologist, every 2–3 months if necessary for potential touch ups.

Evolution

- Time of the treatment will depend upon the severity of the condition and the length of nail to grow out.
- The evolution is favourable in the majority of the cases and the false nail can be removed once the natural nail has regained an adequate physiological shape. The removal is performed by acetone imbibition (acrylic nails), by drilling or simply by clipping the free edge until elimination.

Complications

- Technical and mechanical hazards may be observed:
  (a) Excessive filing, pumicing and inadequate use of the primer can cause brittleness or thinning of the nail.
  (b) Monomers can be irritative and lead to subungual hyperkeratosis or onycholysis or severe nail dystrophy.
  (c) Excessive shrinkage of gel enhancement products may cause a sensation of nail bed tightness.
- Contamination with germs:
  (a) Can appear if there is a poor adherence, allowing the penetration of water between the artificial and the natural nail. Contamination with Pseudomonas is common, giving rise to a green patch.
- Contact dermatitis may occur:
  (a) Mostly due to acrylate monomers. Eyelids, face or more distant areas may be affected. Cases of occupational allergic asthma and rhinitis have also been described. Toxic hazards are exceptional [9, 10].

Author's Point of View

- The results are usually excellent and only one session is enough in most instances. A skilled podologist is mandatory and hopefully in a close collaboration with the dermatologist or the podiatrist.
- This technique is particularly interesting in the prevention of distal embedding, in improper cutting in the corners (Fig. 3.6a–e), in cases of accidental or post surgical nail loss (retronychia ie) of the big toes. Once the nail plate has regrown up for about 3 months, a false nail can be applied on the new forming nail plate.

Dental Thread/Cotton

The use of dental thread or cotton is a simple method, in which the material is inserted between the nail plate corner and the nail fold. It can be quite painful when first performed, but patients usually report immediate relief. The procedure is

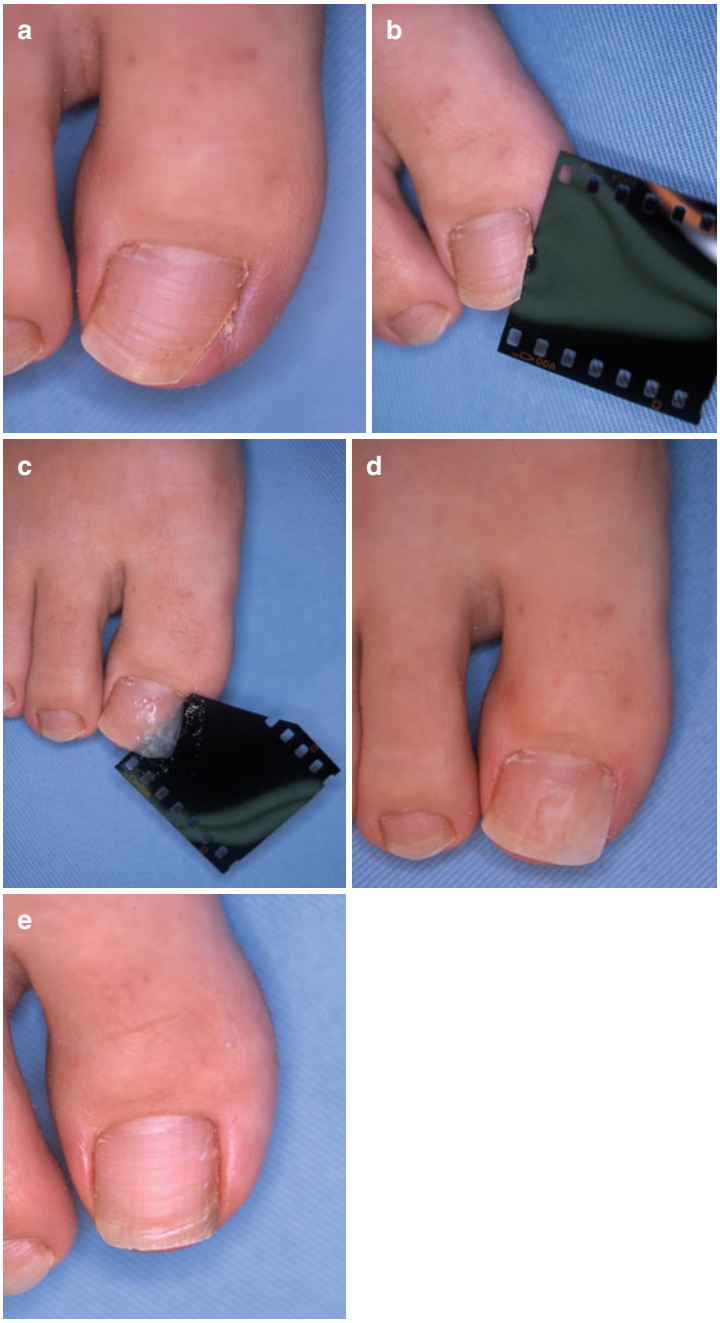

Fig 3.6 (**a**) Moderate ingrowing nail from improper nail clipping in the distal corners of the nail (**b**) a template made from a negative film serves as support for applying the acrylic nail (**c**) acrylic nail spreads to reconstitute the shape of a full normal nail (**d**) immediately after the procedure (**e**) the acrylic nail has grown out and been trimmed away with the nail growth, resulting in a complete normal nail (Courtesy H. Arai, Japan)

repeated on a daily basis, trying to fill, each time, a bit more of the material used. When complete painlessness is achieved and the edge of the nail plate is no longer digging in, the dental thread/ cotton may be fixed with acrylic or cyanoacrylate glue for approximately 1 week. The duration of the treatment is long, but the results in mild cases are good. Consistent post operative care is necessary to avoid recurrences [6, 11, 12].

A recent paper from Mexico used cotton and cyanoacrylate glue in patients with painful stage 1 and 2 onychocryptosis, and considered it as an effective method to treat mild cases. According to the authors, the procedure is easy to perform, inexpensive, allows fast pain improvement and avoids the need for anesthesia and surgery [13] (Fig. 3.7a–d)

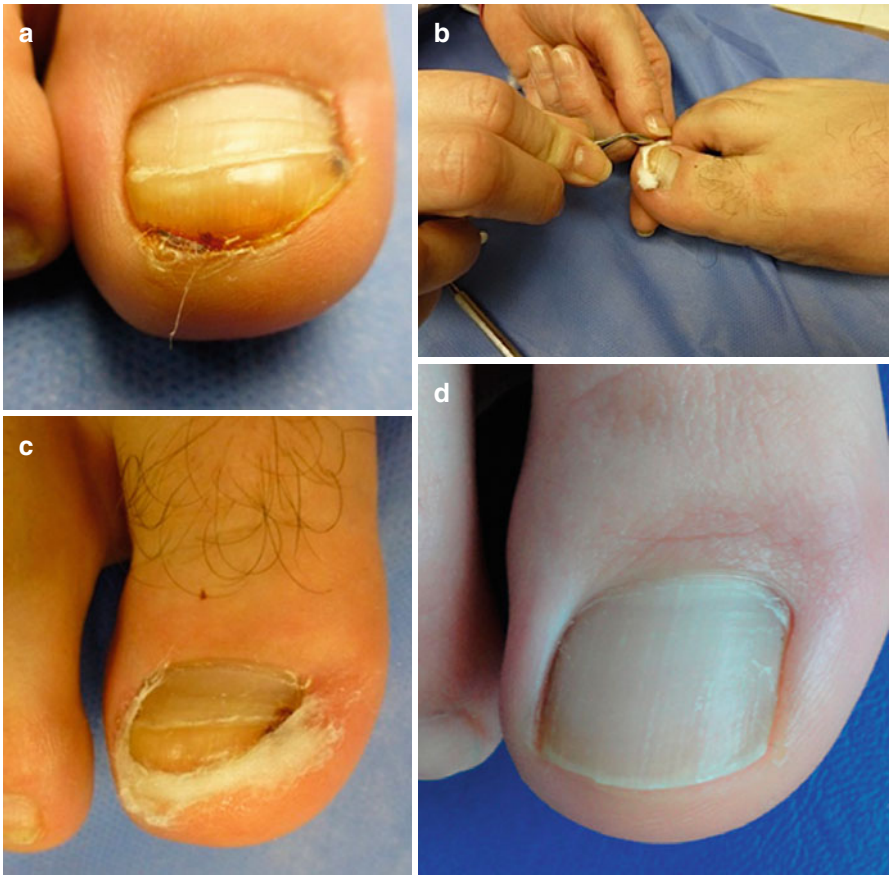

Fig 3.7 (**a**) Lateral and distal ingrowing toenail (**b**) Pushing cotton gauze under the under the lateral and distal nail (**c**) Cotton fixed with "crazy glue" in place (**d**) Outcome after 6 months (Courtesy Domínguez-Cherit, Mexico)

Compression

Compression or massaging the lateral and/or the distal nail folds is useful for the treatment of ingrown nail in newborns or after nail avulsion as a preventive measure. This can be performed using ointments with or without antimicrobial and/or corticosteroids. The results are slow, arising after 1–3 months, depending on the nail plate speed growth [8] (Fig. 3.8a, b)

Some commercial devices consist of a plaster containing a soft cotton roll that should be placed into the lateral sulcus in order to spread out the lateral fold from the nail. This device may be helpful for very minor and transitory forms of ingrowing toenails. Home made similar plasters work the same (Fig. 3.9a–c).

Orthonyxia: Nail Brace Technique

Orthonyxia comes from the Greek 'Orthos' meaning straight and "Onykos" which means nail. These devices, inspired by dental care, especially orthodontia, are aimed to straighten the nail. Nail braces work by gently lifting the sides of the toenail and eventually forcing the nail to grow to a flatter shape over time. Their main indication is transverse overcurvature of the nail [6]. There are two main types of nail braces, adhesive and hooked. Adhesive nail braces are made of a thin strip of composite material that is glued to the surface of the nail. The strip naturally tries to return to a flat state (shape memory alloy) and lifts the edges of the nails during the process. Hooked nail braces consist of a hook (made of dental wire) placed under each side of the plate and upward tensioning occurs from bending the wire in its median part [14–16].

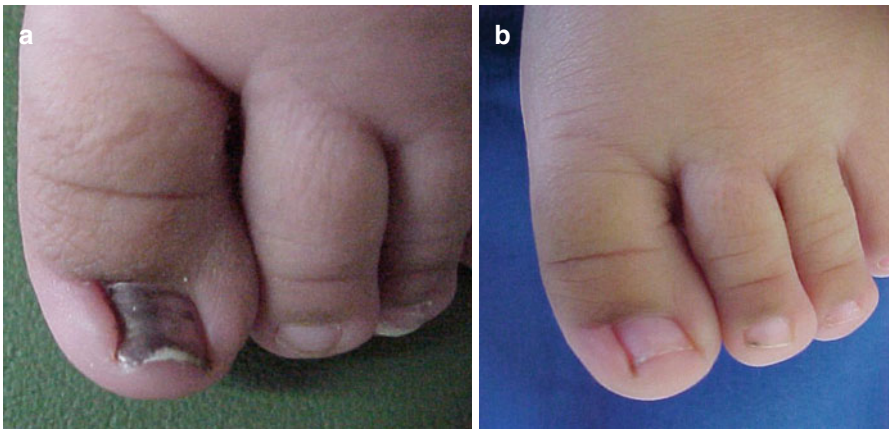

Fig 3.8 (**a**) Hypertrophy of lateral nail fold on the left foot. Massaging with clobetasol cream for several weeks (**b**) Outcome after 6 months

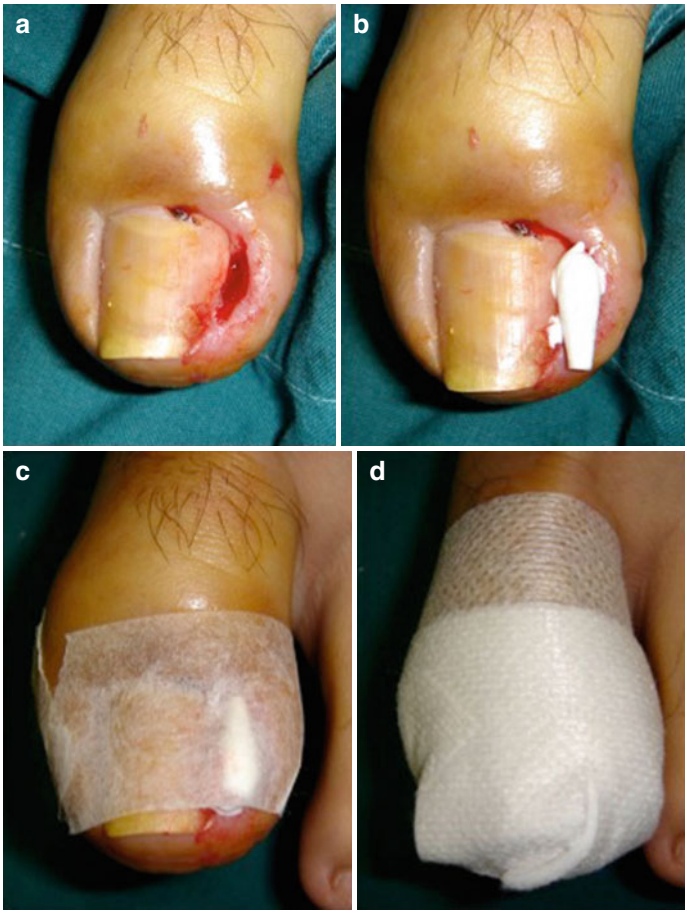

Fig 3.9 (**a**) Curettage of the granulation reveals a very irregular lateral nail edge (**b**) the fold is filled with steroid cream and the tip of a Q-tip is placed into the fold (**c**) an adhesive tape secures the device (**d**) a bulky dressing will exert some moderate pressure. This will be performed on a daily basis until full re-growth of the plate, as the patient did not want any surgery

Nail braces forces were measured in 12 patients with a gauge meter by Erdogan, showing that 600–1000 c Newtons of force were applied with double-string nail braces and extra metal springs. The force increased with the width of the plate [17].

Hook devices are still available in some countries but tend to be replaced by adhesive braces. Adhesive braces are made of a very thin strip of composite material and glued on the dorsum of the nail plate. While flexible, the resilient composite material attempts to return to its natural flat shape and, as a result, gently lifts the sides of the curved nail. This lifting action normally provides relief from the pain within 1–2 days as well as trains the nail to grow flatter over time.

Nail brace application was found to be a safe, simple and inexpensive treatment option for 21 diabetic patients with ingrown toenails in a 2 years follow-up study, with a recurrent rate reaching 28.6 % [18].

More recently, shape memory alloys have been developed, made of titanium or copper-aluminium-manganese [19, 20] and fixed thanks to a photopolymerisation process. To date, there is neither strong evidence-based medicine nor abundant comparative data about the efficiency between the different techniques of orthonyxia.

Some studies compared surgical treatment of ingrowing toenail to orthonyxia. It's just like comparing a plaster cast to nailing for bone fracture!!! The indications are not the same! Of course, they showed that nail bracing is an appropriate alternative to surgery with high patient satisfaction and shorter recovery times, less post operative morbidity and greater patient satisfaction [21, 22].

Indications

- Transverse overcurvature (pincer nail) and mild cases of ingrowing toenail without granulation tissue.

Expectations

- Pain relief with progressive flattening the nail plate.

Material

- Plastic band of different sizes
- Liquid cyanoacrylate glue
- Sandpapers
- Spatulas

Procedure for Plastic Braces (Fig. 3.10a–e)

- Acetone is rubbed on the nail plate to remove the grease and remnants of lacquers. A light abrasion is performed to increase adhesion to the plastic band.
- The best fitting plastic band is selected and a thin layer of glue is applied on the distal half portion of the nail plate.
- The plastic band is fixed with acrylic glue on the nail plate about 3 mm from the free edge, matching its larger axis with the transverse axis of the nail.
- The edges of the device are gently pumiced to allow a smooth surface.

Key Point

- The length of the band should be selected adequately and should be able to cover the whole plate width.
- Do not apply too much glue.
- Try not to use your fingers to fix the plastic band, as they may get glued on the plate! Use thin metallic tools.

Fig 3.10 (**a**) Plastic band (**b**) Pincer nail with marked transverse overcurvature (**c**) Filing the nail plate to increase adhesion (**d**) Cyanoacrylate glue on the nail surface (**e**) Pressing the plastic band onto the nail plate after the procedure (**f**)

Post-op Care

- Patients are advised to avoid the use of enamel and solvents as it may detach the device.
- The devices should be replaced every 1–2 months, as the curvature decreases.

Evolution

- Pain improves usually after 1–3 weeks while the improvement of the transverse curvature appears after 3–6 months (Fig. 3.11a, b).

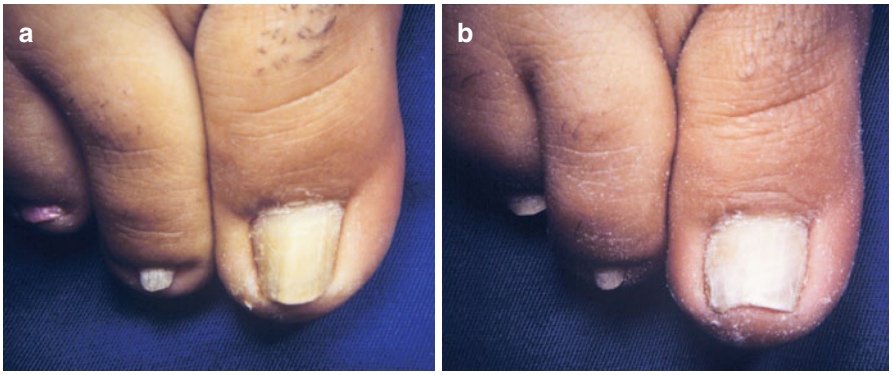

Fig 3.11 (**a**) Pincer nail with marked transverse overcurvature, before treatment (**b**) after 6 months

Complications

- The procedure is almost completely free of complications. Cyanoacrylate glue may cause allergic and/or irritative contact dermatitis.

Author's Point of View

- Hooked braces should not be used anymore, as their placement under the lateral edges of the plate is painful. Adhesive braces are very comfortable to place.
- These procedures work nicely but long term-recurrence is the rule [16].

Nail Tube Splinting (Sleeve Technique)

Nail tube splinting or Sleeve technique consists in using a sterilized plastic gutter, similar to a vinyl intravenous drip infusion tube, to separate the lateral nail folds from the nail plate. It is indicated for the treatment of acute and chronic ingrowing nails, especially those with granulation tissue [8]. A digital nerve block/local anesthesia should be performed before the procedure. The distal nail edge or the nail spicule is held and elevated with mosquito forceps, exposing the ingrowing part of the nail, which is then separated from the nail bed, unfolded and lifted out from the tissue in which it is buried. The lateral margin of the nail plate is detached from the nail bed and then splinted with the lengthwise-incised plastic gutter. The gutter can be fixed with adhesive tape, absorbable sutures or an acrylic resin. It is left in place for a few weeks or months, depending on the time required for the normal nail to grow over the tip of the toe (Fig. 3.12a–f). The technique has the advantage to preserve the matrix and has been reported to be highly effective in one study by Schulte *et al.*, with no recurrences reported in 62 patients who underwent the procedure [23].

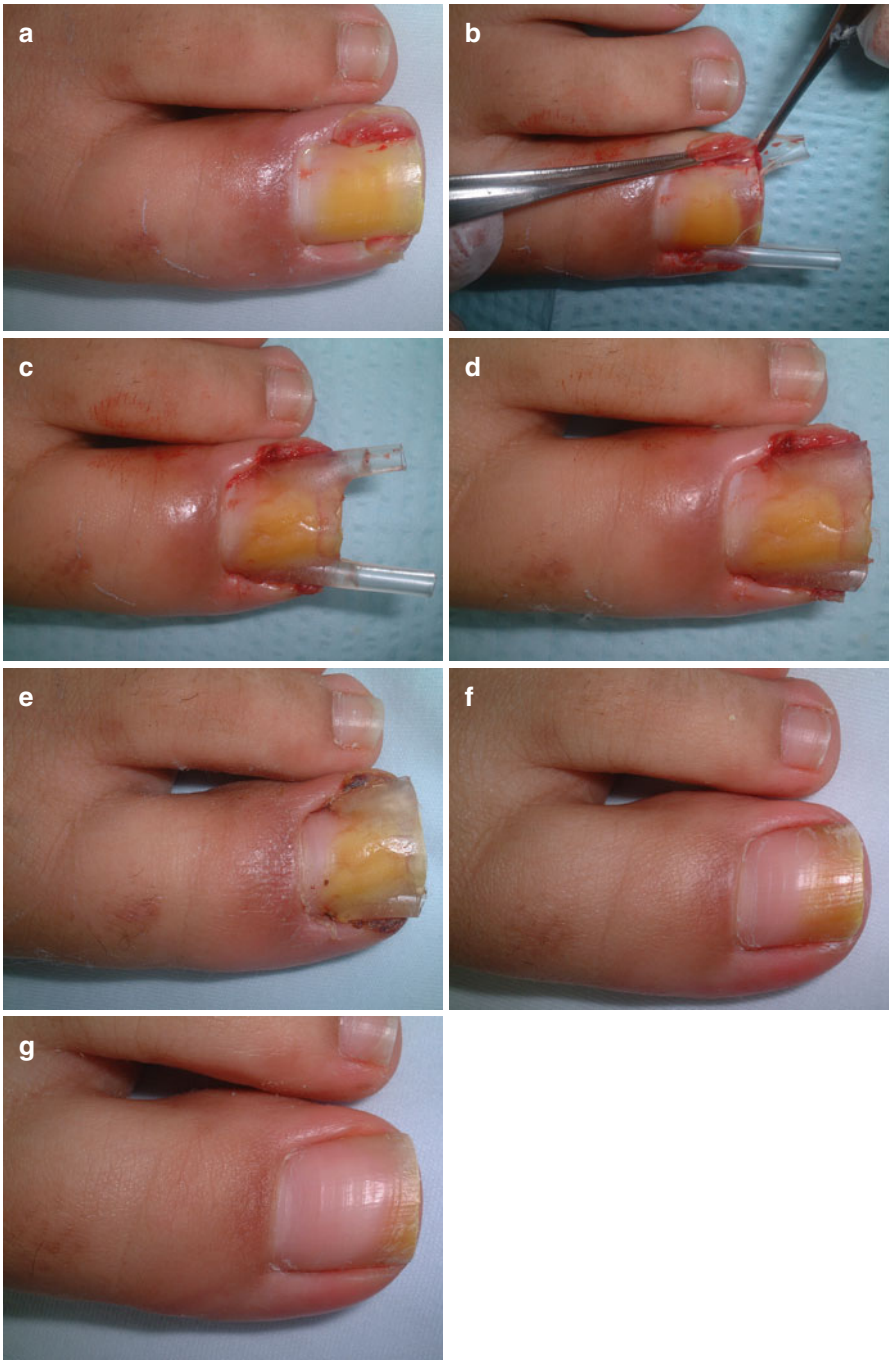

Fig 3.12 (**a**) Lateral ingrowing from improper nail clipping (**b**, **c**) after detachment of the lateral part of the nail from its bed, the plastic tube is split and slid on the lateral edge of the nail (**d**, **e**) the gutter splint is secured with acrylic resin (**f**) Final result after cutting the excess of tube (**g**) Aspect 6 month later (Courtesy H. Arai, Japan)

Matsumoto et al. recently reported a novel splint made of resin attached to the lateral edge of the nail using a bandage with average application duration of 9.3 months. All patients experienced pain relief within a week of splint application and a decrease in the degree of nail deformity. An average follow-up period of 10 months revealed a recurrence rate of 8.2 % [24].

Arai *et al.* compared several conservative techniques on a total of 541 cases and concluded that acrylic treatment with gutter splint and sculptured nail was superior to adhesive tape-attached gutter splint and other conservative modalities [8].

