ON THE NAIL

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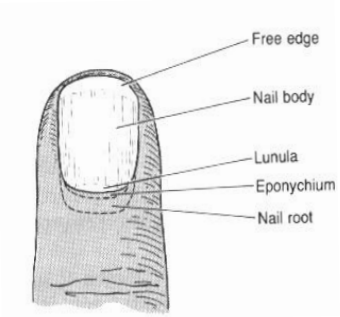
When planning nail management, the anatomy and physiology of the nail, its parts and surrounding tissues should be the starting point. Understanding the anatomy would mitigate against the promotion and propagation of techniques and associated equipment that are not necessary and of doubtful efficacy.

THE ANATOMY OF THE NAIL:

The **nail plate** occupies and grows from an invagination in the epidermis over the dorsal aspect of the distal segment of a digit (the **proximal nail fold)**. The nail plate consists of a **nail root** (the part that remains within the nail fold), **nail body** (the visible part), and its **free edge** (the part that may project beyond the distal attachment of the nail plate). The point at which the free edge becomes free and the area that lies beneath the free edge is the **hyponychium**. This is bounded distally by the **yellow line** (not particularly yellow, but the line at which the nail structures give way to normal epidermal skin). The **eponychium** is the narrow band of epidermis that defends the edge of the proximal nail fold. The **cuticle** is the sticky, white tissue that adheres to the nail plate as it emerges from the nail fold that serves to seal against the ingress of fluids and foreign bodies.[1]

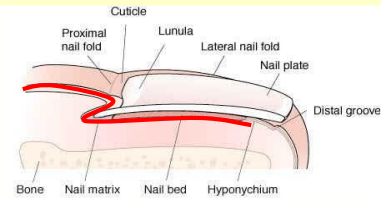


The nail root arises from the **germinal matrix** which is usually attached to the periosteum of the distal phalanx, and it is this attachment that anchors the nail plate firmly in position. The **lunula** is a pale crescent-shaped extension of the germinal matrix which can be seen through the nail plate. The nail plate is attached to the **sterile matrix** by a 'rail and groove' interdigitation which increases the area of contact, and is bounded laterally by the **nail walls**, epidermal folds that protect the lateral nail plate borders. The nail walls arise from the nail fold. Nail **sulci** (nail grooves, gutters) are continuous with the sterile matrix and nail walls, and the lateral nail plate borders reside within the sulci.[2]

PHYSIOLOGY OF THE NAIL:

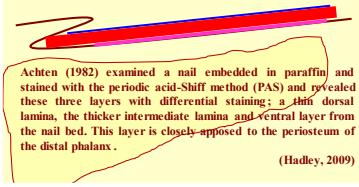
The nail has been proven to consist of three layers – laminations.

The nail grows from the invagination on the dorsal surface of the distal segment of the fingers and toes that we recognise as the nail fold.



Zook *et al*, (1980) stated that:

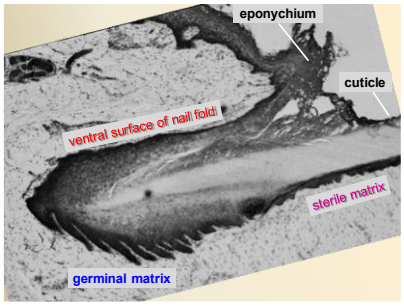
"Microscopic examination reveals the nail production to take place on the **dorsal roof of the nail fold** , **the ventral floor of the nail fold** , **and on the nailbed to the free margin of the nail**."



Achten (1982) examined a nail embedded in paraffin and stained with the periodic acid-Shiff method (PAS) and revealed these three layers with differential staining; a thin dorsal lamina, the thicker intermediate lamina and ventral layer from the nail bed. This layer is closely apposed to the periosteum of the distal phalanx .

(Hadley, 2009)

Most of the onychogenic activity (80%) occurs in the germinal matrix. This is the middle layer which is spongy and absorptive. The sterile matrix migrates with the nail plate, rather in the manner of a 'conveyor belt' as it advances distally and adds 10% to the mass of the nail. This layer forms the connection of the nail plate with the skin of the digit beneath. The dorsal roof of the nail fold adds the last 10% to the dorsal surface of the nail plate and is dense, chemical, and waterproof.[3]



The elongated papillae of the stratum basale (lower left) produce newly divided cells that are incorporated into the nail root, and it is this generative mechanism that drives the nail forward, so that the nail advances.

It has been stated that growth of fingernails is about 1mm per week, the growth rate of toenails being three to five times slower.

Growth rate is related to length of digit, being faster on the longer digits. Growth is fastest in youth, slowing with advanced age, vascular disease,

or ill health. Growth is affected in a health crisis, and this might be demonstrated by a transverse Beau's Line (growth arrest line), or onychomadesis where *the nail plate continues to move distally and is shed when it loses its adhesion to underlying tissues.*[4]

The germinal matrix cells lie beneath the nail root in an arc dorsal to the distal phalanx and distal to the last interphalangeal joint. This arc may be visualised as a 'duct' producing a 'profile' of nail. If the duct is blocked, distorted, or damaged the profile will be altered in cross-section, or continuity. The germinal matrix may be subjected to mechanical trauma, and this may result in permanent damage. Repetitive microtrauma is often sufficient to cause permanent damage.

