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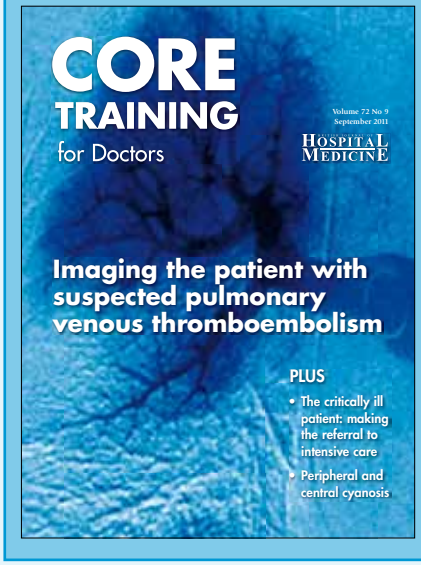

Management of fingertip and nail bed injuries

Introduction

Injuries to the fingertip are a very common presentation to the emergency department, yet are often poorly managed. These injuries have a functionally important impact on day to day living as the fingertip is the most used part of the upper limb and as such is frequently prone to trauma. The nail normally provides a natural protective covering to the fingertip and when breached can allow infection to spread leading to local and systemic consequences. These common injuries can be easily repaired or managed and should be part of all junior doctors' skill sets. This article provides the clinical knowledge necessary to manage these injuries competently.

Fingertip and nail anatomy and function

The fingertip is the part of the digit beyond the distal interphalangeal joint, which includes the nail bed and underlying distal phalanx (*Figure 1*). The skin of the fingertip is highly adapted and specialized for two-point discrimination, pincer and power grip functions, and is aided in this by the nail bed and plate (Brown and Borschel, 2004). The nail plate is formed from the nail matrix, which it then rests upon. The nail matrix is divided into three parts: dorsal, intermediate and ventral. The first two are commonly known as the 'germinal' matrix, with the remainder termed the 'sterile' matrix (Mills, 2007). The nail plate is made of keratin, generated by layers of closely packed and interdigitating corneocyte cells (Mills, 2007). This extends beneath the nail root itself and comprises neurovascular structures.

New nail plate cells become flatter and more translucent distally, transmitting a pink hue from the underlying capillary networks (reflecting the nail bed's extreme vascularity). Proximally a white crescent is seen on the nail, the lunula, which is part of the intermediate matrix (Mills, 2007). Beneath the nail plate lies the nail bed, beginning where the intermediate matrix ends. Like skin it is composed of a deeper dermis and superficial epidermis, connected by matrix crests (Mills, 2007).

The root of the nail is that part which is covered by skin proximally. The thin epithelial layer extending from this is the eponychium. The nail bed epidermis then migrates distally toward the hyponychium (the most distal part of the nail bed, and the epithelial layer beneath the nail proximally)

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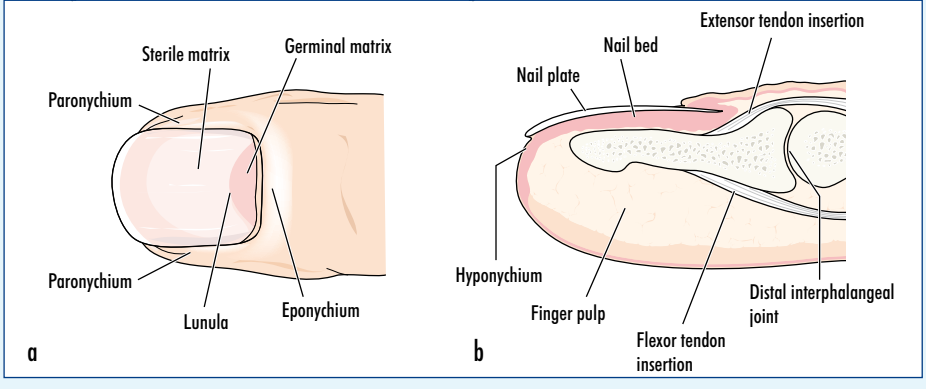
Figure 1. a. Gross anatomy of the fingertip with (b) emphasis on the nail bed. Adapted from the Sydney Hand Surgery Clinic (2008).



(Mills, 2007). The lateral aspect of the nail or paronychium comprises the lateral nail folds into which the nail plate inserts.