Miscellaneous

Several topical treatments may be used to alleviate pain from ingrowing toenails. When there is considerable swelling and reddening of the hypertrophic lip topical treatment with steroids is useful to reduce inflammation and may even produce persistent remission in toddlers [25]. The authors use it in routine, in a form combined with antibiotic (fusidic acid + betamethasone valerate), under occlusion, only during night time. This allows decreasing periungual inflammation and a rapid improvement in less than 10 days, permitting to operate in optimal conditions

Recently, an Italian team thought to evaluate the effect of topical propranolol on granulation tissue in ingrowing toenails considering its effect on haemangiomas. Unfortunately, they could not prove any benefit of this drug on pyogenic granuloma associated with ingrowing toenails [26].

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Chapter 4
Surgical Treatment

Abstract For decades, every year sees a wide number of articles in the podiatry, dermatology, general, and orthopedic literature about treatment of ingrown toenails. There is still a debate about the cause of ingrowing toenails. Some are convinced that the nail is responsible for the condition and thus will intervene on the plate itself; others are prone to the idea that the periungual soft tissues are at fault and favor a surgical procedure on them. The literature offers numerous studies showing the superiority of one technique over another, but none of them showed that the procedure is performed on the same type of ingrowing toenails. Many studies are open, non-randomized with short follow-up. Despite various trials, there is disagreement on which procedures give the most consistent results. Some do not hesitate to compare a conservative technique with an aggressive radical surgical procedure. And of course, comparing a surgical procedure you are used to, to another one with which you are not familiar, will skew the final results. One should also remember that mostly all surgical procedures are operator dependent, and that very easy ones to perform will certainly get higher success rates. There is indeed a no "cureall" technique for ingrowing toenails, but mainly two different approaches: narrowing the plate or debulking of soft tissues. Both excellent, as long as they are performed in appropriate cases. One should carefully examine each patient's toe and decide which technique would suit best according to his/her skills. Sometimes, several types of procedures may be performed on the same ingrowing toenail to obtain best results. All procedures cited in this chapter have high cure rates as long as they are properly performed.

Keywords Ingrowing nail • Surgery • Debulking • Chemical cautery • Pincer nail

Avulsion

Nail avulsion consists in surgically removing the nail plate, partially or totally. This technique has been widely misused for the treatment of lateral ingrowing nails, with an unacceptable recurrence rate, together with high post operative pain and risk of nail dystrophy [1]. As soon as 1979, Palmer and Jones discouraged this procedure as a routine practice, after demonstrating that, out of 208 operated patients, partial

B. Richert et al., *Management of Ingrowing Nails*,
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and total avulsion led to respectively, 83 and 70 % recurrence rates. Except for the treatment of retronychia [2], avulsion is a useless and harmful procedure for the treatment of ingrowing nail [1].

Nail avulsion can be performed either by a distal or a proximal approach. Only the latter will be developed, as it is the only suitable surgical procedure for retronychia, due to distal abnormal adherences between the nail plate and its bed [3].

Indications
Treatment of retronychia.

Expectations
Normal regrowth of the nail plate.

Material
Basic nail ingrowing surgery tray, hemostatic solution (aluminium chloride 35 %).

Procedure
The proximal nail fold (PNF) is detached on its whole width, using anterior and posterior motions of the elevator (Fig. 4.1a). The elevator then reflects the PNF and is delicately inserted under the base of the nail plate where adherence to the matrix is weak. This is the most delicate motion of the procedure, which has to be repeated along the whole width of the plate (Fig. 4.1b). The avulsion progresses distally following the natural cleavage plane, until the nail plate is detached from the entire width of the nail bed (Fig. 4.1c). The nail plate is elevated or grasped with a sturdy hemostat, and its last distal subungual attachments are freed with scissors [4]. The surgeon must remove all successive nail plates [3] until reaching the matrix, which appears as a whitish opalescent structure and without hurting it. Compression for 10–20 s, with cotton-tipped applicators dipped into hemostatic solution suffices to stop any bleeding (Fig. 4.1d) [4].

Key Point

- Inserting the elevator proximally and finding a cleavage plane without hurting the underlying matrix.
- Removing all newly formed nail plates.

Post-op Care

- Pain: moderate.
- Greasy antiseptic dressings until complete healing.

Evolution

- Healing takes between 14 and 21 days.
- A complete regrowth of the nail is obtained in 12–18 months (Fig. 4.2a, b).

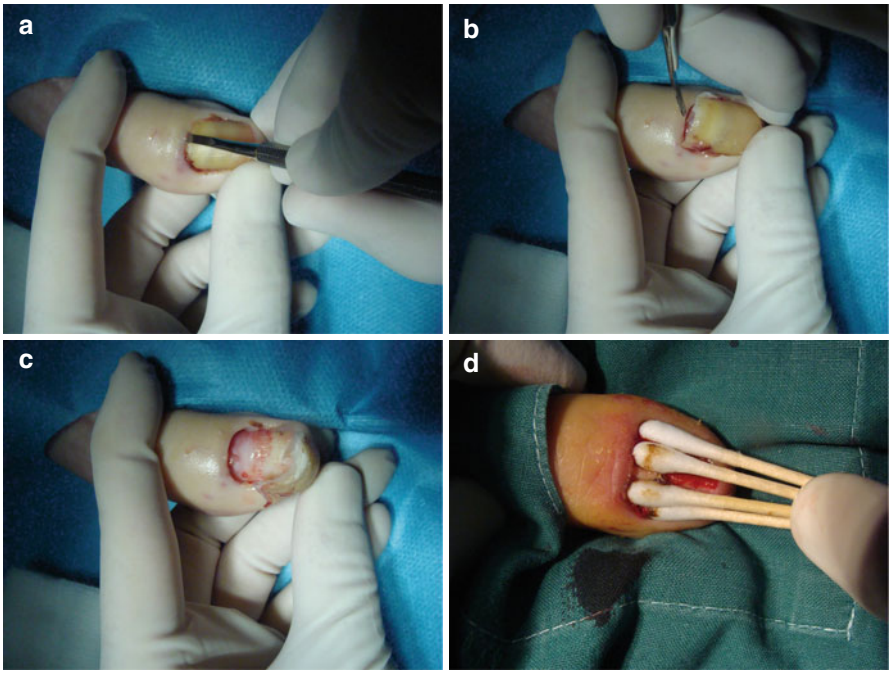


Fig. 4.1 (**a**) The elevator detaches the proximal nail fold from the nail plate, with repeated back and forth motions (**b**) the elevator is inserted under the base of the plate (proximal avulsion); be cautious not to hurt the underlying matrix (**c**) the avulsion progresses proximal to distal until complete detachment of the plate (**d**) cotton-tipped applicators dipped into aluminium chloride suffice to stop any bleeding

Fig. 4.2 (**a**) Retronychia (**b**) 1 year after simple proximal avulsion (patient from Fig. 4.1a, b)

Complications

- Loss of counter pressure induced by the disappearance of the nail plate allows dorsal dislocation of the distal pulp and may promote distal embedding with a subsequent hyperkeratotic reaction (impacted nail). In mild cases, conservative measures include the reduction of the hyperkeratosis in front of the distal nail by using 50 % urea occlusive dressing at night, allowing debridement of the hyperkeratosis with a blade, and massaging back in a distal-plantar direction. Consistent taping is also a very valuable alternative. If there is severe pain, then surgery is mandatory to free the distal edge of the plate (see p. 97). As prevention of such a complication, an acrylic nail may be affixed to the new growing nail when it has reached one-third of its length. However, the upward force exerted by the pulp during gait often detaches the artificial nail.
- Injuring the matrix or destroy the distal nail bed during the proximal avulsion with subsequent nail dystrophy or onycholysis.
- Nail dystrophy may be observed in about 30 % of patients. The nail is thickened and yellowish and grows very slowly [5].

Author's Point of View

- It is astonishing to see how many surgeons still believe that simple nail avulsion (even repeated) is the first treatment option of ingrowing toenail.
- And on the contrary, retronychia is considered as an infection whereas avulsion is curative in this condition!

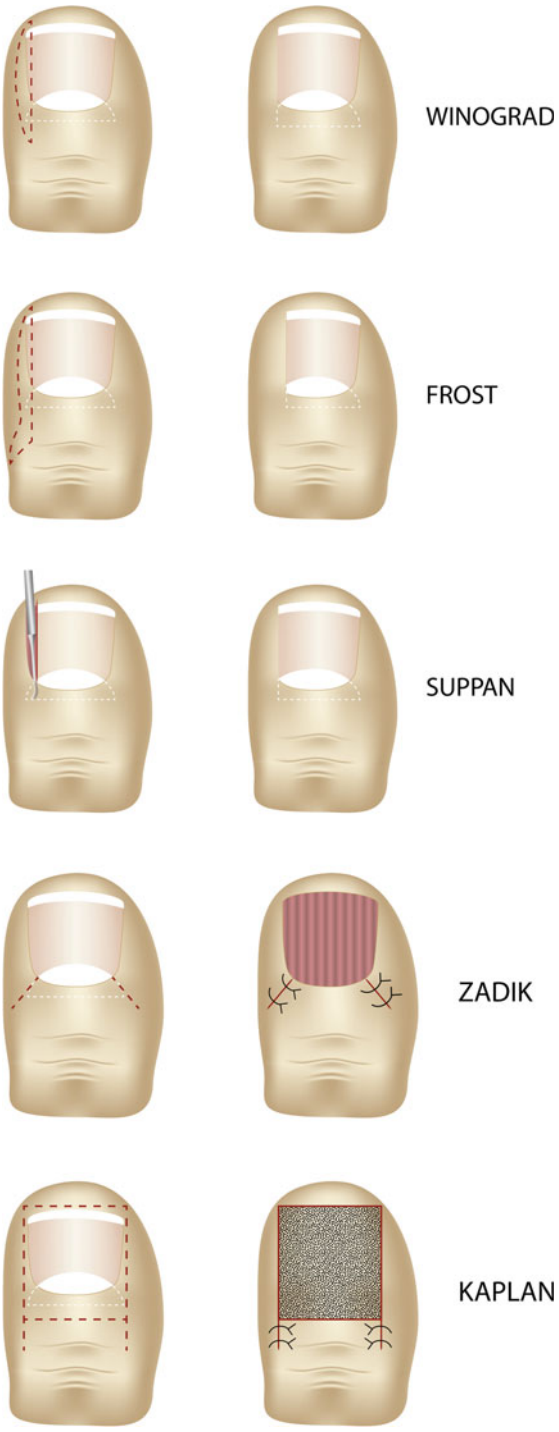
Surgical Resection of the Matrix Horns

Classical Wedge Resection

Partial and total cold steel matricectomies are various and numerous. In the literature, the reader will find the names of Winograd, Zadik, Suppan, Frost, Kaplan and Syme. They are all surgical matricectomies developed for ingrowing nails [6]. A summary of the procedures is listed below and Table 4.1 represents the procedures schematically:

- **Winograd**'s procedure is a partial matricectomy and involves a "D"-shaped excision, removing at the same time the lateral part of the matrix and a portion of the lateral wall.
- **Frost**'s procedure, one of the older "sharp" partial matricectomy procedures, involves an "L"-shaped incision, allowing reclining the proximal fold to expose and excise the nail matrix selectively.
- **Suppan**'s procedure associates the avulsion of a lateral strip of nail with curettage of matrix horn and bed exposed. It is a partial matricectomy.
- **Zadik**'s procedure is also a complete matricectomy. Two incisions at 45° are performed at the junction proximal lateral nail folds allowing reclining the proximal nail fold and exposing the whole matrix area. The latter is excised with the blade and the proximal nail fold is put back in place and sutured.

Table 4.1 Schematic representation of the various partial and total cold steel matricectomies



- **Kaplan**'s procedure involves an "H"-shaped incision allowing complete removal of both the nail matrix and nail bed. This is a complete matricectomy that is almost abandoned, even for removal of tumours. It was formerly indicated for onychogryphosis or permanent nail dystrophy. Now the preference goes to chemical cautery which is much less aggressive and much more comfortable for the patients.
- **Syme**'s procedure, also called the terminal Syme operation is basically an amputation of the tip of the toe. It has nowadays no indication ever in the treatment of ingrowing toenails.

In Germany, the "Emmert plasty" is still the intervention most commonly performed by surgeons for the treatment of ingrown nails [7]. In Germany and Switzerland, it is called the Kocher's surgery, although Kocher had explicitly warned against this method! [1]. Emmert, a Bernese surgeon, proposed the wedge excision of the lateral nail wall, groove, adjacent nail and corresponding matrix [8], which is in fact the method first described by the French military surgeon Baudens (from the Val de Grâce) in 1850 [9], which is indeed a…. Winograd's procedure!

Indications

- When both narrowing the nail plate along with removal of hypertrophic lateral nail fold is needed.
- The procedure is identical to the one used in lateral longitudinal biopsy for lateral longitudinal melanonychias and inflammatory diseases.

Expectations

This procedure works at the same time on the matrix and surrounding tissues. As there are stitches, fast healing is expected.

Material

Full ingrowing nail surgery tray

Procedure

- To facilitate the resection of soft tissue, the procedure starts with the avulsion of a 2–3 mm wide lateral strip of nail plate (Fig. 4.3a, b). The later is detached from its bed and from the PNF using an elevator and cut longitudinally with a nail clipper.
- An incision is carried out starting at the hyponychium with the blade sticking vertically to the lateral part of the clipped nail, and progresses proximally along the bed and through the PNF until it reaches a point halfway between the cuticle and distal interphalangeal crease. The incision then takes on a laterally curved direction (Fig. 4.3b). It is extended until the most lateral part of the nail plate is visualized [1].
- Bone contact is mandatory all time.
- The second incision starts at the same point and extends laterally through the lateral fold, removing the excess tissue, parallels the first incision and curves laterally at the most proximal part to ensure section of the lateral horn of the matrix to meet the end point of the first incision.
- The wedge of tissue is then removed distally to proximally, sticking to the bone, working with fine-tipped curved scissors "tips down" or with a No. 64 Beaver blade shaving the periosteum (Fig. 4.3c).

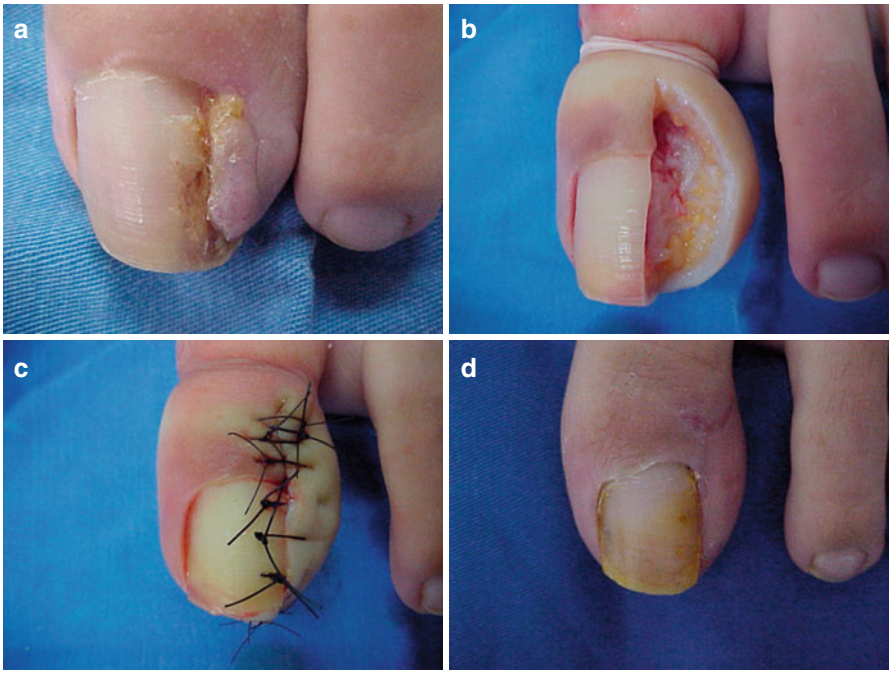


Fig. 4.3 (**a**) Ingrown toenail with pyogenic granuloma (grade III – Heifetz). (**b**) Removal of a lateral portion of nail, bed and matrix (Winograd's procedure) with curving the incision proximally to ensure complete removal of the lateral horn of the matrix (**c**) Immediately after suturing the defect. (**d**) Aspect four months post operatively

- Proximal nail fold and hyponychium are closed with single suture using nylon 4-0. Half-buried horizontal mattress sutures from the lateral nail fold through the nail plate are best to re-create the lateral fold.

Key Point

- Avulsing the lateral part of nail eases greatly the medial incision through nail bed and nail matrix.
- Extending the incision proximally enough and curving proximally ensures to remove of the lateral horn of the matrix, otherwise recurrence is expected.
- Always check that there are no remnants of matrix left. If any structure looks suspicious, remove it with scissors.

Post Op Care

- Antiseptic ointment is applied on the surgical wound and covered with non-adherent gauze and a bulky dressing.
- Potent painkillers should be prescribed, as the procedure is very painful, due to trauma to the periosteum and traction from the stitches.
- Removal of the dressing is done after 1 day, as bleeding may occur. The wound is soaked into an antiseptic footbath until removal of all clotted blood, pad dry and covered with a greasy ointment. This procedure should be repeated twice per day at home until removal of the stitches, 2–3 weeks post op.

Evolution

- Healing is fast. However, pain from surgery may remain for up to 3 weeks and may impair footwear. The patient should be checked after 2–3 months to verify that there is no recurrence (Fig. 4.3d).

Complications

- Infection is the most common complication, especially in patients not doing proper home cares (Fig. 5.3). This may be also observed when surgery is performed on a non-clinically visible infected area. Systemic antibiotics are indicated. Infection may lead to suture's dehiscence.
- Incomplete removal of nail matrix tissue will result in recurrence, spicules or nail inclusion. Epidermal cyst may occur from the inclusion of epidermal cells during incision or suturing.

Author's Point of View

- This technique is the choice of all orthopedic surgeons and some rare dermatologists. Post operative period is very painful and daily activities are compromised by at least 2 weeks. Walking with crutches is necessary for the first days.
- There is no evidence that the recurrence rate of the wedge technique is lower than the nail matrix phenolization [10, 11].

Curettage of the Matrix

It is very rarely used as the sole treatment for ingrowing toenail. After avulsion of a lateral strip of nail, the proximal cavity containing the lateral horn of the matrix is curetted. There is no post operative oozing as observed with chemical cautery.

One paper only compares curettage to electrocauterization. Recurrence rates were considered low in both groups, showing that curettage is as effective as electrocauterization [12]. Some surgeons advocate to curette the matrix before phenolization. A study comparing phenolization with or without prior curettage demonstrated that there was no statistically significant difference between the two techniques [13]. On another hand, it has been clearly demonstrated that removal of all modified tissue immediately after phenolization, either with a gentle curettage or using a blade, dramatically shortens the oozing time from chemical matricectomy [14].

Indications

- Mild cases of ingrowing nails without hypertrophic tissue (Fig. 4.4a).

Expectations

- Narrowing of the nail plate permanently.

Material

- Basic ingrowing nail surgery tray.

Procedure

- A lateral strip of the nail plate is detached from proximal nail fold, lateral nail fold and nail bed, using a nail elevator (Fig. 4.4b, c). Particular attention should be given to fully free the proximal lateral horn from the plate.
- The nail plate is split using scissors or nail nippers up to it most proximal edge under the proximal nail fold (Fig. 4.4d). The strip of plate is removed with a sturdy hemostat or with an elevator (Fig. 4.4e). Be sure to remove the strip of nail up to its most proximal attachments.
- The nail bed, nail matrix, and lateral nail fold are vigorously curetted until complete removal (Fig. 4.4f).

Key Point

- The most proximal attachments of the lateral strip of nail should be completely removed.
- Curettage should be aggressive enough to remove the nail matrix, but should not hurt the underlying periosteum or bone.

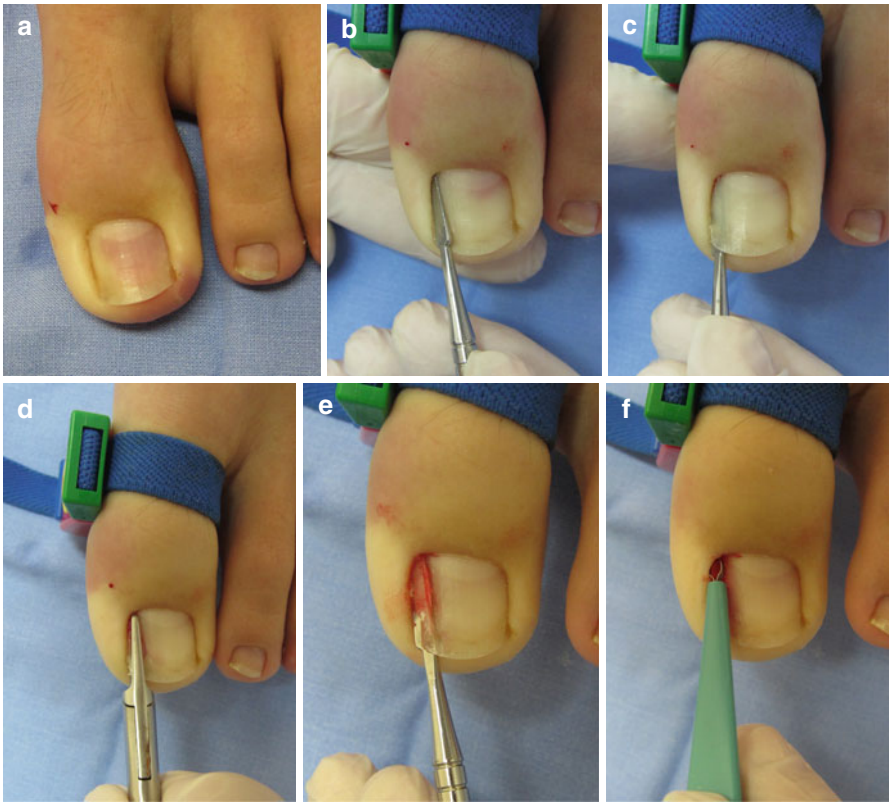


Fig. 4.4 (**a**) Mild case of ingrowing nail (grade I – Heifetz). Bleaching results from the distal digital block (**b**) detaching the lateral nail plate from the lateral nail fold (**c**) detaching the lateral nail plate from the nail bed (**d**) a nail plate strip is cut from the free edge to the matrix (**e**) the nail plate strip is easily avulsed (**f**) nail matrix and bed are vigorously curetted

Post Op Care
- Antiseptic ointment is applied on the surgical wound and covered with non-adherent gauze and a bulky dressing.
- Potent pain-killers should be prescribed.
- Removal of the dressing is done after 1 day. The wound is soaked into an antiseptic footbath until removal of all clotted blood, pad dry and covered with a greasy ointment. This procedure should be repeated twice per day at home until complete healing.

Evolution
- Healing is fast – about 2 weeks.
- Pain is the rule from the injury to the periosteum.

Complications
- Complications are uncommon.
- Recurrence may occur if nail matrix removal is incomplete.

Author's Point of View
- Curettage of nail matrix is extremely difficult because the matrix has an elastic consistence and smooth surface. The procedure almost invariably induces periostitis (as well as electrocautery).
- There are no sufficient studies with long-term follow up to prove any efficacy of this technique. The authors highly recommend against this procedure.

Physical Destruction of the Matrix Horns

Electrosurgery

Electrosurgery uses the electricity to cause thermal tissue destruction, most commonly in the form of tissue dehydration, coagulation, or vaporization. It can be divided into four types based on their mechanism of tissue damage: electrolysis, coblation, high-frequency electrosurgery and electrocautery. Electrocautery uses low-voltage, high-amperage, direct or alternating current to heat a surgical tip causing tissue desiccation, coagulation or necrosis by direct heat transference to tissue. It is compatible with patients who may not tolerate current flow, for example those with an implantable cardiac pacemaker or defibrillator. Most destruction with electrocautery occurs close to the heating element, and is thus more readily seen and controlled compared to electrosurgery. Histologically, this results in amorphous tissue with charred foci and formation of steam spaces [15–17].

Instead of surgical dissection of the matrix horn, electrocauterization may be used. After local anesthesia, a lateral strip of nail is removed and the lateral matrix horn is exposed. Electrocauterization of the matrix is performed in a bloodless field. The power setting depends on personal experience. No matrix horn should remains. As a lot of heat is delivered, a thermal periostitis with long-term post operative pain, long

healing time and nail dystrophy is potentially likely [1, 18]. Electrocautery is a safe procedure, when performed by a trained surgeon and has high success rate, but does not offer any advantages compared to other matrix ablation techniques [12, 19–21].