The germinal matrix is highly vascular, being supplied by a multiplex of arterial anastomoses. Nail production diminishes as the blood flow is reduced. The structure is also subject to bacterial, fungal, and yeast infection. Recovery from these infections depends largely upon the extent and duration of the infection. In the case of the neuroischaemic foot, the sweat and oil glands will no longer be controlled by the autonomic nerves, so the nails will 'accumulate' rather than grow-out, becoming slow-growing, thick, chalky, and friable.

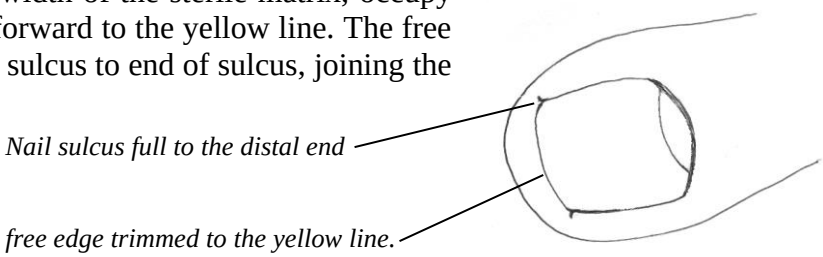
GENERAL PRINCIPLES OF NAIL SHAPING

The practitioner needs a mental model of the 'ideal' anatomy to compare with that which is presented. There must also be an understanding of the normal function of the nail and the dynamics of that function. Interaction with adjacent digits must also be taken into consideration. The aim is to produce the closest possible approximation to the ideal from any given pathology. Nippers, excavators, files, and nail drills need to be used with considerable exercise of control, skill, and dexterity. The intention must be to achieve the optimal extent, coverage, shape, and flexibility in any given situation with constant reference to the dynamics of the soft tissue surrounding structures, including allowance for expected growth.

Work upon the nail plate and surrounding structures must consider the great sensitivity of the anatomy in the region. The greatest risk is of heat generation when using burs. Concentricity of burs is essential. Handpieces with high quality bearings to minimise run-out (wobble) turning at higher rotation speeds (circa 15,000- 25,000rpm) produce least vibration. Well maintained sharp burs with appropriate particle size or cutting design, applied with light pressure, generate least heat, and intermittent lifting of the bur allows dissipation of heat whilst working. Eyes must be protected from the larger displaced particles and pulmonary inhalation of dust must be controlled for safety of the operator and patient. Wet drills offer superior dust control, and the water spray acts as a coolant allowing expansion of technique.

TRIMMING THE NORMAL NAIL

The trimmed nail should cover the entire width of the sterile matrix, occupy both sulci to their distal ends, and extend forward to the yellow line. The free edge of the nail should extend from end of sulcus to end of sulcus, joining the two points by an aesthetic curve.

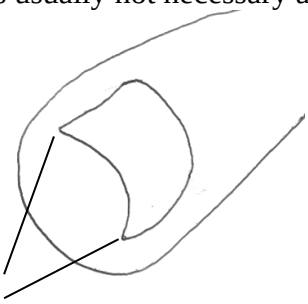


The distal ends of the sulci must not be exposed. In foot health practice the free edge is generally entirely removed. Growth from this point to the next requirement of trimming takes, on average, 6 weeks for those in their 60s, 7 weeks for those in their 70s, and 8 weeks for those in the eighth decade of life.

TRIMMING THE INVOLUTED NAIL

Involuted nails enclose a variable volume of toe pulp. This enclosed toe pulp may become keratinised at the apex, so much so that the hyperkeratosis may blend and appear to fuse with the nail, effectively forming a 'box' which makes the application of nippers difficult. However, the 'box' can be opened, if necessary, using ingrowing nail nippers or a cut-steel or ceramic bur, and the hyperkeratosis reduced. The profile of the nail plate can then be seen, and is usually observed to be no thicker than a normal nail plate. The nail can then be reduced in length to level with the soft tissue surface - <u>never</u> below. Every effort should be made to retain the corners intact. The nail grooves must remain filled to their distal extremities by nail.

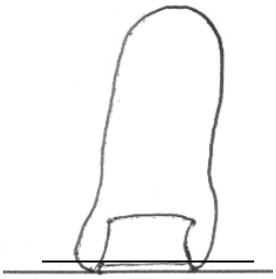
The sides of an involuted nail are best left alone, if comfortable. Cleaning of the nail sulci and any other interference should be minimal. Trimming down the sides and inserting packs is usually not necessary and is not recommended unless there are complications (onychocryptosis, or onychophytic corns in the nail groove). The trimmed nail should extend from distal end of sulcus to distal end of sulcus. The distal edge (for there will be no free edge) can be shaped between these two points. It may be trimmed either to be straight across or may even be reduced in the centre line to produce a negative curve. This latter is sometimes a necessary expedient where the involution is very steep or where the distal phalanx of the toe is upturned or hyperextended.