The nail grows at a rate of about 0.1 mm per day, so it can take at least 6 months for complete resolution of growth (Johnson et al, 1991). The nail itself functions as a protective barrier to the distal phalanx and surrounding soft tissue. Moreover it has a role in two-point discrimination enhanced by counter-pressure on the pulp.

Initial assessment and management

As with any emergency scenario, any more serious injuries identified by a structured primary and secondary survey take precedence. Management should be guided by both the mechanism of injury and the extent of damage; focused history is therefore vital. Key points to the history include handedness, occupation, smoking and tetanus status, time of onset of injury and the presence of any associated wounds (Brown and Borschel, 2004). Previous history of hand injuries and past medical history are also required. It is also important to assess the patient's ideas, concerns about the injury and expectations.

Full hand examination should be performed followed by more direct examination of the injured digit to identify any deformities indicating possible underlying fractures, dislocation or tendon avulsions (e.g. suggesting an open mallet injury). Complete examination of motor and sensory function of the digit is mandatory before any infiltration of anaesthetic. Vascular supply should be assessed including capillary refill of the digit. The wound needs thorough irrigation to help visualize the extent of the wound and remove any contaminating material, and to enable examination for any active bleeding, subungual haematoma or avulsion of the nail and any underlying nail bed laceration.

Antero-posterior and lateral radiographs of the digit should be obtained to highlight any underlying fracture of the distal phalanx. These are extremely common and larger fragments may require Kirschner wire fixation.

In the case of a complete fingertip amputation, the tip should be cleaned and placed between non-adherent gauze soaked in 0.9% saline in a sealed bag; this should then be placed in a second sealed bag filled with melting ice (~4°C). This is kept cool and brought with the patient to theatre should replantation or composite grafting be required. Replantation is not usually possible for true nail bed injuries but only for amputations proximal to the eponychium as distally the vasculature is too small (Rose et al, 1989).

Classification of injuries

Managing fingertip and nail bed injuries early, appropriately and carefully prevents secondary complications including infections and nail deformities. Preventing deformities is also achieved through careful anatomical alignment of the nail bed on repair. Less than adequate alignment leads to increased scar tissue preventing appropriate adherence of the nail plate and can lead to the development of nail ridges or secondary deformities. Nail bed injuries can present in a variety of ways from simple haematomas to complete amputations of the fingertip. Below are the broad categories of nail bed injuries.

1. Subungual haematoma

These result from direct injury to the sterile or germinal matrix leading to bleeding beneath the nail plate. Underlying haematomas cause nail plate separation, and pressure on the underlying nail bed leads to intense pain. The presence of blood beneath the nail indicates an underlying nail bed injury. Management is controversial and debate still exists regarding the course of treatment, but this essentially relates to the amount of blood present beneath the nail.

2. Simple fingertip laceration

In addition to simple skin lacerations, nail bed lacerations occur when the nail bed is crushed between the nail plate and underlying distal phalanx. Lacerations range from simpler straight lacerations to the more complex or stellate injury caused by greater injurious forces.

3(a and b). Crush injuries

These injuries occur from trauma to a larger surface area of the nail and thus have a poorer prognosis with respect to nail deformity. These injuries are not uncommonly associated with underlying tuft fractures of the distal phalanx. The size of these fractures determines which category they fall into (see below).

4. Avulsion injuries

These injuries involve partial or total loss of the nail bed leaving an exposed distal phalanx. There is more potential for long-term complications and subsequent nail deformity.

5. Partial or complete fingertip amputation

Nail bed injuries can be part of a traumatic fingertip amputation whether complete or partial (*Figure 2*). The Allen classification (*Figure 3*) is used to describe amputations that occur across the fingertip (Varitimidis et al, 2005), although this classification falters with oblique injuries.

Figure 3. Allen's classification of fingertip injuries showing the division of injuries into zones. Adapted from the Sydney Hand Surgery Clinic (2008) and Varitimidis et al (2005).