Indications, expectations, material, post op cares and complications are the ones described below for laser matricectomy.

Radiocautery

Radiocautery is a term used to describe a high-frequency electrosurgery. It uses tissue resistance to the passage of high-frequency alternating current to convert electric energy to heat, resulting in thermal tissue damage. Heat generation occurs within the tissue, while the treatment electrode remains 'cold'. This makes radiofrequency more selective and reduces heat generation thus producing only a very narrow margin of thermal tissue destruction, accelerating wound healing and improving scarring [22]. Radiosurgery should not be performed in patients with cardiac pacemakers.

The surgical procedure is identical to the one for electrocautery. The spade-like electrode is rubbed onto the lateral horn of the matrix after avulsion of a lateral strip of nail. Special insulated electrodes are designed for the treatment of ingrowing toenail with radiosurgery. The electrode is flexible and coated for protection of the upper tissue (ventral part of the proximal nail fold) while it destroys the underlying matrix layers (Fig. 4.5). This makes the radiofrequency machine virtually as versatile as the CO_2 laser at a much lower cost [23].

Indications, expectations, material, post op cares and complications are the ones described below for laser matricectomy.

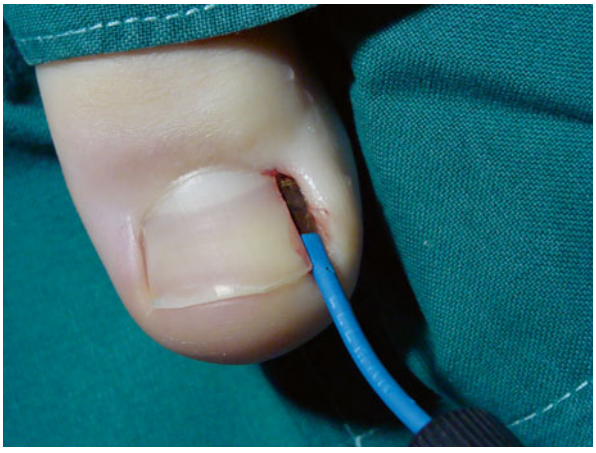


Fig. 4.5 Spade-like coated and insulated bending electrode used in radiosurgery for the destruction of the lateral horn of the matrix

Laser

Laser treatment has been widely described for the treatment of ingrowing nails since 1983 [24], using ablative lasers, CO_2 in the vast majority of cases [25–27], exceptionally Er:YAG [28].

Indications
- Mild cases of ingrowing nails without or with little hypertrophic tissues.

Expectations
- Narrowing of the nail plate permanently.

Material
- Basic ingrowing nail surgery tray.

Procedure
- The area of matrix to be vaporized needs to be exposed. For this, most authors advocate either to retract the proximal nail fold with a hook or perform a lateral oblique incision allowing full exposure of the lateral horn of the matrix (Fig. 4.6a).
- The exposed lateral matrix is dried from any blood.
- The latter is vaporized with carbon dioxide laser [29–31]. Power depends on the machine used and personal experience (Fig. 4.6b).
- Ozawa et al. used methylene blue staining to better estimate the degree of lateral matrix ablation [32]. Another technique consisted in a wide vaporization to an area equivalent of a wedge excision, down to the bone, leaving a defect that was finally sutured [33].

Key Point
- Vaporization should be aggressive enough to remove the nail matrix, but should not hurt the underlying periosteum or bone.

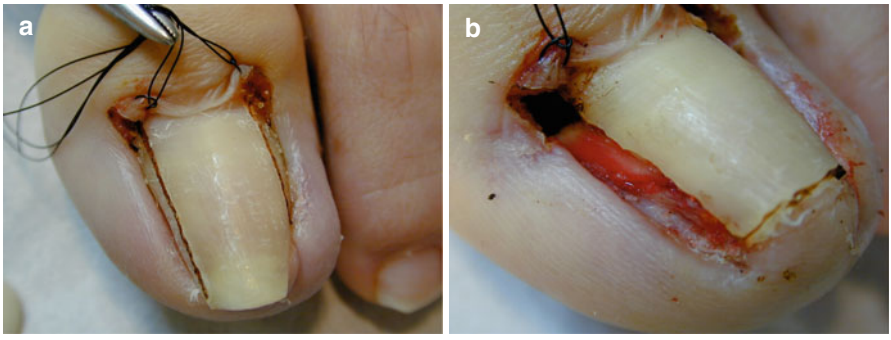


Fig 4.6 (**a**) Two lateral strips of nail are avulsed using the cutting mode (**b**) after avulsion and partial retraction of the proximal nail fold, the matrix is vaporized (Courtesy E. Duhard, Tours, France)

Post Op Care

- Antiseptic ointment is applied on the surgical wound and covered with non-adherent gauze and a bulky dressing.
- Potent pain killers should be prescribed.
- Removal of the dressing is done after 1 day. The wound is soaked into an antiseptic footbath until removal of all clotted blood, pad dry and covered with a greasy ointment. This procedure should be repeated twice per day at home until complete healing.

Evolution

- Most authors emphasized the haemostatic effect and reported minimal pain, quick healing time and good cosmetic outcome [33–36].

Complications

- Complications are uncommon.
- Recurrence may occur if nail matrix removal is incomplete. Recurrence rates were inconstant, varying from 1.45 [37] to 50 % [38]. Orenstein et al. showed that additional vaporization of the lateral nail fold dropped the recurrence rate from 37.5 to 6.2 % compared to the sole partial matricectomy with carbon-dioxide laser [39]. Spicules rates, when reported, reached 5 % [33].

Author's Point of View

- For the authors, carbon dioxide laser for ingrowing nails is poorly evidenced based and has never shown any superiority to the "gold standard treatment" that is chemical cautery.
- The procedure is highly operator-dependant. Best results are obtained with skilled laser surgeons who definitely know the precise anatomic location of the matrix and have an excellent knowledge of their laser device.
- Its main advantage is that it is a "clean" procedure, almost bloodless. A local block is required, as in any surgical procedure.
- Complications are rare, unless a too powerful and deep vaporization was done leading to a painful periostitis.

Chemical Destruction of the Matrix Horns

Phenol 88 %

Nail matrix phenolization is a half a century old technique [40] and it has become more and more popular these last decades among dermatologists and podiatrists. Three consecutive Cochrane studies [41–43] demonstrated that phenolization was the most effective technique for definitive treatment in terms of morbidity and success rate, compared with other excisional surgical procedures, in preventing recurrence at 6 months or more. The preference from nails doctors for this procedure is due to its low morbidity, high success rate when compared with other excisional surgical techniques, besides being very easy, fast and cheap (Table 4.2) [31, 48, 49, 52].

Table 4.2 Largest series published on phenolization with duration of follow-up and success rates

Year	Authors	No of cases	Follow-up in months	Recurrence rate (%)
1995	Kimata et al. [44]	537	6	1.1
2001	Bostanci et al. [45]	350	25	0.57
2004	Andreasi et al. [46]	948	18	4.3
2005	Lau et al. [47]	106	12	5.7
2010	Di Chiacchio et al. [48]	267	33	1.9
2013	Karaca et al. [49]	348	24	2.3
2013	Zaraa et al. [50]	171	2.1	2.7
2014	AlGhamdi et al. [51]	30	6	3.3

Indications

- Treatment of all grades of ingrowing nail.

Expectations

- Narrowing of the nail plate to cancel the nail plate – lateral fold conflict.

Material

- Basic ingrowing nail surgery tray plus Sturdy hemostat.
- 88 % phenol solution.

Procedure

- After a distal digital block, a tourniquet is placed to ensure a completely bloodless field. If blood is present, the cauterant will turn into a brown jelly, meaning that it has coagulated the blood proteins instead of those of the matrix epithelium.
- When granulation tissue is present, it should be curetted for a better view of the nail plate avoiding an excessive nail plate removal (Fig. 4.7a, b).
- The procedure starts with a lateral (or bilateral if the condition affects both sides) avulsion of a strip of nail about 3–5 mm of lateral nail plate: it is detached from the nail bed, and the lateral and PNF using a nail elevator (Fig. 4.7c). The width of the strip to remove may easily be appreciated; while pressing the lateral fold onto the edge of the plate, a line is drawn with a pencil at the medial limit of the lateral fold. Relaxing the fold will exactly show the amount of nail to be removed to suppress the nail/soft tissue conflict. Doing like will also ensure a nice cosmetic result in avoiding to excessively narrow the nail plate.
- Particular attention should be given to fully free the proximal lateral horn from the plate.
- The nail plate is split using scissors or nail nippers up to it most proximal edge under the PNF (Fig. 4.7d, e). The strip of plate is removed with sturdy hemostat or with an elevator (Fig. 4.7f). Be sure to cut and remove the strip of nail up to its most proximal part.
- Remnants of granulation tissue on the bed and in the lateral sulcus are gently curetted away. The matrix should not be curetted. It has been shown that this procedure does not increase the efficacy [13]. Moreover, it may injure the periosteum and the bone.
- The exposed nail bed and matrix are carefully dried with gauze or a cotton swab pushed along the lateral sulcus and under the PNF. No blood should remain.

- Check that the nail overlying the matrix is fully removed because any remnant nail will protect the matrix from the chemical cauterant and prevent its destruction.
- A cotton swab is soaked in the 88 % phenol solution and then cautiously padded on gauze to have it just moistened and not dripping. If there is excess of liquid on the cotton-tipped applicator, it will spill onto the nail folds causing unnecessary burn. This is why the first description of the technique recommended protecting the surrounding skin with some greasy ointment. Any overflow should be mopped away immediately with a gauze.

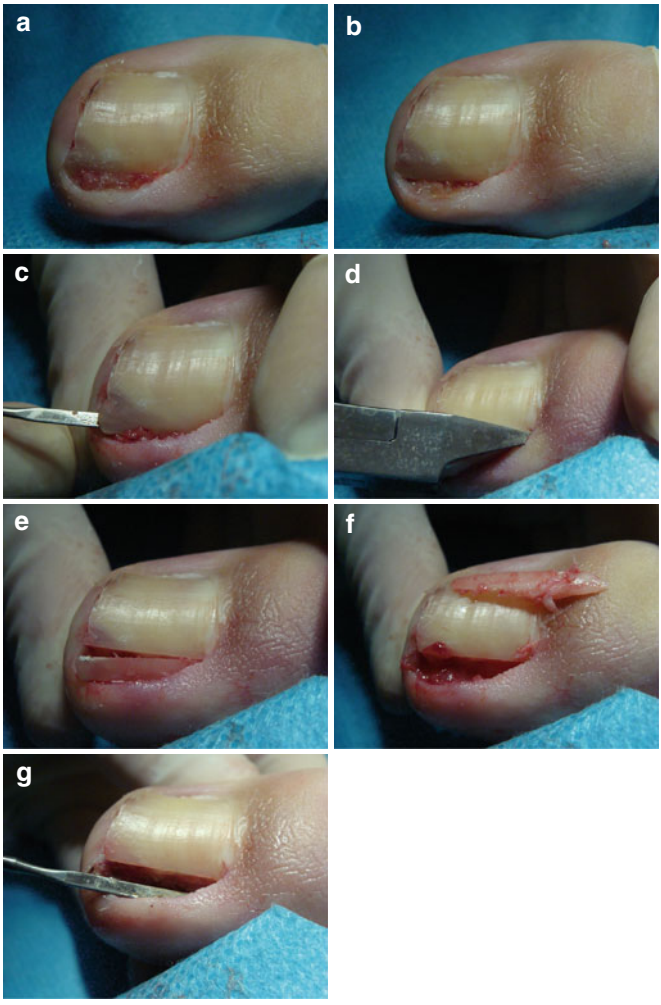


Fig. 4.7 (**a**) Ingrowing nail (grade II – Heifetz) (**b**) after curettage of granulation tissue (**c**) detachment of a lateral strip of nail using the elevator (**d**, **e**) the nail is split using nail nippers up to its hilt, under the proximal nail fold (**f**) after avulsion of the lateral strip of plate (**g**) phenolization using the elevator. The cauterant adheres by capillarity to the elevator (**h**) nail matrix phenolization with a cotton swab (not dripping) (**i**) whitening of the tissue after phenolization (**j**) incomplete resection of the plate up to its hilt interfering with phenolization of the lateral horn of the matrix; the nail is regrowing as it was before (**k**) overphenolization from sliding of phenol under the lateral sides of the plate

Fig. 4.7 (continued)

- Other applicators may be used for applying the cauterant: orange sticks, urethral swabs or the elevator itself (Fig. 4.7g) [53].
- The applicator is pushed into the lateral sulcus, under the proximal fold and rubbed vigorously onto the matrix (Fig. 4.7h). Work it carefully in the lateral and proximal pocket of the matrix.
- Cauterized tissues appear white from coagulation of proteins (Fig. 4.7i).
- One minute seems to be a sufficient time of application of the phenol. This duration has been shown to be clinically effective with high success rate [54]. However, an interesting histologic study on cadavers shown that 4 min is necessary for complete destruction of nail matrix, down to its basal layer [55].
- There is no need to neutralize the phenol as it will be inactivated immediately with the blood flow returning after release of the tourniquet.
- The wound is cleaned with saline solution and dried with sterile gauze. Alcohol lavage does not neutralize the phenol as thought in the past, reason why it was named the "phenol-alcohol procedure". Studies demonstrated that alcohol only dilute the phenol and drags it partially away [56].
- It has been clearly demonstrated that removal of all modified tissue immediately of phenolization, either with a gentle curettage or using a blade, dramatically shortens the oozing time from chemical matricectomy [14].
- Always check that the tourniquet has been removed.

Key Point

- A tourniquet is mandatory as any blood will impair chemical cautery. This is the main cause of recurrence.
- The removal of granulation tissue with curette avoids to avulse an excessive lateral strip of nail plate.
- Remove the lateral strip of nail plate up to its most proximal limits.

- The cotton swab should just be moistened and not dripping.
- Patients must be informed that oozing is not infection.
- Phenol has been demonstrated to be safe for both the patient and the surgeon [57].

Post Op Care

- Antiseptic ointment is applied into the surgical wound and covered with a non-adherent gauze (Fig. 1.30) and a bulky dressing. Sandals are a must post operatively (Fig. 1.29).
- The limb should be kept elevated for 2 days. The dressing is removed after 2 days and the wound cleaned with 3 % hydrogen peroxide to remove all blood clots. Back to normal comfy footwear is possible at that time.
- The lateral sulcus is filled with a thin layer of antiseptic ointment, lotion or antibiotic pellet and covered with a simple plaster.
- The patient is asked to soak his foot twice daily in an antiseptic footbath until oozing disappears.

Evolution

- Oozing appears on the third day and may continue to up to 6 weeks. It can be reduced by applying ferric chloride 20 % at the end of phenolization [58].
- A slight edema on the proximal and the lateral nail folds may remain for 1 week from the irritation from the cautery [59].
- Preoperative and post operative antibiotics are not necessary [60, 61]. Most doctors mix up inflammation and infection.
- Follow-up is mandatory at 3 months to check that there is no recurrence.

Complications

- Complications are uncommon.
- Intense inflammatory process is unusual, but it may appear due to a prolonged time of application of phenol. In these cases non steroidal anti-inflammatory should be used.
- Infection is the most common complication as drainage promotes bacterial contamination. It is mostly observed in patients with poor hygiene and lack of proper home care (Fig. 5.3) [62].
- Perfect healing with a brutal intense inflammation at the junction of the lateral and PNF 6 weeks post operatively, suggests that the nail plate was not severed up to its hilt: the new growing nail pushes the remnant of the former wider nail out, irritating the lateral pocket (Fig. 4.7j). This spur is clipped away with sharp nail nippers allowing complete cure. No new matrix cauterization is necessary.
- When the avulsion induces a medial onycholysis, the cauterant may slide under the detached nail and induce in a definitive nail dystrophy (Fig. 4.7k). To avoid this, pressure on the detached nail with the surgeons thumb during the phenolization, along with very delicate rubbing of a moisturized cotton swab onto the matrix may help.

Author's Point of View

- Nail matrix phenolization is a very easy, fast and cheap procedure to treat all grades of ingrowing nails that every dermatologist should be able to perform. It relieves the patient immediately and offers a very comfortable post op.

- Patients can return to their normal activities in 2 days.
- Recurrence rate is very low (<3 %) (See Table 4.1)

Sodium Hydroxyde (NaOH) 10 %

In 1980, chemical matricectomy with 10 % sodium hydroxyde was tempted and showed excellent results [63, 64]. It was put back on stage by a Turkish team a decade ago [65]. Sodium hydroxide is a strong basic salt and in contrast to phenol (carbolic acid) it causes a basic tissue destruction associated with liquefaction necrosis that is known to heal faster than coagulation necrosis (as induced by phenol). Acid burns on the skin produce a dry crust as a result of coagulation of tissue colloids. The coagulation necrosis is characterized by the loss of the nucleus with preservation of the cellular outline. Protein denaturation occurs following cellular death. The proteins are rendered insoluble thus blocking proteolysis and preserving the dense acidophilic coagulated cells for a period of hours or days. Monocytes and macrophages eventually phagocyte the coagulated cells. Alkaline burns produce a liquefaction necrosis, which results from enzymatic destruction of the cells with a proteinaceous by product that is readily reabsorbed or phagocytized by macrophages. The result is that alkaline burns heal quickly and resolve faster [63]. For this reason, chemical cautery using a base (NaOH 10 %) was attempted for chemical matricectomy.

Indications
- Chemical cautery of the matrix epithelium for permanent destruction. The indications are identical to that of phenol.

Expectations
- NaOH is expected to reduce the oozing period and shorten healing compared to phenol.

Material
- The one used for any chemical matricectomy.
- NaOH 10 %

Procedure
- The surgical procedure is the one for any chemical matricectomy.
- Three application times were evaluated: 30 s, 1 min and 2 min. Thirty seconds application is associated with frank lower success rates and 2 min increases post operative pain and lengthens oozing. One minute is the most adequate application time [66].
- After 1 min, NaOH should be neutralized with 5 % acetic acid solution.

Key Point
- Application time should be one minute, not less, no more.
- With acetic acid solution, a true neutralization occurs with a 1:1 stoichiometric reaction, on the contrary of phenol that is only diluted with alcohol.
- As with any cauterant, NaOH has to be applied with caution in order to prevent overdestruction of the matrix or injury to adjacent tissues.

Post-op Care
- Identical to the one for other types of chemical matricectomy.

Evolution
- NaOH and phenol cauteries were compared in a large study. Phenol was applied for 3 min and NaOH for 1 min. It appeared that they both give high success rate (>95 %) without any significant statistical difference [67].
- Mean duration of post operative drainage is reduced to 10 days with NaOH compared to the 15 days in the phenol group. There was no difference in the severity of the drainage [67].
- Pain is twofold more important in the NaOH group compared to the phenol group during the two first days post op [67].
- NaOH has shown to be safe for chemical matricectomies in diabetics [62]

Complications
- As with phenol, complications seem to be exceptional but nail dystrophy, allodynia and hyperalgesia after sodium hydroxide matricectomy have been recently reported [68].
- Recurrence rates varied from 15/1000 [63] to 5 % [67].
- Amazingly no study mentioned any post op infection with sodium hydroxide cauterization.

Author's Point of View
- NaOH is a good option for chemical matricectomy if phenol is not available. It is very easily found all over the world.
- Even if the oozing time is a bit shortened, the authors found that the post op pain, even for only 2 days, are not worth it, as phenol makes the post op more comfortable and that the overall success rates are identical for both cauterants.
- In their personal experience, they also found that the liquefaction necrosis from NaOH gave an oozing more prone to infection. None of the studies mentioned if they had infection or not post operatively.

TCA 100 %

The latest chemical matricectomy used by a few authors is trichloracetic acid (TCA) with a concentration ranging from 80 to 100 % [69–71].

Indications
- As phenol, TCA is a protein denaturant and induces coagulation necrosis of the cells [70]. The indications are identical to that of phenol.

Expectations
- TCA is expected to reduce the oozing period and shorten healing [69], compared to phenol, but no prospective comparative study has yet been conducted.

Material
- The one used for chemical matricectomy.
- TCA 80–100 % (saturated).

Procedure
- The surgical procedure is the one for chemical matricectomy.
- Application time varied from 10 s to 4 min [69–71].

Key Point
- As with any cauterant, TCA has to be applied with caution in order to prevent overdestruction of the matrix or injury to adjacent tissues.

Post-op Care
- Identical to the one for other types of chemical matricectomy.

Evolution
- Post operative pain was reported to be minimal in most of the patients [69–71].
- Complete healing or major improvement of post operative drainage was achieved within 8–15 days in more than 80 % of the cases in the three studies [69–71].
- Cosmetic results were always considered as satisfactory [70, 71].

Complications
- Barreiros et al. reported moderate complications in only a few cases, 30 days after surgery: mild oozing, erosion or persistent granulation tissue [69].
- Secondary infection occurred in four out of 133 patients [70] and in one out of 25 patients [71].
- Recurrence rates varied between 2 and 5 % [69–71].
- Spicule rate reached 4 % in one study [69].

Author's Point of View
- Up to now, the superiority of TCA over phenol, considered as the "Gold Standard technique", has not been proven, due to the lack of prospective comparative studies.
- The three published studies [69–71], show that TCA matricectomy is safe, simple and an effective procedure. TCA should be considered as a serious alternative, especially when phenol is not available (Table 4.3).
- An average time of 1 min of application seems reasonable, as experimented by the authors.

Table 4.3 Comparison of the differents chemical cauteries for ingrowing nails

	Concentration	Application time	Post op oozing time (days)	Postop pain	Overall success rate (%)	Degree of evidence
Phenol	88 % (liquefied)	1–4 min	15–28	Minimal	95–99	1
Sodium Hydroxyde	10 %	Strictly 1 min	10–18	Severe the first 2 days then minimal	95–99	2
Trichloracetic acid	100 % (liquefied)	10 s to 4 min	8–15	Minimal	95–99	2

1 Double-blind studies, *2* clinical series, *3* anedoctal

Resection of the Soft Tissues

With time, chronic ingrown nail will induce hypertrophy of the lateral and distal nail fold, covering progressively the lateral aspects of the plate, the latter appearing then very narrow (Fig. 4.8a). Narrowing the nail plate in these instances will not solve the problem in all instances and will end in a very narrow nail on a bulky extremity. Here, the surgical procedure should be directed towards the excess of soft tissues that covers the plate or towards the distal pulp against which the nail plate abuts in distal embedding.

Howard Dubois' Procedure

At the end of the nineteenth century, Howard proposed removing a crescent of soft tissue parallel to the distal groove around the tip of the toe to treat ingrowing toenail [72]. Once again, as always in History, this technique was forgotten and reintroduced more than half a century later by Dubois who made it quite popular in France [73, 74].

Indications
- This procedure is a must in the treatment of distal embedding.
- It is also a good approach when dealing with moderate hypertrophic lateral folds.

Expectations
- Removal of enough soft tissues and suturing the defect should induce a pulling down of the distal soft tissues with decompression of the nail.
- The nail plate recovers its original width.

Material
- Tourniquet
- Full ingrowing nail surgery tray
- Non absorbable suture 3/0

Procedure
- As this is a bleeding procedure, placing a tourniquet is mandatory.
- A fish-mouth incision is carried out parallel to the distal groove around the tip of the toe or the digit, about 5 mm distally from the distal groove and 5 mm laterally from the lateral grooves. The incision starts and ends 5 mm proximal to the end of the lateral nail fold.
- A second incision is then made to yield a wedge of maximum 5 mm at its greatest width in the middle of the distal wall (Fig. 4.8b).
- One extremity of the crescent is held with sturdy Adson forceps and pull strongly on it to help the dissection of the area to remove at bone contact with sharp pointed scissors (Fig. 4.8c).
- A #15 blade should be then inserted under the upper part of the incision, skimming the bone from one side to the other, in order to free the attachment of the distal bed.
- Then, check that enough tissue has been freed and removed by pulling on the two edges of the wound with forceps. If not, re-excise a new strip of 3 mm maximum from the lower edge of the wound. Check again and repeat the procedure until accurate removal of tissue.
- Do not hesitate to remove fat generously.
- Suturing the defect immediately frees the distal edge of the nail. Sutures may be simple sutures or a running lock suture for hemostatic purposes (Fig. 4.8d).