Nail must extend to distal ends of sulci.

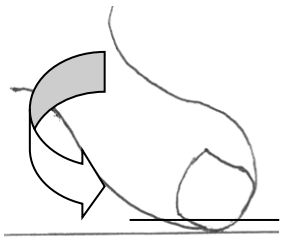
TRIMMING THE NAIL OF A RETRACTED DIGIT

Where lesser digits are grossly retracted, ground forces are applied (from the innersole of the shoe) directly to the apices of the toes. This means that the free edge of the nail is subjected to ground force and the nail plate is forced longitudinally back into the matrix. This is often the origin of the thickening (hyperkeratosis) of the nail plate since the matrix produces more nail substance as a result of the extra blood flow occasioned by both the stimulus and the subsequent inflammation. The free edge of the nail plate must be cut back or made minimal to reduce the amount of ground force received. So far as is possible, the cut edge should be made parallel to the ground/innersole surface. The aim should be to remove the nail from the ground effect or minimise ground contact.

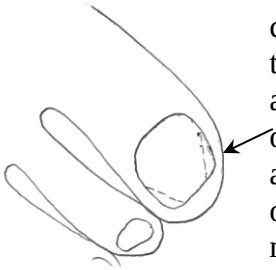


TRIMMING THE NAIL OF AN AXIALLY ROTATED DIGIT

Sometimes a lesser toe is twisted, usually medially by a rotational force. This in turn causes the same rotational force upon the nail plate which will respond by growing in a curved manner, the side touching the ground growing the fastest.
Here the lateral corner of the nail will need to be trimmed parallel to the ground surface to relieve it as much as possible from the ground force.



HALLUX ABDUCTOVALGUS



In the case of hallux abductovalgus, the hallux nail receives ground force or shoe contact force upon the medial corner of the nail plate. This presses the medial soft tissues onto the medial corner of the nail plate, compromising the local blood supply and causing onycholysis (breakdown of the bond between nail plate and nail bed), or onychocryptosis (ingrowing toenail). The hallux, being pushed laterally, is pressed against the second toe - pressurising the lateral sulcus and pulp. Again, onycholysis or onychocryptosis may be the outcome. Here the nail of the second toe must be carefully managed to defend the lateral soft tissue of the hallux. HAV most often occurs as a concomitant to hyperpronation of the foot. This leads to retraction of the lesser toes and loading of the apices.

SUMMARY

If nails are reduced by appropriate use of nippers and the process finalised by smoothing with a dresser, file, bur, or stone, there should be very little need to intrude beneath and around the structures with Black's files and excavators. To do so is to disturb that which is often quite comfortable and break natural seals which are resistant to infection. There is usually no need to clear subungual debris. **Stay out from beneath… work from above on the dorsal surface**.

Correct nail extent after trimming is seen to be vital to the stabilisation and control of the toe pulp and soft tissues of the digit. Loss of nail plate - particularly at the distal corners - leaves the pulp uncontrolled and vulnerable to whatever forces are applied.

From the above it can be seen that there can be no single nail cutting technique applicable to all nails. Each case, indeed, each digit, must be assessed and treated according to the need. Nail trimming will range from

normal cutting where there is no threat to the digit, to shaping and easing of the nail plate in response to the observed threat.

In addition to the application of the principles stated above, there is often a requirement to reduce the thickness of a nail plate. Doing so reduces the pathological nail mass pressed into the dorsal aspect of the toe, delivering comfort, and allowing more room for movement in the toe-box of the shoe. The nail will then not be pressed so tightly upon the digit and thus will cause no pathological reaction. If the nail mass is infected by fungus, then cutting it away will reduce the amount of infected tissue remaining and expose any living fungus to curative agents.

REFERENCES:

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2. Falkner-Heylings J, *Article: John's papers No6, Toenail Trimming - Principles and Practice* 2013

3. G. Achten M.D., D. Parent M.D. *The Normal and Pathologic Nail,* 1983

4. Tortora GJ and Anagnostakos NP, *Principles of Anatomy and Physiology* 6th ed. p129 1990: New York, Harper Collins

ALLIANCE PROFESSIONAL DEVELOPMENT

ON THE NAIL

The answers are not necessarily given in the accompanying text and may need to be researched from textbooks, the Internet and scientific papers. Answers should be submitted on A4 paper and should be of sufficient length to demonstrate full understanding of the topic. Single word answers are not permissible. Try to answer in one or two short paragraphs, not more than a ¼ page.

1. Describe the anatomical relationships of the nail plate

2. Describe the extent of the germinal matrix

3. What factors determine the growth rate of the nail plate?

4. What is the effect of a period of non-growth?

5. What should be the extent of the trimmed normal nail?

6. How should the involuted nail be trimmed?

7. What is the effect of ground forces on the free edge of a nail on a retracted digit?

8. How would you trim the nail on an axially rotated digit?

9. Explain how HAV can generate onycholysis or onychocryptosis.

10. Why do we reduce a thick nail?

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