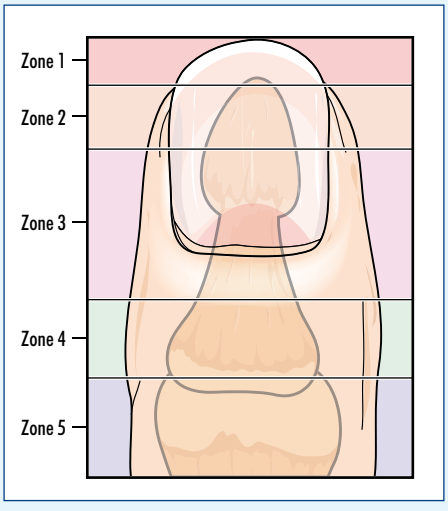
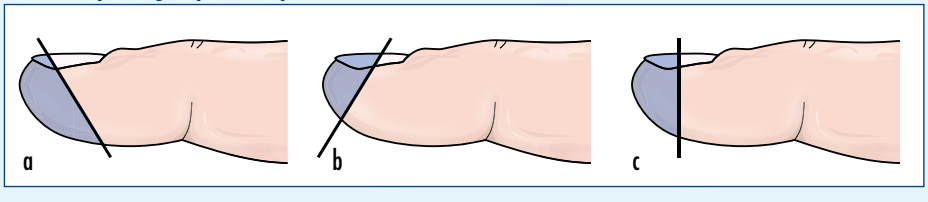


Figure 2. Types of fingertip amputations. a. Volar oblique, (b) dorsal oblique and (c) transverse amputation. Both the oblique injuries can be short or long variations depending on the proximity to the distal interphalangeal joint. Adapted from Jackson (2001).



Specific management of injuries

The immediate priority is to recognize which injuries can be managed in an emergency department setting and which require prompt and appropriate specialist surgical referral. Type 1–3a injuries can usually be managed in the department with either trephine decompression or simple primary repair of the skin or nail bed. Type 3b–5 injuries usually require specialist referral.

1. Subungual haematoma

Small and painless haematomas do not usually require treatment. Primary repair is reported to reduce poor cosmetic appearances and subsequent functional impairment (Wang and Johnson, 2001). However, some authors suggest that routine nail bed exploration is not required for any patient with a subungual haematoma providing the nail and nail margins are intact (Fieg, 2002). Moreover, in haematomas which are only partially adherent to the nail bed and/or paronychium primary repair has no added benefit over trephination (Seaberg et al, 1991; Meek and White, 1998; Roser and Gellman, 1999). Even the presence of underlying fractures with suspected nail bed lacerations does not necessarily automatically indicate primary repair as similar situations have been treated with trephination alone with good cosmetic results (Gellman, 2009).

Consensus suggests that if the haematoma covers less than 50% of the nail bed surface area, then this can be managed by trephination. This traditionally involves boring a heated paper clip or 18 gauge needle through the nail to decompress the bleeding, with subsequent hand elevation. Alternatively, a small portable cautery device can be used quickly and effectively if available. The suggested 50% is an arbitrary threshold, and some advocate that any haematoma covering 25% or more of the nail should have the underlying laceration repaired primarily (Brown and Borschel, 2004). It is important to refer to local guidelines. Haematomas involving more than 50% of the nail surface area do not always require nail plate removal and primary suture repair, but this is decided on a case by case basis.

2. Simple fingertip and nail bed laceration

Primary closure and repair of nail bed injuries is the treatment of choice. Prospective studies have demonstrated no differences in cosmesis, pain or functional outcomes between the classical sutured nail bed repair and that using tissue glues (2-octylcyanoacrylate, Dermabond, Tissue-band) (Strauss et al, 2008). While tissue glue is quicker to use, its relative lack of evidence means that the classical repair (with absorbable suture material) is most commonly performed. The practicalities of repair are discussed below.

3(a and b). Crush injuries

The nail bed may be diffusely injured in several areas requiring all to be approximated to minimize scarring. Small bone fragments (type 3a) do not require fixation (Roser and Gellman, 1999) but larger fragments (type 3b) of the distal phalanx may need Kirschner wire fixation, following referral to a specialist unit.

4. Avulsion injuries

To limit scarring and deformity all nail bed fragments need to be approximated and sutured in place. These can be quite extensive injuries with partial loss of nail bed, needing specialist input with techniques such as reverse dermis graft and nail bed graft which are beyond the scope of this article.

5. Partial or complete fingertip amputations

Fingertip amputations can be replaced as a composite graft, particularly in children which have a higher likelihood of success than in adults. However, a graft will act as a biological dressing whether it survives or not. Composite grafting will require debridement of any devitalized or contaminated tissue from the tip while preserving healthy tissue. The tip is also defatted using sharp dissecting scissors. However, adults may require terminalization of the finger, particularly if the amputation is more distal and re-plantation is not possible (Fassler, 1996).