They should re-approximate the defect and not pull too much on the distal wall.

Key Points

- Freeing the distal bed from the bony phalanx is mandatory. There is often some fibrocartilaginous tissues from the chronic ingrowing. Sectioning those facilitate the pulling down of the distal bed.
- Do not get too close to the distal and lateral grooves. Keep a minimum of 5 mm between the incision and the grooves.
- Remove excess tissue progressively, sparingly at each time, until the correct amount is removed.
- Do not over-tighten stitches.

Fig. 4.8 (**a**) Long standing chronic ingrowing toenail with hypertrophic lateral walls (**b**) drawing of the incision (**c**) after removal of the strip of skin down to the bone (**d**) running lock suture for hemostatic purposes (**e**) 8 months post operatively. The nail has returned to a normal shape and has not been narrowed. (**f**) Note the very discrete scar

Post Op Care

- Expected pain from this procedure is severe and results from the pulling of tissues. Plan potent pain killers (mild opioids narcotic analgesics).
- Very greasy non-adherent dressing. Use Tulle gras and Teflon coated gauze (Telfa®, Melolin®).
- Very bulky dressing as the wound may bleed.
- The dressing should be replaced after 24 h, not later, as bleeding may render the dressing hard and uncomfortable.
- Antiseptics soakings twice per day with removal of any crust is highly recommended.
- The limb should be elevated for 48 h.
- A first set of stitches is removed after 15 days. The remaining ones are removed 1 week later.

Evolution

- The new nail seems then to grow faster immediately as it is freed.
- Pain and discomfort may remain for several weeks.
- Anesthesia and dysesthesia of the distal wall may persist for up to 1 year and result from section of numerous tiny nerves endings on the distal wall.
- If possible this procedure should be performed when sandals may be worn for several weeks. The patient will be only able to wear regular footwear after 1 month or more.

Complications

- Main complication is necrosis from over-tightened sutures after excess removal of soft tissues (see Fig 5.6 p. 130).
- Removal of not enough tissue will not be curative and will result in recurrence.

Author's Point of View

- This is a very rewarding technique when performed adequately (Fig. 4.8e, f).
- A modification of this procedure has been proposed where it is coupled with a partial nail avulsion [75]. For the authors this variant does not offer any advantage to the original technique.

Noel's Procedure

This procedure was described in 2008 by a Swiss dermatologist [76]. He reported his technique on 23 patients. It is aimed to reduce the amount of hypertrophic soft tissue. It may be considered as a vertical variant of a Howard-Dubois.

Indications

- This procedure is indicated when one or both lateral folds are hypertrophic (Fig. 4.9a, b).

Expectations

- Removal of enough soft tissues and suturing the defect results in an immediate cancellation of the plate-fold conflict.
- The nail plate keeps its original width.
- No dystrophy is expected, as the matrix is not touched at any time.

Material

- Tourniquet is mandatory
- Full ingrowing nail surgery tray

Procedure (Fig. 4.9c)

- The first incision runs all along the lateral nail groove up to 1 cm into the proximal nail fold. The blade should be skimming the lateral aspect of the bony phalanx, until it has reached the pulp. The second incision starts from the end of the previous one and extends laterally to remove a vertical wedge-shaped ellipse of soft tissues (Fig. 4.9d).
- Incisions are deep enough to remove a large volume of soft tissues, with preservation of some skin of the lateral aspect of the nail to ensure direct closure (Fig. 4.9c).
- Neither the plate nor the matrix are incised at any time.
- The defect is closed with simple interrupted 4/0 sutures (Fig. 4.9f, g).
- The procedure may be performed if needed only on one side of the toe.

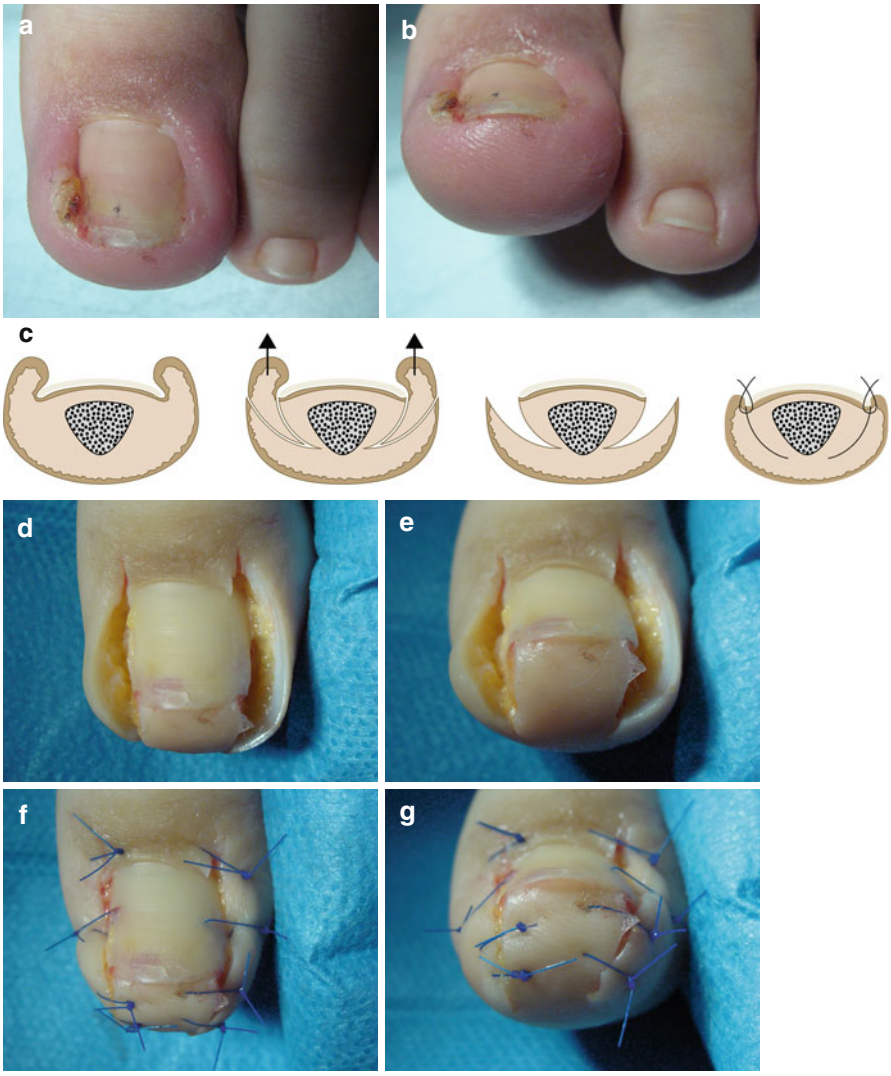


Fig. 4.9 (**a**) Ingrowing toenail with hypertrophy of the lateral walls, upper view (**b**) front view (**c**) scheme illustrating the Noel's procedure (**d**) two vertical wedge of soft tissue are removed, skimming the lateral aspect of the bony phalanx. Neither the plate or the matrix are touched at any time, upper view (**e**) front view showing the extension of the excision down to the pulp (**f**) suturing with eversing suture in order to re-create lateral folds, upper view (**g**) simple stitches are placed at the front

Key Point

- The procedure should remove enough soft tissues in order to avoid recurrences and not too much to impair suturing.
- Back stitches may re-create the lateral fold.

Post Op Care

- Expected pain from this procedure is severe and results from the pulling of tissues. Plan potent pain killers (mild opioids narcotic analgesics).
- Very greasy non-adherent dressing. Use Tulle gras and Teflon coated gauze (Telfa®, Melolin®).
- Very bulky dressing as the wound may bleed.
- The dressing should be replaced after 24 h, not later, as bleeding may render the dressing hard and uncomfortable.
- Antiseptics soakings twice per day, until complete healing and removal of stitches around 2–3 weeks post op.
- The limb should be elevated for 48 h.

Evolution

- Overall cosmetic results for all procedures are excellent.
- Healing is quick as there is no oozing and primary closure.
- There is no risk of nail dystrophy as the procedure does not involve the matrix or the bed.

Complications

- The ones that may occur from any skin surgery: bleeding, infection, necrosis.

Author's Point of View

- This technique is very nice under several conditions: the surgeon should evaluate the adequate amount of soft tissue to excise. Too much removal leads to excessive pulling down of the lateral edge of the plate causing pain and unsightly post operative aspect (narrowing of the toe with vertical lateral aspects). If not enough tissue is removed, recurrence is likely.
- To ensure a nice cosmetic aspect, it is important to re-create the lateral fold using back stitches: the needle is run into the lateral aspect about 2–3 mm volar to the plane of the nail bed-bone interface, through the nail bed and plate, and back again through the lateral thumb skin, which upon knotting will be elevated, thus forming a lateral nail fold (Fig. 4.9f).
- In the author's experience, in some instances this technique may not be sufficient: the removal of the excess tissue may reveal the cause of the ingrowing nail that may be either a too wide or transversally overcurved nail plate. This is obvious per operatively. A treatment of the cause is necessary (narrowing of the nail plate) and should complete the procedure several weeks after complete healing (see Clinical Case 15 (Marie), page 200).
- The authors find that this procedure requires some more experience than Dubois'. The toughest part of the procedure is the skimming curve incision around the bony phalanx.

Debulking of Soft Tissue with Secondary Intention Healing (Vandenbos' and Super "U")

This technique was first described in 1959 by Vandenbos and Bowers [77] who proposed a theory whereby the excess skin surrounding the nail was burdened with

daily weight-bearing, resulting in the bulging of nail-fold soft-tissues and subsequent pressure necrosis. Recently, Chapeskie brought back this procedure in vogue but with some slight modifications [78]. Dr Ival Peres Rosa from Brazil developed in 1989 another variant that he called the "Super U" [79, 80]. All these procedures share a wide debulking of the soft tissues, with some very slight differences. In both techniques, neither the matrix nor nail bed are involved. The name "super U" comes from the U-shape of the debulking all around the tip of the toe. In these techniques, healing occurs by second intention. They are easy to perform but long healing procedures. These original techniques were created to remove only the soft tissues, but nail matrix phenolization can be performed in the same session if the physician thinks that narrowing the nail is necessary. Indeed, debulking may reveal the original cause of the chronic ingrowing, like transverse overcurvature.

Indications
- Chronic ingrowing with prominent hypertrophy of lateral and distal nail folds (Fig. 4.10a)
- Congenital hypertrophic lip in infants.

Expectations
- Removal of enough hypertrophic tissues to free the nail with second intention healing of the wound without resulting hypertrophic walls.

Material
- Tourniquet
- Full ingrowing nail surgery tray
- Absorbable suture 4/0

Procedure

The first incision starts at the junction of the lateral – proximal nail fold and runs laterally up to the lateral half of the lateral aspect of the toe. It curves then distally to reach the tip of the toe. A same incision is performed on the other side and joins the previous one, giving the U shape. The third incision starts from the same place as the first one and skims the contour of the plate down to the bone. Using sharp scissors, the tissues in between these two U shaped incisions is removed down to the bone (Fig. 4.10b). Be careful not to remove the onychodermal band. The hypertrophic tissue between the two inverted "U" incision lines is removed all around the nail unit. The fat tissue at the distal fold is preserved to serve as a "bumper" post operatively, otherwise the distal phalanx abuts directly on the shoe which is painful.

- In the Vandenbos' procedure, a portion of the proximal nail fold is excised (V notch) and the very tip of the pulp remains in place (it is not a U shaped excision) (Fig. 4.11a–f).
- Hemostasis is achieved with a running locked suture with absorbable suture (4-0) all around the U shaped wound (Fig. 4.10c). In the Vandenbos' procedure, delicate electrocautery is used to stop the bleeding.

Key Point
- Tourniquet is mandatory to avoid bleeding during the procedure.
- Be generous, remove all the hypertrophic tissue down to the bone.

Fig. 4.10 (**a**) Chronic lateral and distal ingrowing (Heifetz grade III) (**b**) after removal of a "U" strip of skin all around the nail unit, removing a part of the lateral and distal nail folds, thus freeing the nail (**c**) a running lock absorbable suture is performed for haemostatic purposes. (**d**) Haemostatic foam is applied onto the wound left for secondary intention (**e**) outcome after 4 months

Post-op Care

- Bleeding might be an issue at the removal of the dressing. An injection of a large amount of anesthetic or saline on the lateral aspect of the distal joint will stop the bleeding in a few seconds. Do not apply a tight dressing to stop the bleeding as this may cause pain in the following hours.
- Hemostatic foam may be applied on the wound to limit bleeding (Fig. 4.10d)
- Pain is moderate and light painkillers are usually enough.
- The affected limb should be elevated for 2 days.
- The wound is covered with a greasy non-adherent dressing and covered with several layers of gauze as a bulky dressing. It is replaced after 48 h.
- Antiseptics soakings twice per day and greasy ointment are mandatory till complete healing
- Sandals are recommended until almost complete healing.

Evolution

- Healing takes about 40 days and is the main drawback of these techniques.

Fig. 4.11 (**a**) Terrible chronic ingrowing toenail with exophytic lateral walls (**b**) Vandenbos' procedure with wide lateral debulking and leaving the distal pulp, limiting the risk of injuring the onychodermal band (**c**–**e**) progressive healing by secondary intention (**f**) final outcome (Courtesy H. Chapeskie, Canada)

Complications

- Infection is possible in case of a poor home care.
- Removal of onychodermal band may give rise to parrot beak nail (which will never occur in the Vandenbos' procedure).
- Excess removal of the distal fat tissue results in loss of padding inducing persistent pain at the tip of the toe when wearing shoes.
- The two last complications are less prone to develop with the Vandenbos' procedure that leaves a piece of the distal wall.

Author's Point of View

- These two procedures are excellent for severe cases of hypertrophic lateral and distal nail folds. They are very easy to perform, generate very moderate pain and have almost no risk of dystrophy.
- Despite it is considered as an aggressive procedure with a long healing time, the outcome is fantastic (Fig. 4.10e).

Tangential Excision ("Shaving")

This technique is known for a long time and probably from the antic times!

Indications

- Main indication is the hypertrophic distal fold in infants neither involuting spontaneously nor with topical steroids massaging (Fig. 4.12a).
- Moderate distal ingrowing in adults not responding to conservative treatments.
- Another option might be a moderate hypertrophic lateral lip.

Expectations

- Freeing the distal nail abutting on the hypertrophic lip and responsible for pain.

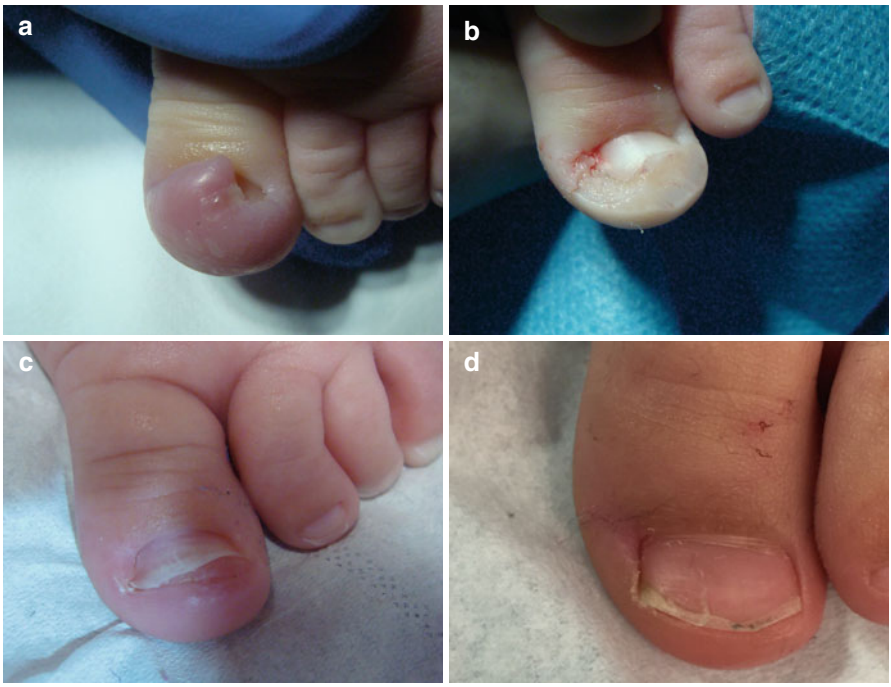


Fig. 4.12 (**a**) Very prominent distal wall in an infant. Conservative treatments have failed (**b**) shaving of the hypertrophic distal tissue (**c**) results at 6 weeks, the nail is regrowing normally and the kid accepts to wear shoes! (**d**) Aspect at 1 year follow-up

Material
- Scalpel and # 15 blade
- Hemostatic solution

Procedure
- With the blade resting horizontally on the proximal plate and perpendicular to its longitudinal axis, the excessive distal tissue on which the nail abuts is tangentially excised from side to side (Fig. 4.12b).
- Compression with aluminium chloride solution suffices to ensure hemostasis.

Key Point
- Have a wide motion, be generous in your excision and check that the distal edge of the nail is free.

Post Op Care
- Pain is very limited, as the pressure from the nail has been relieved.
- Healing comes from secondary intention: greasy dressings with soakings twice daily until complete healing.

Evolution
- The freed nail seems to grow faster as it has been freed.
- Healing from secondary intention occurs in about 2 weeks and even much faster in infants (Fig. 4.12c).

Complications
- Poor post op care may result in infection.
- Poor excision will result in recurrence.

Author's Point of View
- It is a very quick and safe procedure with very few side effects, especially in infants where it may even be performed after occlusion with EMLA cream for 2 h.

Tweedie and Ranger Flap

Indications
- Hypertrophic lip of the great toenails in adults (Fig. 4.13a). Can be performed on one side or both sides of the great toenails. Not for ingrowing nails with transverse overcurvature.

Expectations
- Preserving the width of the nail plate.
- Reported 92 % success of the technique, after a follow-up ranging from 18 months to 3 years, but only one publication exists on the procedure.

Material
- Full nail ingrowing surgery tray

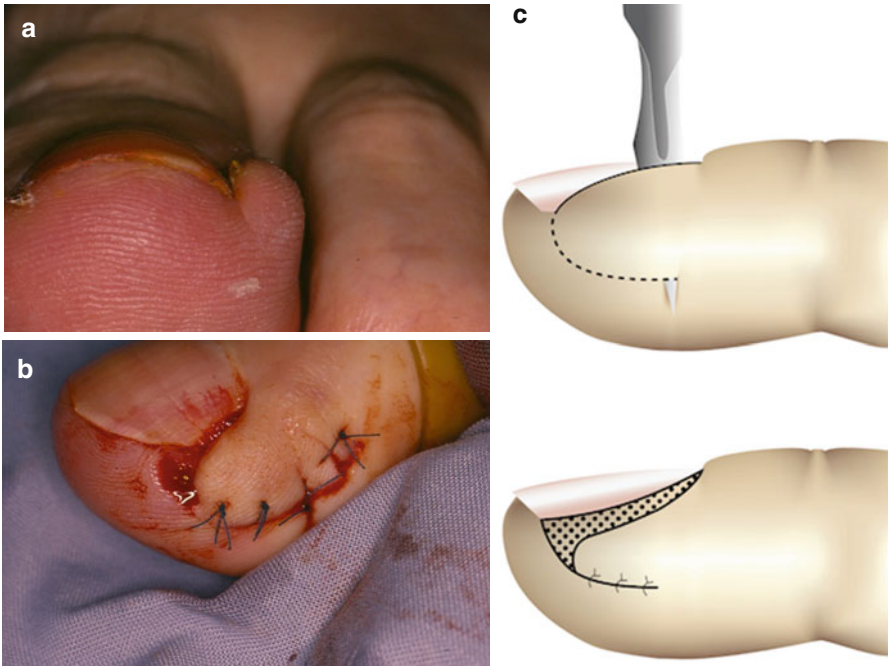


Fig. 4.13 (**a**) Hypertrophic lip in an adult resulting from long standing ingrowing of the lateral fold (**b**) flap transposed and sutured (**c**) scheme illustrating the procedure

Procedure: (Fig. 4.13b)

- Hemi or complete distal digital block, according if one or two sides are concerned.
- The pointed extremity of a scalpel blade #11 is inserted vertically in the proximal part of the lateral nail sulcus, in order to have it reappear about 1 cm below on the lateral aspect of the toe, transfixing the lateral nail fold. The blade is then pulled straight distally to free a flap. The flap is transposed inferiorly, with the help of a Burrow's triangle at the proximal inferior part of the incision. The excess of tissue at the inferior part of the flap is cut away. Suturing the flap ends surgery (Fig. 4.13c). A small defect remains for secondary intention on the upper lateral part of the nail.

Key Point

- Having an enough large peduncle (1 cm at least) at the base of the transposition flap.

Post-op Care

- Pain: severe. Flap transposition procedures are painful. Ensure proper analgesia with potent painkillers.
- Greasy antiseptic dressings until complete healing.
- Remove stitches after 10–15 days according to evolution.

Evolution

- Healing is quick, as this is primary closure. The small upper part of that is left for secondary intention healing and will close in about 8–10 days.

- Pain may result from pressure on the wound from adjacent toe. Wearing large sandals is best!

Complications

- If the base of the transposition flap is not wide enough, there is a risk of necrosis. This may also occur in heavy smokers and patients with vascular impairment. If this happens, healing will occur by secondary intention. Beware of too tight shoes as pressure may impair vascularization of the flap.

Authors' Point of View

- In the author's experience, this flap is painful, as are all transposition flaps and especially when performed on the richly innervated extremities. Amazingly, the only publication [81] mentions that the procedure was remarkably pain-free.
- The cosmetic result shows a lowered down hypertrophic lateral folds, giving rise to a bilateral bulbous aspect.
- No other publication has been released since the original one 30 years ago. A Turkish team has described an almost similar technique [82], called lateral fold plasty. The princeps publication is not mentioned in their references. They coupled it with partial excisional matricectomy in some severe cases. The issue is identical: lowering the hypertrophic lip.
- Another variant of this procedure was described by Bose [83], by cutting away the proximal end of the flap and let the defect heal by secondary intention, which ends in fact to a unilateral super U.
- Recently, Hashish et al. suggested a new technique preserving the matrix: it consists in performing a nail fold and nail plate excision followed by the elevation of a composite flap of nail bed and underlying periosteum which is then advanced over the defect. The technique was reported as highly effective in a 105 case-series study, with good cosmetic results and high patient satisfaction. No recurrent case was noticed over a 6 months to 8 years follow-up period [84]. The authors have not yet used this surgical procedure that appears to be a variant form of the Tweedie and Ranger's flap. More data are needed to fully appreciate this technique.

Deroofing

Deroofing is a term that has been coined to describe the surgical removal of the upper surface of a canal or a cavity (fistule, abcess…).

Indications

- The only indication in nail surgery is harpoon nail [85]. Here, the canal runs within the lateral nail fold (Fig. 4.14a).

Expectations

- The main goal of the procedure is to open the canal to expose the long spur that skewers the distal lateral fold.

Fig. 4.14 (**a**) Harpoon nail (**b**) a flutted probe is inserted in the canal (**c**) deroofing of the canal (**d**) showing the offending spur (**e**) as the nail plate showed a transverse hypercurvature on that side, a chemical cautery was performed to ensure definitive cure

Material

- Full ingrowing nail surgical tray

Procedure

- Best is to introduce a fluted probe at the distal opening of the canal (Fig. 4.14b) and to incise its whole length with a blade resting on the probe (Fig. 4.14c).
- The lateral parts of the roof are severed with fine scissors allowing complete exposure of the spur and lateral aspect of the nail (Fig. 4.14d).
- The spur may be clipped away and the wound left for secondary intention healing.
- However, this procedure very often demonstrates the overcurvature of the nail plate demanding a radical cure. An avulsion of a lateral strip of nail, corresponding to

the width of the offending part of the overcurvature, followed by chemical cautery completes the procedure in most instances (Fig. 4.14e).
- Another therapeutic option would be a wide debulking of the soft tissues (VandenBos' or Super U procedure). A labiomatricectomy (wedge resection carrying out the lateral fold with the spur in its canal and the corresponding matrix) may also be performed, but has not the favor of the author's because of the pain induced by the traction of the stitches.

Key Point
- Be sure to perform a complete cure. In many cases, deroofing might not be sufficient, as harpoon nail is the consequence of a wide overcurved nail and treatment of the cause is mandatory.

Post Op Care
- The one of chemical cautery (see p. 92).

Evolution
- The one of chemical cautery (see p. 93).

Surgical Procedures on the Bone and/or Bed for Pincer Nails

Widening pincer nails has always been the aim of nail surgeons. Of course, a simple bilateral chemical cautery will relieve pain that is the main issue for the patient [86]. But the nail may appear much narrower. However in some cases, especially in younger patients, it is worth trying to alleviate pain but also to improve the cosmetic aspect of the nail. For this, several techniques are available. They consist either in flattening the bone and spreading the bed laterally or elevating the lateral horns of the matrix.

Flattening the Bone and Spreading the Nail Bed (Haneke's Procedure, Suzuki's Variant, Fanti's Variant, Kosaka's Variant)

These procedures stem from the pathogenesis of the pincer nails [87, 88]. The goals of each of them are twofold, even if they are achieved in different ways (Table 4.4):

Table 4.4 Comparison of the different procedures for flattening the nail bed

	Haneke	Suzuki	Fanti	Kosaka
Complete avulsion of the plate		X	X	X
Chemical cautery of the matrix horns	X		X	
Removal of bony dorsal distal tuft	X	X	X	X
Nail bed elevated in two flaps	X	X	X	
Nail bed elevated in one flap				X
Removal of the distal and lateral fold		X	X	

1. Suppression the distal dorsal bony tuft
2. Lateral expansion of the pinched nail bed

Indications
- Pincer nails with a proven osteophyte on X-rays (Fig. 4.15a, b)

Expectations

- Decreasing the pressure of the wide base of the terminal phalanx from the matrix horns. Taking the outward pressure of the wide base of the terminal phalanx away from the matrix horns will result in less uncurving of the proximal nail and thus less overcurving of the distal part of the nail plate. This alleviates pain immediately post operatively.
- Flattening and enlarging the nail bed

Material
- Tourniquet
- Full ingrowing nail surgery tray
- Bone rongeur
- Absorbable suture 3/0
- Absorbable suture 6/0

Procedures
Haneke's Procedure

The aim of this technique is, at the same time, to narrow the nail plate with chemical cautery, remove the bony dorsal distal tuft and expand the nail laterally, by the use of special reserved tie-over sutures and plastic tubes to keep the nail bed stretched over the bone.

- After bilateral cauterization of the matrix horns, an avulsion of the distal 2/3 of the remaining plate is performed.
- A medial longitudinal incision of the nail bed is carried down to the bone from the margin of the remaining nail plate to the hyponychium. The osteophyte can be felt when the scalp run on the distal dorsal tuft.
- Another transverse incision in the skin of the tip of digit, 0.5 cm beyond the hyponychium and perpendicular to the first one is performed, like an inverse "T", allowing a full access to the underlying bone.
- The nail bed is dissected from the bone, forming two flaps. Both are reclined laterally to expose the distal dorsal aspect of the bony phalanx (Fig. 4.15c).
- The osteophyte is generously removed with a bone rongeur, flattening the distal phalanx (Fig. 4.15d).
- The flaps of the nail bed are spread out using reversed tie-over sutures with 4/0 threads going from one lateral nail fold over the pulp to the other lateral nail fold and back again. These sutures are fixed at the volar aspect of the toe pulp. Thin rubber tubes may be inserted into the lateral nail sulci, over which these sutures are laid to avoid cutting of the threads through the paronychial tissue (Fig. 4.15e).

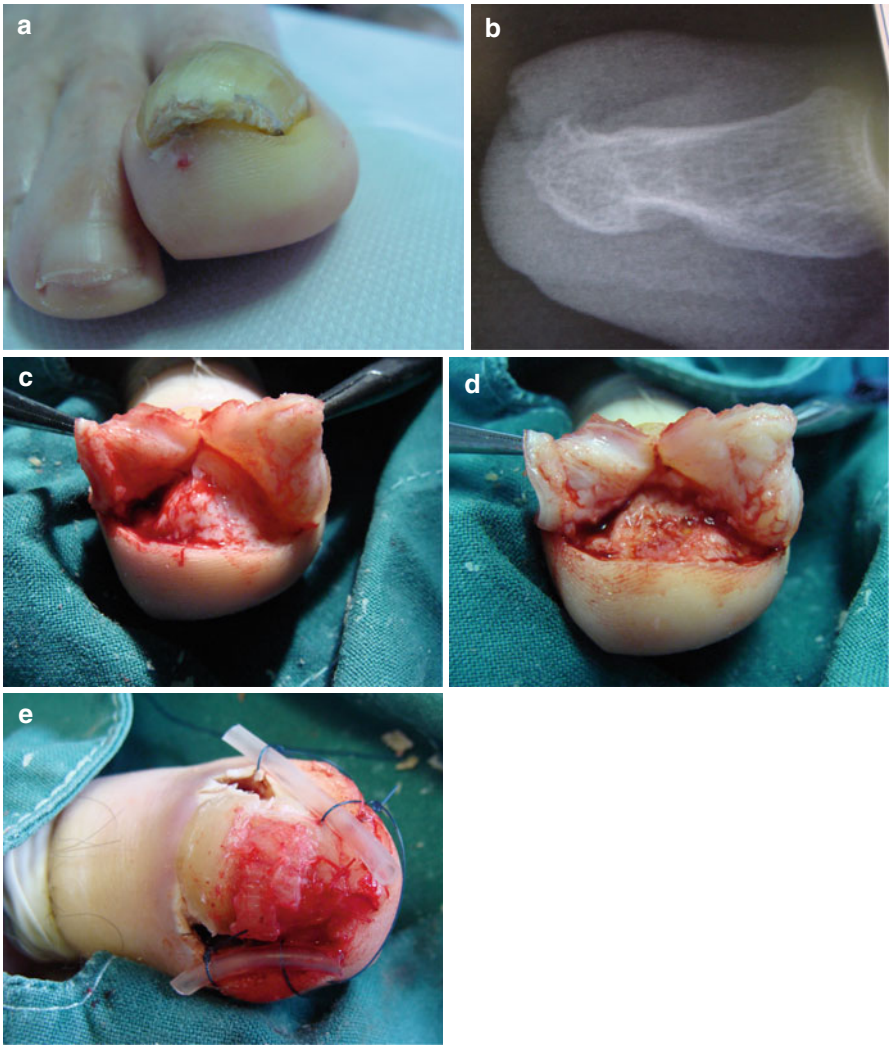


Fig. 4.15 (**a**) Painful thick pincer nail. Was thought to be onychomycosis and treated for so without any results (**b**) X-rays lateral view showing a prominent dorsal distal tuft (**c**) elevation of two lateral flaps of the bed reveals the distal tuft (**d**) after removal with a bone rongeur (**e**) after suturing the bed and expanding the bed with reverse tie over sutures

- When the nail folds are pulled outward a triangular defect may appear, which is easily closed by an inward rotation of the inner margins of the nail bed flaps. The degree of rotation depends on the severity of nail bed pinching. When the hyperostosis is not too severe, a locked running suture may be sufficient to spread the bed.
- The flaps are sutured to each other using 6/0 absorbable sutures.

Suzuki's Variant

This technique is almost identical to the one of Haneke's. The differences from Haneke's technique are that: (1) there is no bilateral nail matrix cautery, (2) the nail plate is completely avulsed (3) the lateral nail folds and distal nail fold are cut away and (4) the two nail bed flaps are transposed and sutured laterally on the border of the wound resulting from the removal of the lateral and distal nail folds. The resultant triangular defect is covered by a free skin graft. An onycholytic area will develop at the place of the graft [89].

- A complete nail avulsion is performed.
- A "U" shaped excision of the lateral nail folds and distal fold is performed to create a space where the nail bed will be stretched laterally.
- The first incision joins the medial to the lateral junction of the proximal–lateral nail folds and runs about 5 mm ahead of the boundaries of the lateral and distal nail sulcus.
- The second incision parallels to the previous one but sticks to the borders of the nail bed.
- Be careful to avoid removing the onychodermal band.
- This periungueal tissue is removed in a "U", in order to have a flat plan. Be sure to remove the depth of the lateral sulcus.
- A medial incision on the nail bed, carried down to the bone, starting 2 mm distally from the lunula, extends to the hyponychium.
- The nail bed is dissected from the bone elevating two lateral flaps.
- The osteophyte is thus fully exposed and is removed with a bone rongeur.
- Nail bed flaps are transposed laterally – one on each side – and sutured to the edge of the "U" with absorbable suture 5-0.
- A running locked suture with absorbable suture 5-0 is performed around the distal incision of "U" to avoid bleeding.
- This procedure creates a distal inverted "V" notch without nail bed. A free skin graft is harvested to cover the defect. This will allow coverage of the bone removal area. However, this will also impede regrowth of the nail bed with longitudinal ridges. This normal skin will be responsible for a small area of permanent onycholysis.

Fanti's Variant

It is considered a variation of Suzuki's technique [90]. The differences are that: (1) there is a bilateral nail matrix cautery, (2) the resultant triangular defect is left for healing by secondary intention. This is faster than a graft and resultant onycholysis is less likely.

- After bilateral cauterization of the matrix horns, a complete avulsion is performed.
- A complete nail avulsion is performed.
- A "U" shaped excision of the lateral nail folds and distal fold is performed to create a space where the nail bed will be stretched laterally.
- The first incision joins the medial to the lateral junction of the proximal–lateral nail folds and runs about 5 mm ahead of the boundaries of the lateral and distal nail sulcus.

- The second incision parallels to the previous one but sticks to the borders of the nail bed.
- Be careful to avoid removing the onychodermal band.
- This periungueal tissue is removed in a "U" (Fig. 4.16a, b) in order to have a flat plan. Be sure to remove the depth of the lateral sulcus.
- A medial incision on the nail bed, carried down to the bone, starting 2 mm distally from the lunula, extends to the hyponychium and the nail bed is elevated in two lateral nail flaps (Fig. 4.16c).
- The osteophyte is thus fully exposed and is removed with a bone rongeur (Fig. 4.16d).
- Nail bed flaps are transposed laterally – one on each side – and sutured to the edge of the "U" with absorbable suture 5-0.
- A running locked suture with absorbable suture 5-0 is performed around the distal incision of "U" to avoid bleeding (Fig. 4.16e).
- This procedure creates a distal inverted "V" notch without nail bed. Hemostatic foam is placed into the defect to limit the bleeding. It is left for healing by secondary intention (Fig. 4.16f).

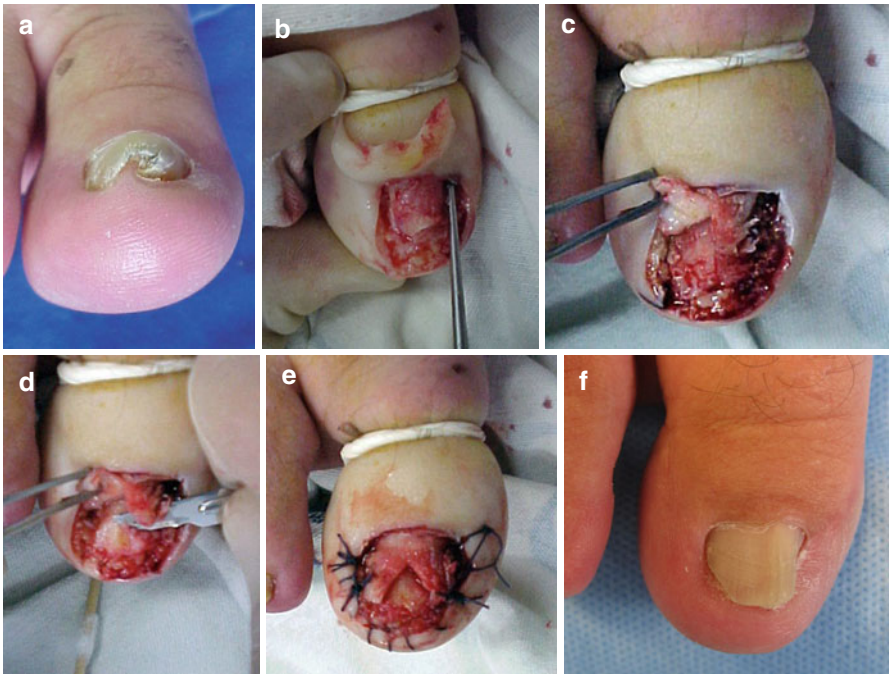


Fig. 4.16 (**a**) Pincer nail with severe transverse overcurvature (**b**) After avulsion of the nail plate the lateral and distal wall are removed in a U shape shave exision (**c**) a medial incision starting 2 mm ahead of the lunula and extending up to the hyponychium is performed (**d**) the bed is elevated from the bony phalanx in two lateral flaps. The distal tuft of the matrix is removed, flattening the phalanx (**e**) nail flaps are transposed laterally and sutured to the edges of the U excision (**f**) outcome after 8 months

Kosaka's Variant

This procedure is a bit more demanding and requires a skilled surgeon. The differences from the previous techniques are that the nail bed is elevated as a single flap and spread laterally [91].

- After total nail plate avulsion, a W-shaped incision is made 5 mm ahead of the nail margins (Fig. 4.17a–d).
- The nail bed is delicately detached from the bony phalanx, using a blade, fine sharp tipped-scissors or even the elevator. The main issue is not to pierce the nail bed during the procedure.
- The whole nail bed is elevated as a whole, in a single flap, and reclined dorsally (Fig. 4.17e)
- The exposed dorsally protruding osteophyte is removed with a bone rongeur or with a diamond burr, in order to render the dorsal aspect of the distal phalanx flat (Fig. 4.17f).
- The lateral nail walls are de-epithelialized or shaved, and the bed stretched laterally (Fig. 4.17g) and sutured with 5-0 absorbable sutures (Fig. 4.17h, i).

Key Point

- The nail plate must be left on place and firmly pressed onto its bed during chemical cautery to avoid sliding of cauterant under the plate that would induce overdestruction of the matrix for procedures where cautery is associated.
- Bone removal should be generous but not excessive. It should allow a complete flattening of distal phalanx.
- Nail bed is very fragile and should not be torn away during its detachment form the bone. Dissection should be delicate.

Post Op Care

- Pain is severe to very severe due to the nail bed plasty. Potent painkillers should be prescribed at least for 2 days.
- As the surgery involves the bone, prophylactic antibiotics should be prescribed. The authors favour azithromycine 500 mg, the day prior to surgery, the day of the surgery and the day after the surgery.
- The wound is covered with a large amount of greasy antiseptic ointment and non-adherent dressing, completed by a bulky absorbent dressing. Replacement should occur after 2 days maximum as the wound may bleed and render the dressing sticky.
- Elevation of the limb is mandatory.
- Antiseptics soakings twice per day, completed by a thin layer of antiseptic ointment, are performed until complete healing.
- Reverse sutures are left in place, as they are absorbable. Remaining stitches are removed after 4 weeks.

Evolution

- Oozing will appear from the chemical cautery, if any.
- Complete healing takes from 20 to 30 days.
- A complete regrowth of the nail occurs in 9–12 months (Fig. 4.16f).

Fig. 4.17 (**a**) Pincer nail, upper view, note the triangular shape (**b**) front view, note the severe pinching (**c**) drawing of the W-shaped incision, front view (**d**) drawing of the W-shaped incision, upper view after nail avulsion (**e**) elevation of the nail bed as one flap, exposing the distal hyperostosis (**f**) after rongeuring the bony tuft (**g**) stretching the bed laterally over the flatten bony phalanx (**h**) the lateral walls are either de-epitheliazed or trimmed to fit to the new size of the bed (**i**) after suturing upper view, compare with **a** (**j**) after suturing front view

Complications

- Reverse suture may drop. To prevent that, be sure that the reverse tie-sutures are fixed properly at the volar aspect of the toe pulp.
- Delayed healing and infection may occur. It results from poor home care and bad hygiene. Patient should be well informed about the importance of the post operative cares.
- Removal of the onychodermal band may lead to parrot's beak nail, making trimming of the nail difficult.

Author's Point of View

- These procedures have very high success rate. They are adequate as they are directed toward the etiologic factors of the nail pincer. The nail may be not completely flat but the cosmetic aspect of the nail is highly improved. According to authors, the success rate is over 80 % for the Haneke's procedure [87]. Suzuki, Fanti and Kosaka report high success rate but without quoting a rate.
- These procedures often frighten old patients that just want to get rid of their pain and prefer a simple chemical cautery.

Elevation of the Lateral Part of the Nail Bed in Pincer Nail (Zook's Procedure)

This technique was first described by Brown, Zook and Williams in 1998 during the Annual Meeting of the American Association for Hand Surgery and published in 2000. The aim of the procedure is to flatten the pinched nail bed by elevating the lateral nail bed with dermal grafts, preserving thus the nail matrix and the width of nail plate [92]. After 5 years Zook, Chalekson, Brown and Neumeister compared the use of autograft and homograft dermis. They showed that there were no significant differences in the appearance of the nail or relief of symptoms. However, surgical time was much less when homograft dermis was used [93]. Both techniques are considered as a good option for the treatment of transverse overcurvature of the nail [93, 94], but homograft dermis is not allowed in some countries.

Indications

- All types of transverse overcurvature of the nail – pincer, tile or plicated nail (Fig. 4.18a).

Expectations

- Flattening the nail bed through elevation of the paronychial folds by placement of dermal grafts.

Material
- Full ingrowing nail surgery tray

Procedure
- The procedure starts with a complete nail avulsion (Fig. 4.18b).
- Two small oblique incisions are performed on the tip of the digit, in line with the most lateral aspects of the nail bed, large enough to get into a dental spatula or a fine scissor.
- Using the dental spatula or a fine scissor, the paronychial folds are gently freed from the bony attachments bilaterally, to elevate the deformed paronychium on both sides, creating two tunnels between the nail bed and the underlying phalanx. Be careful not to pierce the nail bed.
- When an autogenous dermis grafts is used, the donor area is chosen according to the thickness of the dermis and secondary scar. The intergluteal sulcus may be a good option as well as the thenar area of the hand [94].
- A small incision is performed proximal to the eponychial fold.
- A Bunnel straight triangular point with a nylon suture (5-0) is passed distally into the tunnel and out through the tip incision. The graft is placed through the needle and the thread. The needle is pulled proximally to the eponychium bringing the suture and graft into the tunnel, elevating the paronychial fold (Fig. 4.18c, d).
- Any excess of graft is excised distally, if needed.
- The incisions of the tip of the digit and eponychium area are sutured using a nylon 5-0 (Fig. 4.18e).

Key Point
- Avulsion is mandatory in order to ease the tunnelisation under the bed.
- The detachment of the lateral bed from the bone should be very delicate in order not to pierce the nail bed.
- A straight needle (Bunnel needle) is required.

Post Op Care
- Antiseptic ointment is applied on the surgical wound and covered with non-adherent gauze and a bulky dressing.
- Expect severe post operative pain and prescribe potent painkillers
- The dressing is removed after 1 day. The wound is then washed with antiseptic soap twice daily and covered with a greasy ointment.
- Sutures are removed after 10 days.
- Comfy shoes are a must for at least 1 month.

Evolution
- The new nail grows flatter in about 9–15 months (Fig. 4.18f, g).

Fig. 4.18 (**a**) Pincer nail, upper view, note the triangular aspect of the plate (**b**) after nail avulsion (**c**) after tunnelization under the lateral nail bed, a dermal graft is placed to elevate the nail bed (**d**) the same procedure is performed on the other side (**e**) immediate post operative aspect (**f**) after 9 months (**g**) after 2 years

Complications

- Infection is rare, but may be observed after traumas. In this case, antibiotics are prescribed.
- A graft of insufficient size may be responsible for recurrence.

Author's Point of View

- This procedure is a good option to treat all types of transverse overcurvature, but requires a good training, especially for the tunnelisation step.
- Homografting decreases the surgical time and avoid a scar in the donor area, but some countries do not authorize it for safety reasons.

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Chapter 5
Potential Complications and Their Management

Abstract Complications may be reduced to a minimum by preventive measures, such as careful patient selection, sterile technique, accurate procedure and meticulous care of the nail matrix. The nail surgeon should never abandon a patient showing complications. The more surgery is performed, the more complications may arise. Their recognition and management is part of the patient's follow-up.

Keywords Nail • Complications • Infection • Dystrophy • Necrosis • Post op pain • Dysesthesia • Bleeding • Reflex sympathetic dystrophy

Nail surgery can be challenging and many different factors can impact surgical outcomes. Specific and aspecific complications of nail surgery must be timely recognized and addressed appropriately. A sound surgical approach must be chosen in order to achieve a good surgical result and minimize the complications of nail surgery.

It is of utmost importance that the surgeon never abandons a patient with any post-op complication. Patients need to feel that you care for them and that you do your best also to deal with unpredictable complications, should they arise. If necessary, the dermatologic surgeon should also be open to involving other colleagues including fellow dermatologists, hand surgeons or infectiologists who may be able to offer their help and expertise for difficult cases [1].

Complications after procedures for ingrowing toenails include, as in every surgery, bleeding, infection, necrosis and recurrence. Some are similar to skin surgery complications (implantation cyst, hypertrophic scar and cheloid) or to limb's surgery (reflex sympathic dystrophy). Few are specific to nail surgery (nail dystrophy and spicules).

These complications shared by all surgeries will be discussed along with their management. Complications linked to each specific procedure for ingrowing toenails are developed in the chapter where they are described.

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Complications Shared with Other Surgeries

Post operative Pain

The digits are among the richest anatomic areas in free C-fiber nerve endings, which are responsible for relaying painful stimuli to the central nervous system. Post operative pain may be spontaneous or elicited by touch and may exaggerate the patient's perception of the degree of swelling adding to the discomfort. One explanation is that the Meissner's corpuscles, which are responsible for detecting light touch in the digits, have been shown to be partly innervated by C-fiber nerve endings and may play a role in pain transmission. This may explain the severe pain upon touch (allodynia) that is experienced by some patients at the surgical site [2, 3]. Too tight dressings may impair the blood flow and enhance swelling at the operating site.

Prevention

- Inject long-acting anesthetics (bupivacaine or rovipacaine) to offer a post operative analgesia for up to 16 h. Prescribe painkillers according to the expected pain post operatively (See section "Post Operative Management"). Some procedures induce very little pain (chemical cautery, debulking) whereas some others are very painful (wedge excision, Dubois', ie).
- The operated digit is very sensitive to touch post-surgery and should be judiciously protected against trauma with a bulky dressing.
- To prevent any swelling that will promote pain and throbbing, elevate the limb for 48 h (footstool) and avoid too tight dressings.

Management

- If all mentioned above recommendations are carefully followed, post operative pain is usually well tolerated by patients.
- If there is major pain, perform an X-ray and rule out any infection.

Dysesthesia

Occurrence of post operative long-term dysesthesia after nail surgery is a phenomenon well known by experienced nail surgeons. However no quantification of its frequency, its location, duration and impact on daily activities was ever done. Recently, it has been shown that a sensory disturbance was observed in about half of the patients (47 %) without any relationship to the extent of the surgery undertaken. The most reported sensations were numbness or loss of sensation (16 %) and

tingling (8 %). When mapping the locations of altered sensation (Fig. 5.1), the digit tip was the most commonly affected (34 %) with the proximal nail fold (28 %) and margin beneath the free edge of the nail (24 %). Complete or partial resolution was noted in 35 % of cases after 6–12 months but 11 % had still no improvement. There is no clear explanation for this phenomenon up to now [4].

Bleeding

The risk of excessive bleeding during surgery is minimal when operating on ingrowing toenails as the surgeon operates in a bloodless field using a tourniquet. However, post operative bleeding within the wound may lead to haematoma (Fig. 5.2). It has been proven that discontinuation of blood thinners may increase the risk of cerebral and cardiovascular complications [5]. With no documented increase of severe

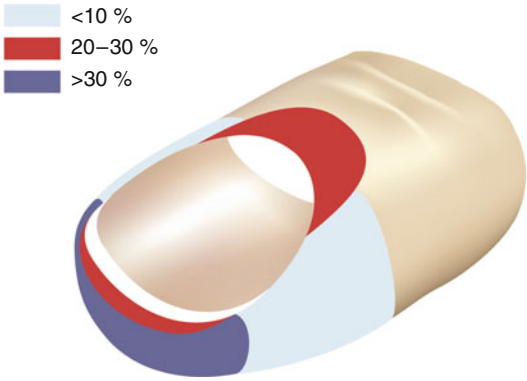

Fig. 5.1 Mapping of site and frequency of paresthesia after nail surgery (Adapted from Walsh et al. [4])

Fig. 5.2 Hematoma of the lateral nail wall in a patient undergoing aspirin for blood thinning

hemorrhagic complications during perioperative use of these medications, data provide a compelling argument to maintain patients on medically needed blood thinners during skin and nail surgery [6].

Prevention

- The use of a bulky dressing for at least 48 h combined with elevation of the limb limits the risk of excessive post operative bleeding.

Management

- For limited bleeding, vigorous rubbing of a cotton-tipped applicator dipped in 35 % aluminium chloride will usually suffice.
- For moderate bleeding, oxidized cellulose or calcium alginate dressings work nicely.
- For severe post operative bleeding, injection of some anaesthetic (0.5 cc) as a wing block will act as a volumetric tourniquet (anesthetic tamponade of the nail unit), until clotting occurs.
- Do not use electrocoagulation!

Infection

Strict antiseptic technique should be performed as the nail unit lies on the phalanx directly below, with little intervening dermis and no subcutaneous tissue. The surgical procedure almost always extends to the periosteum posing a risk of osteomyelitis, should the sterile field be compromised. Most of the time, infection results from poor homecare and/or lack of hygiene (Fig. 5.3): some patients may not be able to bend enough to reach their toes, especially old people, others may be frightened seeing the wound or have a low pain threshold and do not want to touch their wound.

Prevention

- Use strict aseptic procedures.
- Ask manual workers and patients with poor hygiene to scrub the digit twice daily with antiseptic soap, 2 days prior to surgery.
- Particular care should be taken in home care and renewal of dressings.
- Antibiotic prophylaxis should be prescribed only for prevention of endocarditis and joint prosthesis infection.

Fig. 5.3 Post operative infection presenting as an acute paronychia. The patient did not perform the daily home care as indicated. The collection of pus was drained and systemic antibiotics were prescribed

Management

- If infection occurs, first sample the pus. Then administer antibiotics against staphylococcus and adapt later according to the antibiogram.

Necrosis

Necrosis is an unpredictable complication. The condition may involve the whole extremity as well as a very small limited area (Fig. 5.4). Cases of digital necrosis have been described after accidental extended use of tourniquet [7]. It may also arise from lidocaine with epinephrine in patients with impaired blood supply of the limbs [8] (Fig. 5.5) from too tight stitches (Fig. 5.6), or from excess volume infiltration of the local anaesthetic.

Prevention

- Epinephrine for nail surgery is not necessary as the surgery is almost always performed with a tourniquet.
- Avoid anything that may impair the venous and lymphatic flow: inject the minimum volume of anaesthetic necessary, avoid proximal « ring » block; place the tourniquet just before starting surgery and remove it as soon as the procedure is over.
- Do not over-tighten stitches especially in Dubois' procedure.

Fig. 5.4 Discrete necrosis of a small zone of the proximal nail fold overlying the area of chemical cautery. This event is rare. It will heal without any consequence, neither on the success of the surgery, nor on the healing time (Coll M. Henry, Rennes, France)

Fig. 5.5 Total necrosis of the tip of the great toe. The patient received epinephrine-containing anesthesia from a resident. He was a heavy smoker and had severe peripheral impairment

Fig. 5.6 Necrosis of the distal wall 4 days after a Dubois' procedure for distal embedding nail. Healing was complete without any sequelae at 4 weeks post-op

Management

- Give strong pain killers as the condition is extremely painful.
- Prescribe peripheral vasodilatators (calcium channel blockers), blood thinners (aspirin) in order to increase the blood flow in the extremities.
- Start systemic antibiotics to avoid potential infection.
- Involve hand surgeons if debridement is required.

Recurrence

Recurrence is a common complication in surgery of ingrowing toenails. It is not rare to see a patient that had multiple surgeries for the same ingrowing toenail. Either the surgeon is at fault (Fig. 5.7) by selecting and performing an inadequate procedure, or the patient that keeps on tearing off his nails or keeps clipping his nails in the distal corners.

Prevention

- Clearly explain to the patient the procedure that will be performed and give him the average recurrence risk rate. The latter is in most instances under 5 %.
- Always perform surgery that you master.
- Be sure to have removed the part of matrix you desired if working with narrowing the nail plate.
- Bleeding is the main reason for recurrence in chemical cautery.
- Excessive granulation tissue may develop after wide debulking. Careful follow-up of the wound is mandatory in order to adapt the dressing.

Fig. 5.7 Recurrence of an ingrowing toenail. One can see that the lateral strip that was avulsed regrew completely as the matrix horn was not properly destroyed. This is a common complication from beginners with chemical cautery: the surgical field should be completely bloodless. Cauterants induce a coagulation of protein and if any blood is present, they will coagulate the blood proteins instead of the proteins of the nail bed and matrix

Management

- Surgery should be repeated after having discovered what went wrong.

Implantation Cyst

Implantation cysts arise from the implantation of epidermal cells into deeper layers while incising or suturing. They are a well-known but not a frequent complication of nail surgery. They are associated with suturing and needle trauma and may arise from any type of surgery involving the nail apparatus (Fig. 5.8). They were reported as being the most common complication after full thickness grafts following complete nail unit excision [9].

Fig. 5.8 (**a**) Implantation cyst on the lateral aspect of a great toenail after an Emmert's procedure. (**b**) Excision of the implantation cyst

Prevention

- Minimizing needle trauma will help prevent this complication.
- Avoid pulling excessively with the forceps on the lateral edge of an incision. Prefer hooks.

Management

- Implantation cysts are not regarded as major complications and can be easily excised.

Reflex Sympathic Dystrophy (RSD)

This unpredictable complication has been linked to a myriad of inciting events, most commonly bony fractures, as well as nail surgery [10–12]. The syndrome is more common in women and peaks around the age of 50. The clinical course of RSD is characterized by three stages (acute, dystrophic and atrophic) with significant overlap. The acute stage starts within hours or days of the injury and lasts around one month. It is characterized by a triad of sensory (pain, mechanical allodynia, hyperalgesia, hyperesthesia), autonomic (abnormal blood flow and temperature regulation with hyper or hypohidrosis), and motor (decreased muscle strength, tremor) symptoms. The pain is described as spontaneous and continuous; it is felt as a deep pain and has a burning, shooting, or throbbing character. It is typically out of proportion to the inciting event, is never limited to a single nerve distribution and may have an orthostatic component (pain is worse in dependent position). The dystrophic stage occurs after 3–6 months and is characterized by a thin, glossy skin with hyper or hypotrichosis [13]. The nails may be affected during this stage and are usually described as brittle but acute inflammation and leukonychia have also been described [14]. The atrophic stage, starting on average 8 months post surgery, may be self-limited or progressive leading to irreversible atrophy of the skin and skeletal muscles, joint contractures, and osteoporosis of the underlying bone.

Prevention

- Keeps always RSD in mind when facing a patient with abnormal pain post operatively.
- Always first rule out any other cause for pain.
- Ask the patient to mobilize his/her toe as soon as 2 days after surgery.
- RSD occurs twice more often on the fingers. The risk on the toenail is extremely limited.

Management

- Do not delay referral to a specialized pain clinic for early diagnosis.
- Treatment modalities include physical therapy, cognitive and behavioral therapy, drugs (anti-inflammatory drugs, membrane stabilizing drugs), peripheral nerve blockade and sympathetic ganglion blockade. Refractory cases may benefit from chemical or electrical neuromodulation modalities (intrathecal pump, electrical spinal cord stimulation).

Hypertrophic Scar and Cheloid

Hypertrophic scars and keloids of the nail apparatus are very infrequent and unpredictable. They have been described after electrosurgery for recurring ingrowing toenails (Fig. 5.9) and after grafting of the nail bed. Amazingly, hypertrophic scars and keloids at the nail unit are not described as more frequent in colored people.

Prevention

- Close follow-up of the healing up to 6 months in order to start treatment as soon as possible.

Fig. 5.9 Terrible cheloids after electrocautery for permanent destruction of the nail matrixes (Coll Dr Burden, UK)

Management

- First-line treatment is the association of steroid infiltration and silicone gel and/or pads. Surgery is contraindicated.
- If failure, brachytherapy may be proposed, especially in patients under 60 years old.

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Chapter 6
Case Reports

Clinical Case 1 Nilton Gioia Di Chiacchio

Fig. 6.1 This 20 year-old male had been suffering from a recurrent ingrowing of the great toenail for the last 9 years. He went through eight different surgical procedures (the patient could not explain them) before he came to us

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Type of Ingrowing Toenail

Bilateral ingrowing with moderate soft tissue hypertrophy.

Scoring

Heifetz III

Aim of the Treatment

The aim of the procedure should be to remove a portion of the hypertrophic lateral nail folds together with the lateral matrix horns, in order to ensure a definitive cure.

Management

A suitable technique here would be the removal of a lateral portion of the nail unit and lateral fold, as performed for a longitudinal lateral biopsy, in a lazy S excision. This allows a fast recovery with good cosmetic issue and a low chance of recurrence.

The incision curves proximally to be sure to remove the most proximal and lateral horns of the matrix. One should remember that the lateral horns might reach to or even beyond the midline of the lateral aspect of the great toe. This anatomical particularity explains why spicules are the most common complication of this procedure if not properly done.

This surgery requires a patient in good general health, with no history of diabetes or vascular disease. The patient must be advised that the post-op is very painful and that potent pain killers will be required. Sandals should be worn for 3 weeks until removal of the stitches. Labour interruption is expected to be at least 1 week (according to the patient's work).

Alternative Treatments

Curettage of the granulation tissue along with avulsion of a lateral strip of nail plate and phenolization of the lateral horns of the matrix is another good option. This procedure is less painful and return to work is possible after 2 days, but oozing and twice daily home care will last at least 3 weeks.

Fig. 6.2 Delimitation of the tissue–S excision

Fig. 6.3 Delimitation of the tissue–S excision

Fig. 6.4 Delimitation of the tissue–S excision

Fig. 6.5 Delimitation of the tissue–S excision

Fig. 6.6 After excision of the lateral nail folds and nail matrix

Fig. 6.7 After excision of the lateral nail folds and nail matrix

Fig. 6.8 After excision of the lateral nail folds and nail matrix

Fig. 6.9 Immediately post op–suture with nylon 3-0

Fig. 6.10 Immediately post op–suture with nylon 3-0

Fig. 6.11 Immediately post op–suture with nylon 3-0

Fig. 6.12 Immediately post op–suture with nylon 3-0

Result

Fig. 6.13 Post op Day 2

Fig. 6.14 Post op Day 15

Fig. 6.15 Post op Day 30

Fig. 6.16 Post op Day 120

Fig. 6.17 Post op Day 210

Clinical Case 2 Nilton Gioia Di Chiacchio

Fig. 6.18 This 18 year-old male had been suffering from a recurrent ingrowing great toenail for 2 years. He went through three chemical cauterizations of the lateral nail folds granulomas together with oral antibiotics without success. The nail plate had never been touched

Type of Ingrowing Toenail

Bilateral ingrowing with severe soft tissue hypertrophy.

Scoring

Heifetz III

Aim of the Treatment

The aim of the procedure should be to remove a generous portion of the hypertrophic lateral nail folds, preserving the distal nail fold, associated with removal of the lateral matrix horns. Thus, the treatment will act both on the cause of the ingrowing (too wide nail plate) and on its consequence, the hypertrophic lateral folds (resulting for the chronic ingrowing) perpetuating the condition.

Management

It was decided for a generous removal of the lateral nail folds with phenolization of the matrix horns and preservation of the distal nail fold (Vandenbos' procedure). The latter had to be preserved as it was not hypertrophic and its conservation would avoid a parrot peak nail in the long-term post operative, which may be observed in some cases after the Super U technique.

The excision of the hypertrophic lateral nail folds exposes the full lateral edges of the nail plate. Two lateral strips of nail plate are avulsed down to the very bottom of the proximal cul-de-sac. The surgical field should remain dry, without any blood, and the chemical cautery of the matrix horns, using phenol, is performed. A running lock suture is performed on the lateral nail folds for haemostatic purposes.

Injecting bupivacaine after the removal of the tourniquet will stop the bleeding by creating a large edema of the area and will allow a comfortable post op for 8 h.

Antiseptic ointment covered with non-adherent gauze is placed onto the wound. Gentle pressure may be obtained with some amount of cotton mesh and elastic gauze. This dressing must be held for the first 48 h postop.

Good general health is mandatory for this procedure (no history of diabetes or vascular disease). The patient must be advised that the postop is moderately painful and that painkillers will be required. Home care will consist in twice-daily soakings in tepid water with an antiseptic solution and application of an antiseptic ointment on the wound until complete healing. Sandals should be worn until then. Labour interruption is expected to be 4–6 weeks.

Alternative Treatments

Performing only the debulking of the excessive surrounding tissues would have been an option, either with secondary intention healing (Super U, Vandenbos techniques) or with suturing (Noel's procedure) but the cause of the ingrowing (too wide nail plate) would not have been treated at the same time, exposing this patient to possible recurrence. Coupling both procedures increases greatly the rate of definitive cure.

Fig. 6.19 Drawing of the excision to be performed

Fig. 6.20 The removal of the hypertrophic lateral nail folds clearly shows the cause of the ingrowing: too wide nail plate

Fig. 6.21 Phenolization of the matrix horns, after avulsion of two lateral strips of nail

Fig. 6.22 Immediate post op. Running lock suture–Vicryl 3-0

Result

Fig. 6.23 Post op Day 2

Fig. 6.24 Post op Day 15

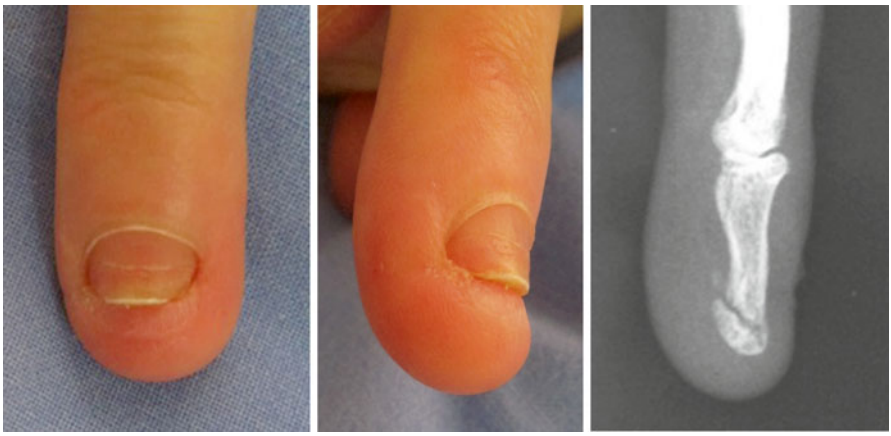
Fig. 6.25 Post op Day 15

Fig. 6.26 Post op Day 15

Fig. 6.27 Post op Day 25

Fig. 6.28 Post op Day 160

Clinical Case 3 Nilton Gioia Di Chiacchio



Figs. 6.29, 6.30 and 6.31 This 53 year-old female had a trauma on her 4th right finger 9 months ago, associated with a fracture of the distal phalanx and nail loss. The new nail is growing out but causes her a lot of discomfort distally

Type of Ingrowing Toenail

Distal Embedding

Scoring

Heifetz I

Aim of the Treatment

The procedure should lower the distal wall against which the distal nail plate abuts and causes pain. Freeing the nail plate will allow it to grow out and relieve the patient.

Management

Removal of a crescent-shaped strip of flesh down to the bone, all around the distal nail unit (Fish-mouth incision) will immediately lower the distal tip of the nail bed and pulp, freeing the nail. This procedure is known as the Howard-Dubois' technique.

The fish-mouth incision should be carried out parallel to the distal groove around the tip of the digit, about 5 mm below the level of the distal and lateral grooves reaching 5 mm into the lateral aspects of the distal phalanx. The incision starts and ends 5 mm proximal to the end of the lateral nail fold. A second incision is made to yield a wedge of 5 mm at its greatest width in the middle of the distal nail fold. Enough fat should be removed in order to allow closure. Sutures may be simple stitches. They should re-approximate the defect and not pull too much on the distal nail fold to avoid necrosis. A greasy non-adherent dressing is placed directly on the wound and covered with a not too tightened bulky dressing. The limb should be elevated for 2 days.

Pain is severe from the pulling down of the tip of the finger and potent pain killers should be prescribed.

Alternative Treatments

Conservative treatments such as softening the distal nail plate with urea 40 % or thinning it with a drill, taping the distal wall down or fixing an acrylic nail may suffice in moderate cases. In more severe cases, surgery is mandatory. Shaving the distal wall will work but in adults may lead to permanent shortening of the nail bed with subsequent distal onycholysis.

A distal "Super U" might be an option, but remains a bit aggressive for a moderate case like this one.

Fig. 6.32 Delimitation of the tissue

Fig. 6.33 Delimitation of the tissue

Fig. 6.34 Delimitation of the tissue

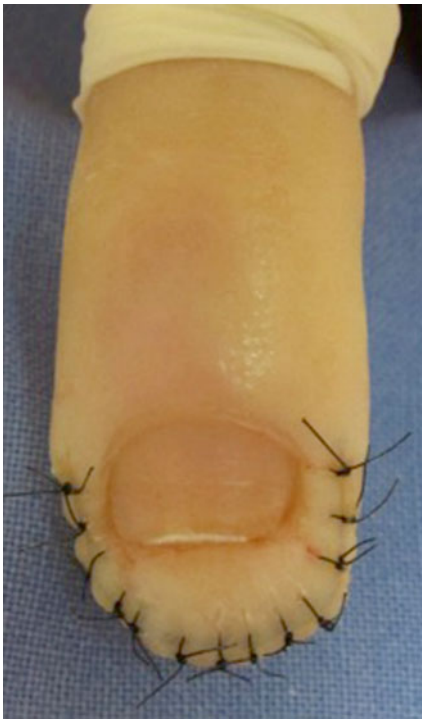


Fig. 6.35 Immediate post op. Nylon 4-0

Fig. 6.36 Immediate post op. Nylon 4-0

Result

Fig. 6.37 Post op Day 10

Fig. 6.38 Post op Day 30

Fig. 6.39 Post op Day 30

Clinical Case 4 Nilton Gioia Di Chiacchio

Fig. 6.40 This 33 year-old male had been suffering from a recurrent ingrowing of the lateral side of the great toenail for 3 years. He went through some conservative procedures with podiatrists without success. There was a discrete transverse overcurvature that induced a repeated friction against the upper part of the shoe, resulting in a distal and median onycholysis

Type of Ingrowing Toenail

Unilateral ingrowing with moderate soft tissue hypertrophy.

Heifetz Scoring

Grade III

Aim of the Treatment

The aim of the procedure is directed to suppress the conflict between the lateral part of the nail plate and the lateral nail fold. For this, a combination of narrowing the plate and reducing the size of the lateral fold seems to be the best option. Curettage of the hypertrophic tissue coupled with a chemical cautery of the lateral horn of the matrix was chosen.

Management

After curettage of the hypertrophic and granulation tissue of the lateral nail fold, a lateral strip of the nail is avulsed. In a bloodless field, phenol is applied onto the exposed portion of nail matrix.

Phenolization is a widely used and easy to perform technique, with high cure rates and very few complications, the main one being infection.

In this special case, at the 40th post operative day, a mild nodule with moderate erythema developed just above the portion of the matrix that was phenolized.

A foreign body reaction and an inclusion cyst were considered as a possible complication.

The patient underwent a new surgical procedure in order to explore the area. A "L" incision was performed (Frost's procedure), running into the lateral sulcus and curving down proximally to allow a complete exposure of the lateral horn of the matrix. This revealed an inclusion cyst that was removed. Nylon 4-0 was used for re-approximation of the edges of the incision.

Result

Frosts' technique was described in 1950 as a modification of the original technique performed by Winograd (see page 80 Chapter 4). It is best indicated for ingrown nail type I–II and especially for recurrent cases. In our case, the "L" incision was not performed to treat the ingrown nail, but to expose the lateral matrix area.

Fig. 6.41 Immediate postop–phenol

Fig. 6.42 Post op Day 10–phenol

Fig. 6.43 Post op Day 40–phenol. Note the erythema and the nodule

Fig. 6.44 Exposure of the lateral matrix area, just after the "L" incision

Fig. 6.45 Immediate postop

Clinical Case 5 Nilton Gioia Di Chiacchio

Fig. 6.46 This 16 year-old male had been suffering from a recurring ingrowing great toenail for 2 years. He already went through two surgical procedures (the patient cannot describe which procedures he went through) before he came to us. The patient has plantar hyperhidrosis

Type of Ingrowing Toenail

Bilateral ingrowing with moderate soft tissue hypertrophy.

Heifetz Scoring

Grade III

Aim of the Treatment

The aim of the procedure should be to remove the granulation tissue and see what is at issue, either a too wide or an overcurved nail plate. Then narrowing the plate should definitely solve the problem. Chemical cautery with phenol was decided.

Management

Hyperhidrosis is a known cause of precipitating nail ingrowing. It softens the nail and the latter breaks in the lateral sulcus, giving rise to an irregular nail edge that literally acts as a saw in the lateral sulcus. For this patient we recommended a 20 % aluminium hydroxide cream to limit sweating and potential recurrence.

Alternative Treatments

Noel's procedure or a Super U might have been another option, thus avoiding any modification of the nail plate. The latter were not chosen because of the long healing period (over 8 weeks). Here there is no more ingrowing, but the nail plate is a bit too narrow and the lateral edges are very fragile. A posteriori, a Noel's procedure would have been a better choice and would have given a better cosmetic result. But the patient wanted a quick, effective and painless treatment. He is very happy with the results.

Fig. 6.47 Immediate post operative phenolization

Fig. 6.48 Post-op Day 40. Note the leukonychia on the proximal nail plate. It shows an excess of detachment of the nail plate and an over-burning of the nail matrix due to excess of phenol

Result

Fig. 6.49 Post-op Day 240. Note that the nail plate is markedly narrowed from the overzealous chemical cautery

Clinical Case 6 Nilton Di Chiacchio

Fig. 6.50 48 years-old male, radiology technician. For the last 3 years, he followed a podiatric treatment for an ingrown great toenail, without improvement. Granulation tissue grew despite systemic antibiotics and ointments. The patient admitted poor personal care. No personal history of systemic disease was recorded

Scoring–Type of Ingrowing Toenail

Juvenile ingrowing toenail. Hypertrophic soft tissue, chronic infection and granulation tissue in the nail grooves

Heifetz Scoring

Grade III

Aim of the Treatment

Removal of granulation and hypertrophic tissue (as much as needed) and narrowing the nail plate.

Management

After evaluation of the clinical presentation and the daily activities of the patient, it was decided to combine a complete removal of hypertrophic tissues with a partial bilateral nail matrix cauterization.

After a distal digital block, a tourniquet was applied. The granulation and hypertrophic tissues were removed using a sharp curette.

Two lateral strips of nail (3 mm) were split from the distal nail plate up to its most proximal part and avulsed. Phenolization was performed on both exposed sides. A good evaluation of the width of the nail strip to be avulsed is a main issue, in order to avoid excessive narrowing of the nail plate, associated to poor cosmetic outcome. One should remember that the amount of granulation and hypertrophic tissues is not proportional to the size of the strip to be removed.

Mild pain killers were prescribed. The patient was asked to bathe and wash the wound twice a day and to cover it with an antiseptic ointment and gauze till complete healing, which occurred after 30 days. He returned to his job 7 days after the procedure, wearing wide comfortable shoes.

Alternative Treatments

As the hypertrophy of the soft tissues involved the lateral and distal nail folds, a "Super U" could have been another option. This choice was declined as the healing time was too long for this patient wishing to promptly return to his daily activities.

Fig. 6.51 Before surgery, prominent granulation and hypertrophic tissues

Fig. 6.52 After removal of granulation and hypertrophic tissues followed by nail matrix phenolization

Result

Fig. 6.53 Outcome after 8 months

Clinical Case 7 Nilton Di Chiacchio

Fig. 6.54 Pincer nail–Note the triangular shape due to the distal overcurvature of the nail plate and the thickened nail plate

57 year-old woman, lawyer, complaining of a painful right great toenail for the last 5 years. Wearing shoes is uncomfortable and walking long distance is extremely painful. The nail plate is very hard and difficult to cut. She has developed diabetes and hypertension 15 years ago. Her mother has the same toenail problem.

Scoring–Type of Ingrowing Toenail

Pincer nail

Heifetz Scoring

Grade I

Aim of the Treatment

The aim of the treatment should be directed to decrease the pressure of the lateral nail edges into the lateral nail folds.

Management

Considering the occupation of the patient and her comorbidities (diabetes and hypertension), a conservative treatment was chosen, using a plastic memory alloy device. The procedure is easy to perform and no anesthesia is required.

The nail plate is cleaned with alcohol and pumiced (file or drill) to smooth the surface, erasing any ridging and eliminating varnish staining and keratin granulations. This step allows increasing the adhesion of the plastic device to the nail plate. The length of the plastic device is shaped to the width of the nail plate. The surface of the plastic device to be glued to the nail plate should also be gently pumiced to increase adhesion. A thin line of cyanoacrylate glue is deposited transversally on the nail plate, at its distal third. The device is placed, abraded surface down, onto the glue and a firm pressure with the thumbs is exerted for at least two minutes. The procedure should be repeated every 2 months, after removal of the previous device.

The patient is advised to avoid manicure and enamels. Pain improvement is expected after 1 week and the enlargement of the nail plate slowly occurs over several months.

Alternative Treatments

If the patient had accepted to take time off work, a surgical procedure, such as narrowing the nail plate with chemical cauterization, along with flattening of the nail bed (Haneke and Fanti's techniques) would have been other possible options.

Fig. 6.55 Pre-treatment appearance

Fig. 6.56 The plastic device is a bit too wide for the plate and has to be shaped to the proper size

Fig. 6.57 Pumicing the surface of the nail plate to enhance adhesion

Fig. 6.58 Pumicing the undersurface of the device to increase its adhesion to the plate

Fig. 6.59 A transverse line of cyanoacrylate glue is applied onto the nail plate

Fig. 6.60 The device is pressed firmly on the nail plate

Fig. 6.61 Aspect immediately post treatment

Result

Fig. 6.62 Results of the technique after six months. Compare with Fig. 6.54

Clinical Case 8 Nilton Di Chiacchio

Fig. 6.63 32 year-old healthy woman, complaining of a painful left big toe for the past 6 years. She stated that the nail plate started to pinch the lateral nail folds and progressively the curvature of the plate (and pain) increased over time. Her father and her oldest sister have the same problem. An X-ray (lateral view) showed a small osteophyte of the dorsal part of the distal phalanx

Scoring–Type of Ingrowing Toenail

Pincer Nail

Heifetz Scoring

Grade I. Slight erythema and swelling of the nail folds.

Aim of the Treatment

The aim of the treatment is the widening of the distal nail plate along with the flattening of the nail bed, in order to decrease the pressure of the lateral aspects of the nail plate onto the folds.

Management

Considering that the patient is young and healthy, the Fanti's procedure was chosen to treat this pincer nail.

After a distal digital block, the procedure starts with a classical phenolization on both sides of the nail plate: after avulsion of two lateral strips of nail plate, both sides of the exposed matrix are cauterized using 88 % phenol. The remnant nail plate is then delicately avulsed. A strip of skin (about 3 mm wide) is removed all around the distal tip of the toe, in a "U" shape excision. The nail bed is incised in its medial part, down to the bone, starting 2 mm distally to the distal border of the lunula up to the hyponychium. A perpendicular incision to the previous one is performed, running across the hyponychium. Each side of the nail bed is cautiously dissected from the bone, forming two flaps that are reclined to better expose the dorsal aspect of the distal phalanx. The osteophyte is cut away using a bone rongeur, thus flattening the dorsal aspect of the bony phalanx. The two nail bed flaps are spread laterally over their original position and sutured to the lateral edge of the "U" incision, leaving a V shaped defect that is left for healing by secondary intention.

The pain improvement is expected after 1 week and the enlargement of the nail plate occurs slowly several months over.

Alternative Treatments

Conservative treatment (orthesis) could have been an alternative treatment. Even if it may give good results, it takes a long time to achieve a flattening of the plate (over several months). Limiting the treatment to only phenolization is also another option, suppressing immediately the "pinching" of the lateral nail folds onto the bed. It is a fast and very comfortable procedure, with quick recovery but in some instances the nail bed does not flatten completely and this may be responsible for the remaining discomfort especially with footwear.

Haneke's technique is a variant of this procedure with similar results.

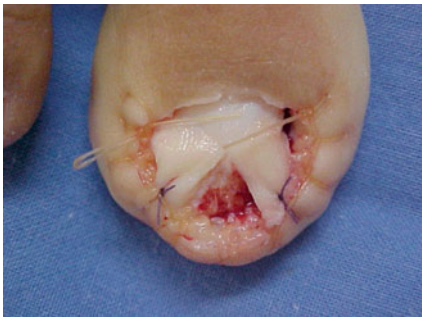


Fig. 6.64 Immediate post operative appearance

Result

Fig. 6.65 One year post operative

Clinical Case 9 Nilton Di Chiacchio

Fig. 6.66 35 year-old male, telemarketer. Plays volleyball and runs ten kilometers every week-end. Due to trauma, his nail plate was shed twice and since then, the new nail became ingrown laterally and distally, hindering the practice of sports. Clinical examination showed a hypertrophy of the lateral nail folds and a distally embedded nail plate. Due to surgery on his contralateral knee, he was excluded from any sport activity for 4 months

Type of Ingrowing Toenail

Lateral and distal embedding. Chronic infection and hypertrophy of the surrounding tissues.

Heifetz Scoring

Grade III

Aim of the Treatment

Removal of the hypertrophic tissue without intervening on the nail plate and nail matrix, to let the new nail grow out.

Management

Considering the hypertrophy of the lateral and distal nail folds, the chance of having the patient excluded from sports for several months and the patient's occupation allowing him to remain seated at work, without the need to wear shoes, it was decided to perform a wide debulking of the hypertrophic tissue without narrowing the nail plate ("Super U").

After a distal digital block, three incisions were performed:

1. A bilateral straight incision, perpendicular to the proximal nail fold starting at the cuticle line and ending at the external limit of the hypertrophic tissue;
2. Another incision starting at this point, running parallel to the lateral fold, distal fold, and contra lateral side, ending at the other nail fold, forming a large "U";
3. The third incision begins at the same place as the first one, running through the lateral nail groove up to the distal fold, turning to the other side and ending at the beginning of the contralateral nail groove. One should pay attention to keep a distance of 2 or 3 mm from the hyponychium to avoid removing the onychodermal band.

The hypertrophic tissue was removed en block, and dissected from the bone. Hemostasis was achieved with a running locked suture performed with absorbable suture (4-0) around the distal part of the wound. Healing occurred by second intention in about 40 days.

Alternative Treatments

Others techniques could have been used, in order to remove the hypertrophic tissue, such as the Howard-Dubois' procedure. The latter is however insufficient to remove enough of the hypertrophic tissue. The Vandenbos' technique would not have been able to remove the distal hypertrophy.

Fig. 6.67 After removal of the lateral and distal hypertrophic tissue in a "U" shape excision

Fig. 6.68 Running-locked suture around the distal edge of the wound to limit bleeding

Result

Fig. 6.69 Result after 3 months

Clinical Case 10 Nilton Di Chiacchio

Figs. 6.70 and 6.71 25 year-old healthy male student. Seven years ago, a trauma caused the avulsion of the second left toenail. The new nail plate grew thicker, detached from the nail bed, with lateral malalignment, giving rise to a severe longitudinal overcurvature ("parrot beak"). He complained about pain while wearing shoes, walking and practicing sports. Podiatric care was tried without any improvement

Scoring–Type of Ingrowing Toenail

Onychogryphosis

Heifetz Scoring

not applicable.

Aim of the Treatment

As there is no surgical technique allowing an improvement of such a permanent nail plate dystrophy, secondary to nail matrix and nail bed damage, and, considering the limitations in the patient's daily activities, it was decided to permanently destroy the altered matrix.

Management

After a distal digital block, a tourniquet is placed. The nail plate was easily detached from its proximal attachments (proximal nail fold and matrix), as the distal bed was epithelialized. A cotton swab soaked with 88 % phenol solution was rubbed on the nail matrix and nail bed for a bit more than one minute.

Alternative Treatments

Due to the permanent damage of the nail matrix and bed, only some conservative treatments could be performed, such as applying 40 % urea paste and nail abrasion. Both decrease the thickness of the plate, but the procedure should be repeated at regular intervals.

Fig. 6.72 After nail plate removal

Fig. 6.73 After the nail matrix phenolization

Result

Fig. 6.74 Result 2 months post operatively

Clinical Case 11 Marie Caucanas

This 19 year-old young man presented with a 5 year history of ingrowing great toenail (Fig. 6.75a, b). It was mildly painful, but bothering him during footwear. He had not sought for any treatment before.

Fig. 6.75 (**a**, **b**). Clinical views of the ingrowing big toenail

Fig. 6.76 (**a**, **b**) Immediate post operative appearance

Fig. 6.77 One-week post-op

Fig. 6.78 Six-week post-op

Fig. 6.79 Six-month post-op

Type of Ingrowing Toenail

Juvenile ingrowing toenail

Scoring

Heifetz stage III, considering the formation of granulation tissue in the nail grooves and hypertrophy of the surrounding tissues.

Aim of the Treatment

The aim of the treatment was to reduce the volume of hypertrophic tissues and in the mean time to narrow the underlying too wide nail plate.

Management

The first choice treatment ended up to a partial matrix phenolization after aggressive curettage of the pyogenic granulomas (Fig. 6.76a, b). The latter revealed the too wide nail plate for the bed.

An alternative to this technique could have been a Noel's procedure, though sometimes it brings light to a rather too large nail plate that needs an additional small partial matricectomy to fully cure the condition. It is also more painful in the immediate post operative following days. In the author's opinion, this case highlights the versatility of segmental chemical cautery, which can be performed in the vast majority of the cases without prominent hypertrophy of the lateral walls.

Result

The patient experienced mild pain and had a quick relief of the initial symptoms (Fig. 6.77). The result after a 6 week and 6 months follow-up is shown in Figs. 6.78 and 6.79.

Clinical Case 12 Marie Caucanas

This 13 year-old boy was sent by his GP for a 1 month-lasting painful lateral ingrowing of his left great toenail (Fig. 6.80).

Fig. 6.80 Ingrowing left lateral great toenail, precipitated by a hallux valgus and a Morton's toe

Type of Ingrowing Toenail

Juvenile ingrowing toenail.

Scoring

Heifetz stage I, considering the slight erythema and swelling of the lateral lip of periungual soft tissues.

Aim of the Treatment

Obvious orthopedic abnormalities favouring the occurrence of this ingrowing toenail were noticed: a marked hallux valgus associated with a Morton's toe (second toe longer than the first one), leading to the overlapping of the second toe over the big toe when the shoe is worn. Hence, the main goal consisted in reducing the inflammation of the soft tissue and improving the foot deformities.

Management

As a first choice treatment, a mixture of local potent steroids with fucidic acid 2 % cream was applied, under occlusion, at night during 2 weeks. It solved the inflammation and the patient was prescribed corrective orthopedic insoles with a toe separator orthoplasty. An alternative treatment could have been a partial matrix phenolization though it would also have needed an additional corrective orthopaedic treatment otherwise the recurrence risk would have been high due to the presence of the associated orthopaedic toe abnormalities. In this case, a partial phenolization was considered as a too much aggressive approach, considering the very beginning stage of this ingrowing toenail.

Result

When the patient came back after a 6 months follow-up, he was fully cured (Fig. 6.81). He admitted not having worn his insole and silicon orthoplasty 3 weeks ago while hiking in the mountains, which was responsible for a subungual hematoma. He was happy to avoid surgery and willing to wear his corrective equipment on a daily basis.

Fig. 6.81 Follow-up after 6 months: the patient developed a haematoma after hiking but the ingrowing toenail did not recur

Clinical Case 13 Marie Caucanas

This 25 year-old female sought medical advice because she had been trying to clip her embedded nail plate, day after day, during several weeks, but could not reach the deepest part of it. It all started when she clipped the corner of her nail: she observed developing inflammation of the soft tissues. A spur now emerges on the hyponychium, appearing as an erythematous and oozing papule (Fig. 6.82).

Fig. 6.82 Typical aspect of a harpoon nail, with the tip of the lateral spur emerging in the hyponychium

Type of Ingrowing Toenail

Harpoon nail.

Scoring

Heifetz III, considering the chronic infection, formation of granulation tissue in the lateral nail groove and hypertrophy of the surrounding tissues.

Aim of the Treatment

Considering this type of ingrowing nail, a deroofing of the lateral fold will expose the spur. A further treatment will be decided per operatively.

Management

The patient benefited first from a curettage of the granulation tissue. The deroofing of the lateral spur revealed an increased lateral transverse curvature of the nail (Fig. 6.83). In order to correct this overcurvature and insure a definitive cure, a 3 mm strip of lateral plate was removed, taking away the offending spur (Fig. 6.84) and its corresponding part of matrix was destroyed with phenol. A greasy dressing was applied for 48 h and the patient healed quickly.

Result

After 1 year, the patient was really happy with the cosmetic result (Fig. 6.85a, b) but still continued to clip her nails too short…

Fig. 6.83 Debulking of the hypertrophic tissues and deroofing of the spur expose the transverse overcurvature of the lateral part of the nail plate

Fig. 6.84 Avulsed 3 mm strip of lateral nail plate taking away the lateral spur

Fig. 6.85 Result after 1 year, (**a**) dorsal view (**b**) front view

Clinical Case 14 Marie Caucanas

This 33 year-old male was initially treated by podologists, who persisted in clipping the corners of his left great toenail. Then the patient underwent two successive phenolizations performed by a dermatologist, apparently with consistent per operative hemorrhage. Recurrence occurred with progressive hypertrophy of the soft tissues and became chronic with epidermization of the granulation tissue (Fig. 6.86).

Fig. 6.86 Ingrown left big toe nail, with major hypertrophic lateral folds

Type of Ingrowing Toenail

Juvenile ingrowing toenail

Scoring

Heifetz III, considering the granulation tissue and the hypertrophy of the lateral soft tissues.

Aim of the Treatment

In view of this chronic ingrowing toenail associated with hypertrophic tissue covering the lateral parts of the plate, a debulking technique is a first choice.

Management

Here, the previous chemical cauteries with phenol most probably did not succeed due to the peroperative bleeding, implying that haemoglobin became the protein target of phenol, instead of the matrix.

Debulking was performed following a Noel's procedure.

The incisions were carried through the lateral nail groove, up to one centimeter into the proximal nail fold and extending laterally to remove a wedge-shaped ellipse of soft tissues (Fig. 6.87a, b). Enough tissue has to be removed, down to the lower third of the toe, while preserving some skin of the lateral aspect of the nail to ensure direct closure. This surgery does not involve the plate, nor the bed or the matrix, thus the width of the nail plate is not modified. The defect was closed with simple interrupted 4.0 sutures (Fig. 6.88a, b). It is important to remove enough soft tissues to avoid recurrences. Vandenbos' procedure could have been an alternative, with longer healing by secondary intention.

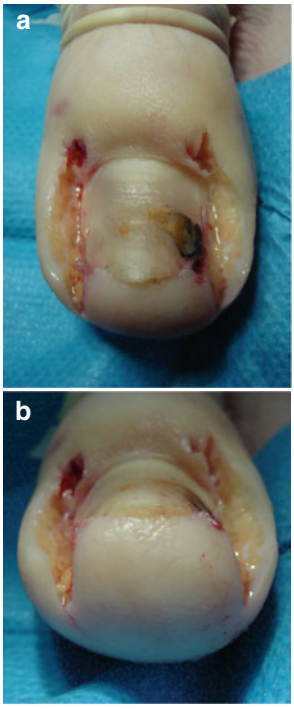


Fig. 6.87 Resection of the hypertrophic lateral folds in Noel's procedure (**a**) dorsal view (**b**) front view

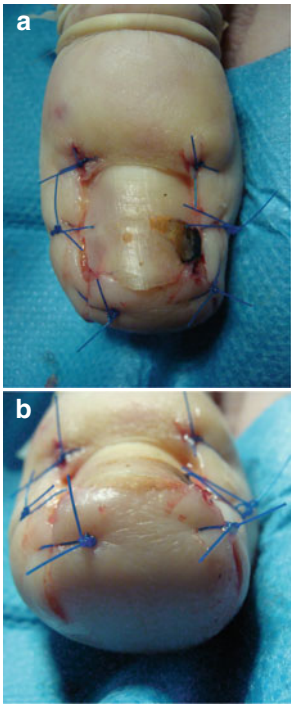


Fig. 6.88 Noel's procedure completed (**a**) dorsal view (**b**) front view

Result

After 4 months, the patient was very happy with the result (Fig. 6.89a, b). The shape of the nail appeared trapezoidal so the patient was advised to perform straight clipping of his nail, without taking away the corners. He should seek medical advice promptly if any problem arises.

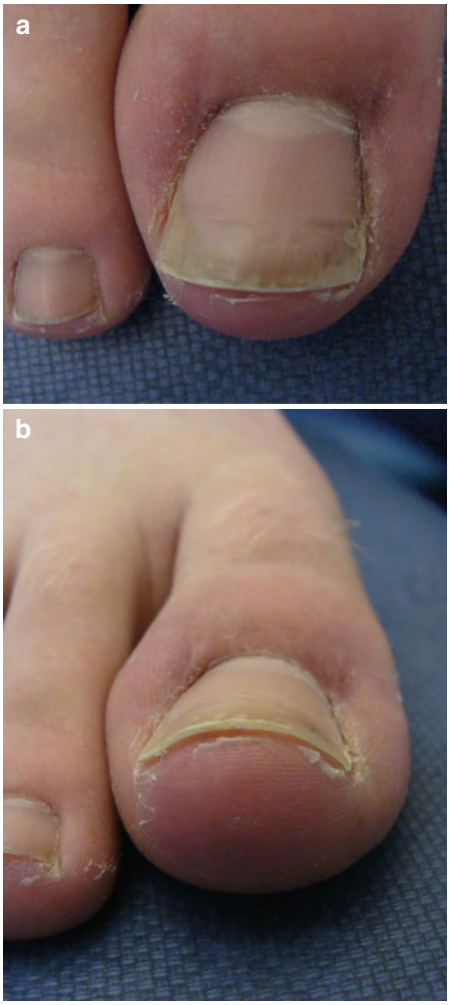


Fig. 6.89 Follow-up after 4 months (**a**) dorsal view (**b**) front view

Clinical Case 15 Marie Caucanas

This 23 year-old male presented to our department for a chronic ingrowing of the left great toenail. He had tried many conservative treatments without improvement. Pain was amazingly only moderate considering the prominent hypertrophic lateral and distal walls (Figs. 6.90, 6.91 and 6.92). However, there was a constant oozing that promoted painful infectious flare-ups requiring systemic antibiotics. These episodes are became more and more frequent and the patient wanted a radical cure. And he acknowledged that he had met a nice girl and was very anxious to undress, especially his socks….

Figs. 6.90, 6.91 and 6.92 Clinical appearance

Type of Ingrowing Toenail

Juvenile ingrowing nail.

Scoring

Heifetz III, considering the presence of granulation tissue, the hypertrophy of the surrounding tissues and the episodes of infection.

Aim of the Treatment

Considering the very severe hypertrophy of the distal and lateral nail walls, a debulking technique is the best indication.

Management

The patient benefited from a Noel's procedure, with removal of two vertical wedges of hypertrophic tissue, skimming the bone, down to the pulp. However, this procedure did not lower the distal wall covering the plate. An additional Dubois' was performed (Fig. 6.93) pulling down the distal wall.

After suturing, the nail was fully freed laterally and distally but discovered a nail with a marked transverse overcurvature, which probably initiated the condition (Fig. 6.94). As the surgery was quite large, narrowing the plate was not performed and a wait-and-see attitude was chosen.

After 10 weeks, the patient showed a fantastic improvement (Fig. 6.95), but the lateral side of the plate showed some ingrowing due to its overcurvature (Fig. 6.96). Chemical cautery was proposed to the patient to avoid further worsening, but he refused it because he felt so well without any pain.

He came back after 3 months with a frank recurrence on both sides (Fig. 6.97), with pyogenic granuloma (Heifetz III). A chemical cautery with phenol was performed (Fig. 6.98) ensuring a permanent narrowing of the nail plate. Healing occurred in 3 weeks.

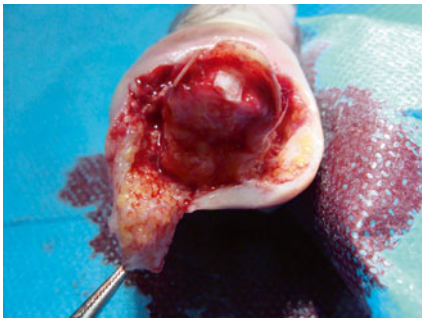


Fig. 6.93 After both Noel and Dubois' procedure

Fig. 6.94 After suturing

Fig. 6.95 Aspect 10 weeks post operatively

Fig. 6.96 Discrete recurrent ingrowing

Result

The result was optimal. No more hypertophic tissue and the overcurvature, probably the primum movens of the condition, had disappeared (Fig. 6.99 and 6.100).

Fig. 6.97 Frank recurrence on both sides

Fig. 6.98 Bilateral chemical cautery

Fig. 6.99 Long-term follow-up, upper view

Fig. 6.100 Long-term follow-up, front view. The overcurvature has disappeared

Clinical Case 16 Bertrand Richert

This 72 year-old lady, former lawyer, presented to our department for a very unsightly and painful left thumbnail (Fig. 6.101a, b). This had progressively evolved over the last 10 years. She suffered from osteoarthritis. She had never done anything as everyone told her that nothing could be done.

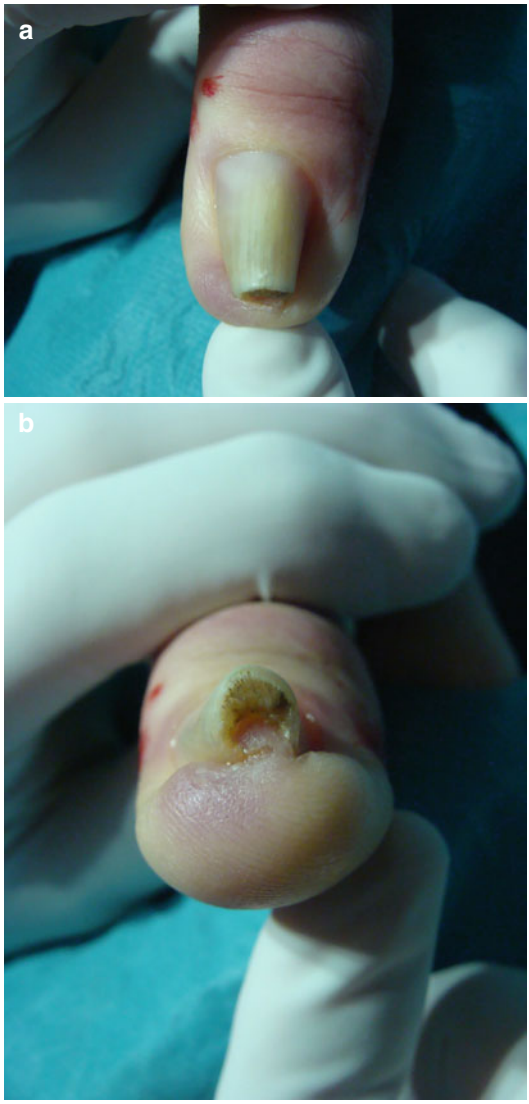


Fig. 6.101 (**a**) Pincer nail, upper view (**b**) front view

Type of Ingrowing Toenail

Pincer nail.

Scoring

Heifetz scoring I. Pain is moderate but some movement of the daily life may be very painful, like searching for keys in a bag.

Aim of the Treatment

Suppressing the pinching effect of the 2 lateral nail edges on the subungual tissue is the main goal for relieving the patient. Second comes the esthetic improvement by flattening the nail plate.

Management

Here conservative treatments are completely useless. To relieve the pressure on the subungual tissues, a chemical cautery of the lateral horns of the matrix is reasonable but this is will lead to an extremely narrow nail. This side effect may be compensated with an acrylic nail, but the latter may get easily torn away.

First choice treatment is the treatment of the cause of the condition: working on the distal bony phalanx and spreading laterally the nail bed. Several options are available, the Haneke's, Suzuki's, Fanti's or the Kosaka's procedures.

The Haneke's procedure was selected. Two lateral strips of nail were avulsed and the exposed matrix horns were cauterized with phenol. The distal 2/3 of the nail plate were delicately avulsed and an incision on the medial line of the bed, starting just ahead of the remaining plate and extending to the hyponychium was performed. A transverse incision on the hyponychium, (as a reversed T) allowed elevating two lateral flaps up to the matrix. These flaps were spread laterally and sutured to the lateral wall. Here, the problem was that the pinched nail bed left only a very narrow bed after avulsion (Fig. 6.102). We informed the patient that she would have a flat nail but must probably a narrow one.

Three months post operatively she came back for a control and the nail had even increased its transverse curvature distally (Fig. 6.103a, b), but the proximal part looked wider than before. The patient was very happy, as the pain has disappeared immediately after surgery.

Result

When she came 7 months post operatively, the nail had largely widened and had flattened completely (Fig. 6.104a, b).

Fig. 6.102 Immediately after the procedure

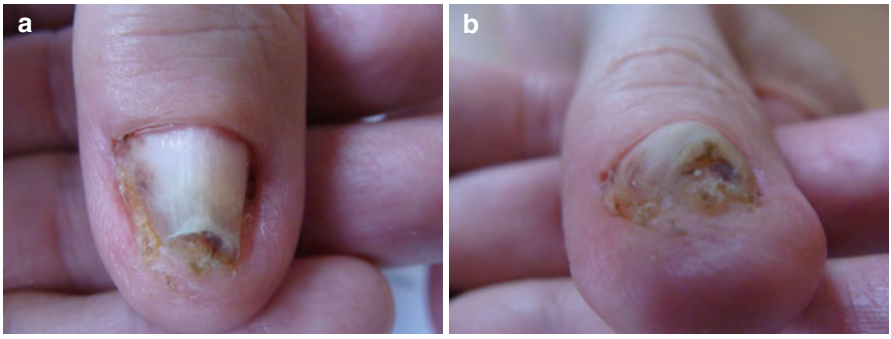


Fig. 6.103 (**a**) Three months post operatively, upper view (**b**) front view

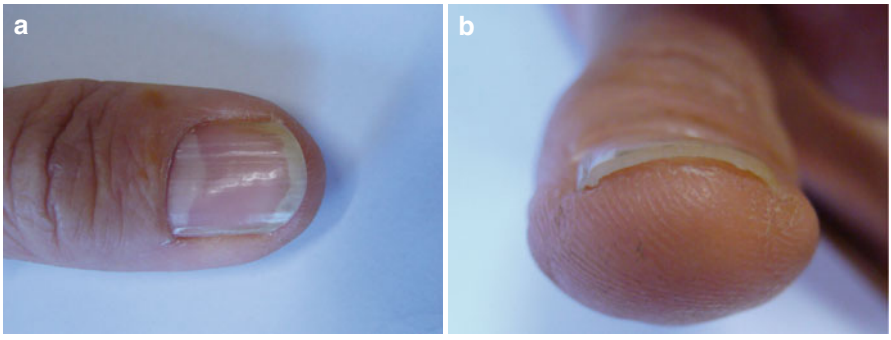


Fig. 6.104 (**a**) 7 months post operatively, upper view (**b**) front view

Clinical Case 17 Bertrand Richert

This young 16 year-old teenager suffered from ingrowing nail on both toes for the last 5 years (Fig. 6.105a, b). He had consulted several podologists without improvement and had twice a chemical cautery with recurrence. He was playing football as a hobby and this was becoming very painful. His mother obliged him to do two soakings per day and to apply some antiseptic ointment. Fortunately, probably thanks to that, he never had any infective flare-up.

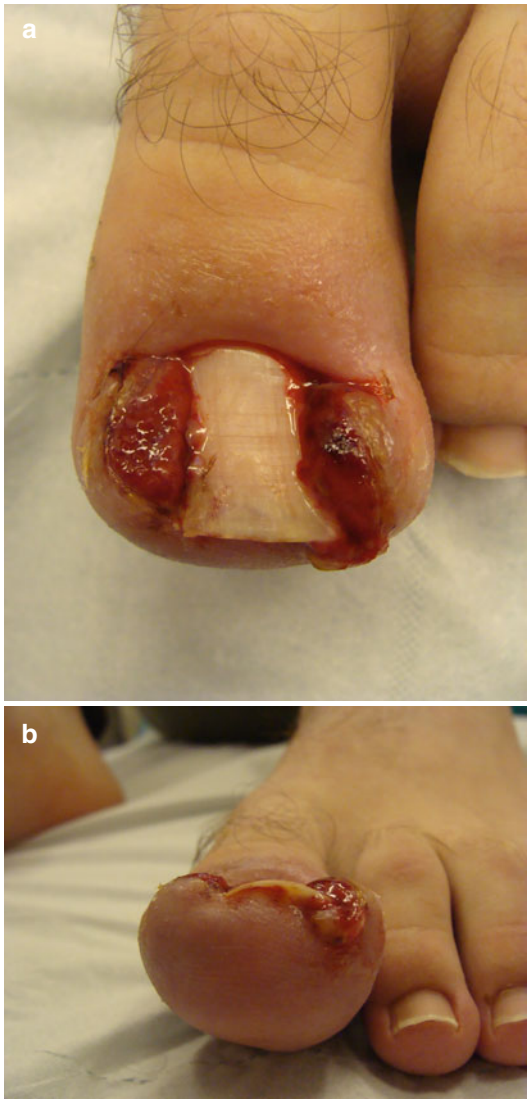


Fig. 6.105 (**a**, **b**) Clinical appearance

Type of Ingrowing Toenail

Juvenile ingrowing toenail.

Scoring

Heifetz scoring stage III. Prominent granulation tissue.

Aim of the Treatment

Here the main goal is to remove the granulation tissue and see what is the cause for the ingrowing beneath. According to what will be found, either a debulking of the lateral fold or a permanent narrowing of the plate with chemical cautery will complete the procedure.

Management

After vigorous curettage of the granulation tissue, one observed that the lateral borders of the plate are uneven and are the cause for the arising of the granulation tissue (Fig. 6.106). Careful examination of the toe in front view also reveals that the plate has transverse overcurvature (Fig. 6.107).

Lateral moderate debulking of the lateral walls was performed in order to completely free the nail (Fig. 6.108a). Upper view reveals that the nail is also too wide for its plate (Fig. 6.108b).

Two lateral strips of nails were avulsed in order to adapt the width of the nail to the size of the toe (Fig. 6.109a). This narrows also the overcurvature of the nail (Fig. 6.109b). A chemical cautery was then performed with phenol on both sides and some phenol was applied on the excision wound for haemostatic and anesthetic purposes (Fig. 6.110a, b).

Control at 1 month showed nice healing (Fig. 6.111). Post operative pain was almost nil. Complete healing occurred in 7 weeks.

A “Super U” procedure would have been too aggressive in this case, especially as there was no distal ingrowing. Another option would have been a Noel’s procedure, but this would have needed stitching and the patient lived far away, wanted the least painful post op and minimal control visits. Here a slight debulking of the lateral walls combined with a chemical cautery permitted to work on the consequences and the cause at the same time. This procedure heals easily by secondary intention (and the mother has shown that she was doing excellent home care) and phenol has an anesthetic effect post operatively.

Result

The nail has came back to a normal shape, had no dystrophy and showed no sign of recurrence (Fig. 6.112a, b).

Fig. 6.106 After curettage of the granulation tissue, one sees that the lateral borders are uneven

Fig. 6.107 Front view showing the overcurvature of the nail plate and the slight hypertrophy of the soft tissue

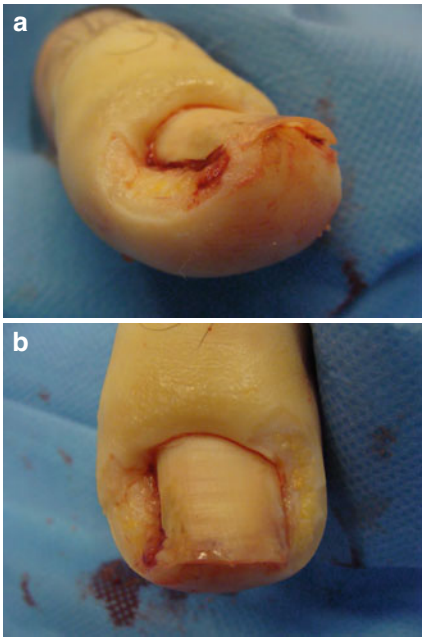


Fig. 6.108 (**a**) After slight debulking, lateral view. (**b**) After slight debulking, upper view. The nail is clearly too wide

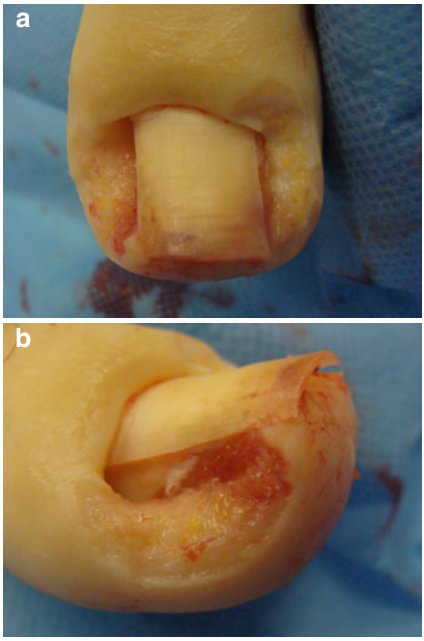


Fig. 6.109 (**a**) After avulsion of two lateral strips of nail plate, upper view (**b**) lateral view

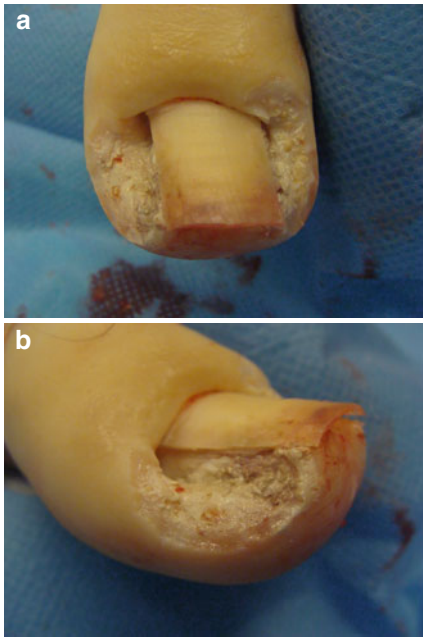


Fig. 6.110 (**a**) After chemical cautery, upper view (**b**) lateral view

Fig. 6.111 Clinical appearance, 1 month post operatively

Fig. 6.112 Clinical appearance, 1 year post operatively

Clinical Case 18 Bertrand Richert

This 39 year-old male patient sought medical advice for a painful left great toenail (Fig. 6.113a). He had a full duplication of the great toenails, on both sides (Fig. 6.113b). Amazingly, he never had any problem with the right foot, and ingrowing occurs only in between the duplicated nails, not medially or laterally.

He had problem to find adapted footwear due to the width of his foot. He was walking a lot as a postman and pain was becoming bothering.

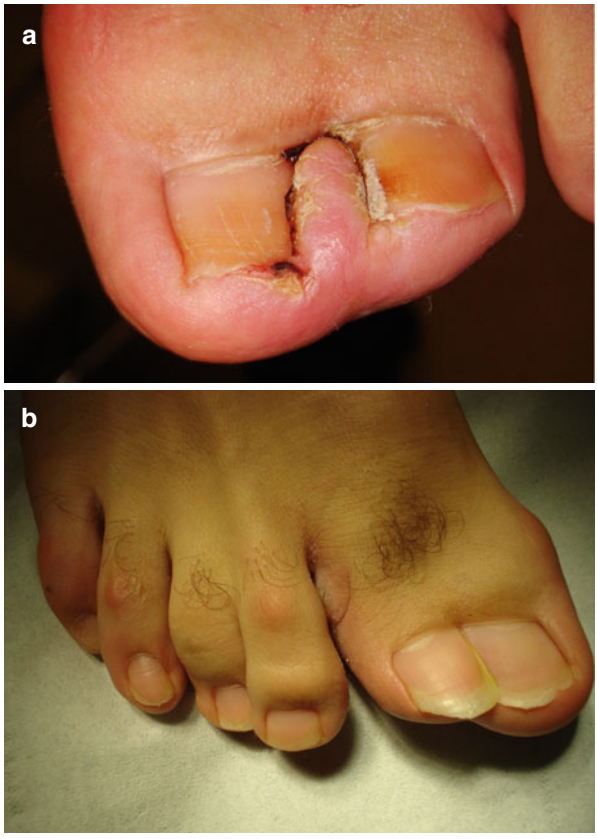


Fig. 6.113 (**a**) Duplicated toe with hypertrophic tissues squeezed between the two nails. It is obvious that the patient clipped the lateral side of one nail to try to alleviate pain. (**b**) opposite foot

Type of Ingrowing Toenail

Juvenile ingrowing toenail.

Scoring

Heifetz stage II/III

Aim of the Treatment

Removing the hypertrophic tissues and reducing the width of the two nail plates.

Management

After a vigorous curettage of the soft tissue, two lateral strips of nail, one on the lateral side, one on the medial side are avulsed. The exposed matrixes are cauterized with phenol (Fig. 6.114).

Result

Healing occurred without any problem. On a late follow-up the patient said that the ingrowing was slowly and progressively recurring (Fig. 6.115a, b).

Careful clinical examination revealed that the left great toe had indeed two extensor tendons (Fig. 6.116a) whilst the right one received only one (Fig. 6.116b). This explains why the right great toenail is problematic: the two nail units, even if knitted together, may move partially independently. This motion mobilizes and squeezes the soft tissues in between the two nails, precipitating the ingrowing. When the right extensor tendon moves, the whole duplicated nail unit moves as a whole, reason why no problem ever appeared at that site.

As the patient did not want to undergo heavy surgery (nailing the two nail units together) we proposed him to wrap the toe with a tape in order to have the two nail units moving at the same time. It worked.

Fig. 6.114 Immediately after surgery

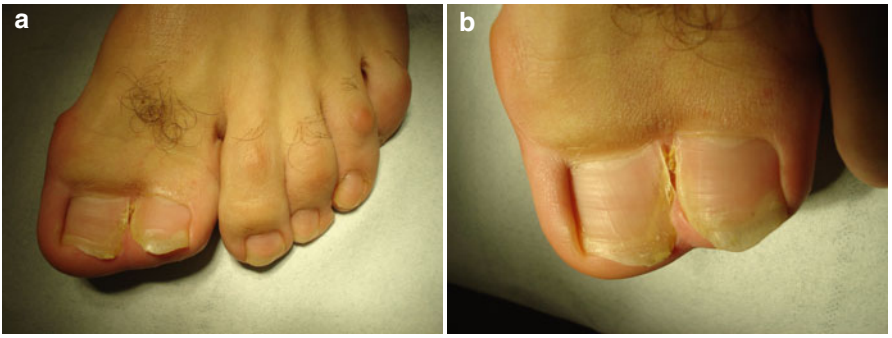


Fig. 6.115 (**a**, **b**) Discrete recurrence of the ingrowing

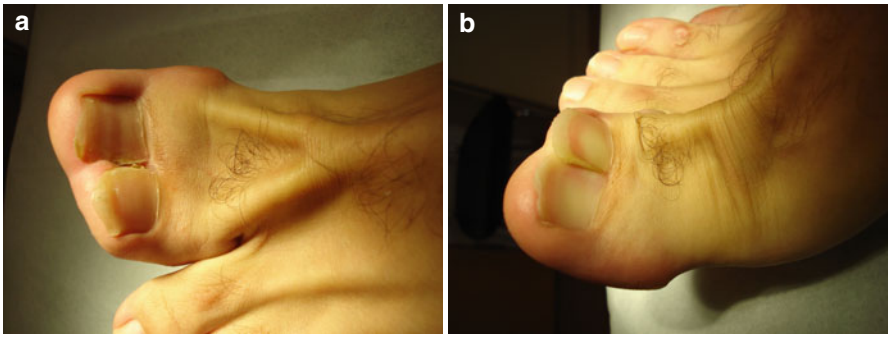


Fig. 6.116 (**a**) The left great toenail has two extensor tendons (**b**) the right toenail has only one extensor tendon

Clinical Case 19 Bertrand Richert

This charming 12 year-old young girl suffered from chronic nail ingrowing for years (Fig. 6.117a, b). She had attempted nail bracing repeatedly without success. This is a familial trait as her father and brother both had surgical procedures for their nails. The mother was reluctant for a surgical procedure, as her husband and son, even if cured, have narrow nails. She did not want the same for her daughter who might be bothered with the cosmetic aspect of her toenails when she would grow older.

Fig. 6.117 (**a**) Chronic ingrowing with hypertrophic lateral walls (**b**) the nail plate disappears in the lateral tissues

Type of Ingrowing Toenail

Chronic juvenile ingrowing toenail.

Scoring

Heifetz scoring stage II

Aim of the Treatment

Here we did agree with the mother and proposed her as first choice surgery a debulking of the soft tissues, without intervening on the matrix or the bed. For this young girl, practicing a lot of sports, a Vandenbos' or a Super U procedure with secondary intention healing over several weeks is not the first choice.

Management

A Noel's procedure is here the best choice. Two lateral vertical wedges, one on each side, were removed (Fig. 6.118a), skimming the lateral aspect of the bony phalanx and reaching the ventral aspect of the toe (Fig. 6.118b).

Reversed sutures were used on the side of the nail plate in order to re-create the lateral folds (Fig. 6.119a) and simple stitches for the anterior and inferior part of the defect (Fig. 6.119b).

Pain was moderate and very well tolerated with the help of paracetamol and ibuprofen.

Another option would have been a Howard Dubois' procedure…What she indeed benefited from on the opposite great toenail !

Result

After 1 year the result was fantastic (Fig. 6.120). She had no more ingrowing and had started to apply nail polish!

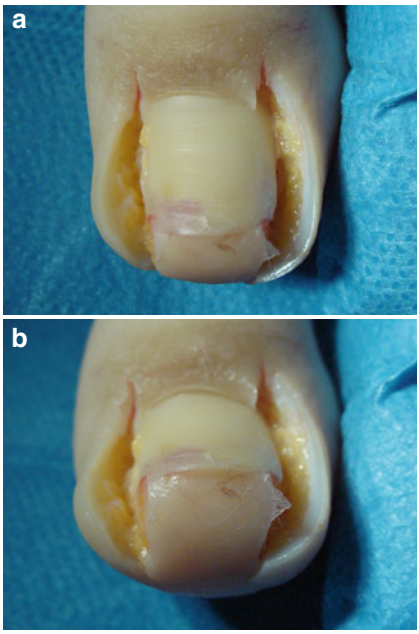


Fig. 6.118 (**a**) Removal of two vertical wedges (**b**) skimming the bone, down to the pulp

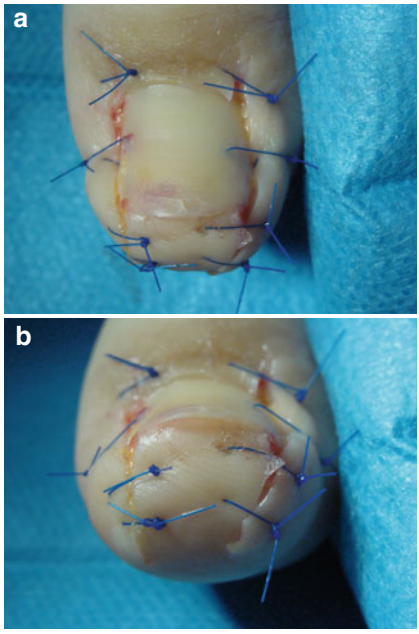


Fig. 6.119 (**a**) Suturing the defect to the plate with reversed stitches to re-create a lateral fold (**b**) simple stitches on the anterior part. Note that the plate is freed on its lateral sides

Fig. 6.120 Appearance at week 3 post operatively

Fig. 6.121 Aspect at 1 year follow-up

Clinical Case 20 Bertrand Richert

This 15 year-old boy had suffered from an ingrowing right great toenail for more than 4 years (Fig. 6.122a, b). He had had three chemical cauteries on each side with each time recurrence.

He came asking for a definitive treatment and suggested avulsing the nail and destroy the matrix permanently. He played hockey and this was almost no more possible because of the pain.

He had severe plantar hyperhidrosis.

Fig. 6.122 (**a**) Chronic ingrowing, upper view (**b**) front view. The nail plate does not appear to be too wide

Type of Ingrowing Toenail

Juvenile ingrowing toenail, chronic form, with hypertrophy of the lateral walls and granulation tissue.

Scoring

Heifetz stage III

Aim of the Treatment

Here, it is obvious that the first issue is to act on the hypertrophic tissue. This will allow seeing the real shape of the nail plate and, if needed, having it narrowed. On a front view, the nail plate does not seem too wide.

Two main options are possible, either a Noel's procedure or a Vandenbos' or Super U.

A Vandenbos' procedure is chosen as there is no distal ingrowing.

Management

A 10# blade was inserted in the lateral sulcus and pushed vertically downwards to reach the pulp, skimming the lateral aspect of the bone. The blade was then moved forward to remove the lateral soft tissues. The posterior pedicle was excised with scissors (Fig. 6.123a, b). The distal wall was left on site as there was no ingrowing. This will allowed a protection also during footwear and there was no risk to injure the onychodermal band.

Result

Post operative pain was minimal as there was no pulling from stitches. Infiltrating massively the lateral aspect of the medial phalanx prevented bleeding and hemostatic foam was placed around the wound. A bulky greasy dressing came on top to absorb any further bleeding. Home care was easy and consisted only in soakings and applying large amounts of antiseptic ointment.

At a 1 year follow-up, there was no more ingrowing, the toe has recovered a normal shape (Fig. 6.124). There is a slight medial traumatic onycholysis from repeated buffeting in his hockey shoes.

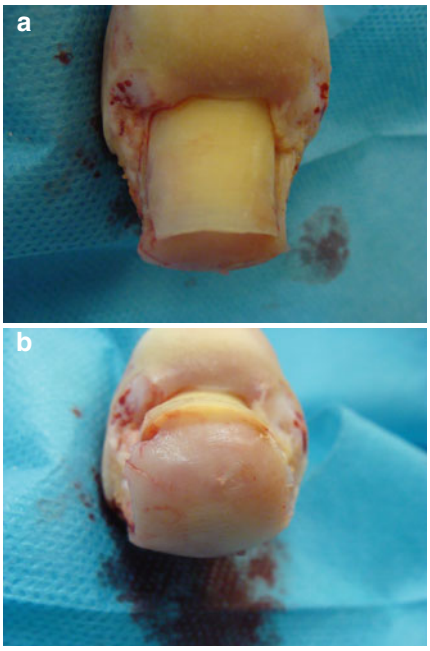


Fig. 6.123 (**a**) Immediately after surgery, upper view (**b**) front view

Fig. 6.124 Follow-up at 1 year

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