If minimal bone is exposed this may require shortening with a bone rongeur. Like all other types of injury the nail bed is aligned and sutured and the skin closed (see below). In those injuries with some pulp skin loss without exposure of the bone and with an intact nail bed, alternative day antibiotic-impregnated dressings will suffice to achieve wound healing through epithelialization. In those with exposed bone but sufficient intact nail bed, local flap coverage may be required (Fassler, 1996). Such flaps are beyond the scope of this article and require referral for specialist input (Jackson, 2001).

Classical repair of nailbed lacerations

The repair of a nail bed laceration should follow six simple steps (*Figure 4*) and can be applied to type 1–3a injuries (*Figure 5*). Following these steps ensures careful and appropriate repair is performed and thus limits postoperative complications.

Step 1: preparation

Repair itself is best performed with the patient in a supine position with the arm abducted on a hand table, prepared with antiseptic skin preparation (povidone-iodine), and draped accordingly.

Step 2: analgesia

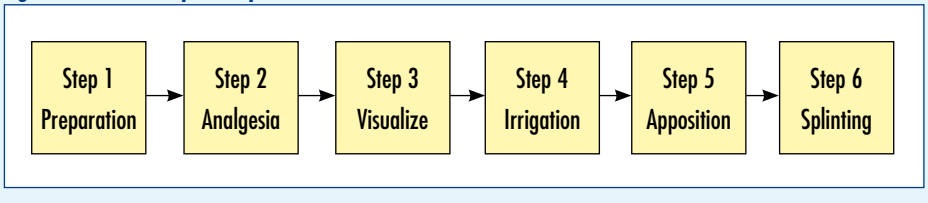
The finger should be anaesthetized with a digital ring block using 0.25–0.5% bupivacaine and 1% lidocaine.

Step 3: visualize

Custom-made digital tourniquets are the preferred tool and should be used for more extensive injuries. Alternative tourniquets include Jacques (or any rubber catheter) wrapped around the base of the finger and clipped tight with a haemostat over the dorsum of the proximal segment of the finger. Using a cut glove in this way as a tourniquet should be avoided as it must be removed after the procedure and not forgotten or it can become potentially dangerous (Brown and Borschel, 2004).

The nail plate needs to be gently lifted off from the underlying matrix with sharp scissors, dissecting above the level of the nail bed (Brown and Borschel, 2004). The

Figure 4. The six steps of repair of the nail bed.



eponychial fold should be lifted from the plate as well. The nail will be used as a natural splint when the nail bed is repaired so needs to be kept clean and moist in a gallipot with 0.9% saline solution.

Step 4: irrigation

The nail bed needs to be thoroughly debrided of any foreign bodies or debris and irrigated with 0.9% saline; not only will this clean the wound but it will enable visualization of the underlying laceration.

Step 5: apposition

Using loupe magnification of 2.5–3.3x to best visualize, approximate the underlying laceration as closely as possible under minimal tension. Lacerations to either the germinal or sterile matrix should be sutured with interrupted absorbable suture material, preferably 6.0 Vicryl rapide (7.0 in children). Any laceration involving the skin surrounding the nail bed needs to be approximated and sutured using non-absorbable sutures, preferably 5.0 nylon, e.g. Ethilon (6.0 in children). These should remain in situ for 2 weeks before removal, which may require the edges to be undermined.

Step 6: splinting

The next step is to re-site the nail plate which acts as a natural splint to aid healing. In patients with an underlying distal phalanx fracture the nail plate acts as a rigid splint (Roser and Gellman, 1999). It encourages the breakdown of adhesions between the germinal matrix and eponychial fold and maintain the alignment of the nail bed edges (Pasapula and Strick, 2004), acting as a platform for the new nail to follow as it grows.

It has been suggested (although studies are limited) that use of the old autologous nail can increase the infection rate and this will depend on the extent of the original injury sustained, i.e. compound fractures and heavy degrees of contamination. Some suggest that on removing the nail with surgical separation infection subsides even in cases of severe paronychia (Schiller, 1957). More recently some have advocated the use of silver foil from the suture pack cut into shape or acrylic nail replacements when the autologous nail is missing, too fragmented or dirty to be used (Yeo et al, 2010). These replacements prevent adhesions forming to the germinal matrix causing a loss of the groove under the eponychial fold (Yeo et al, 2010).

The free nail requires cleaning and removal of any contaminating material and may require debriding. Some surgeons bore a hole into the centre of the nail to allow drainage of any bleeding postoperatively, but this is not necessary as bleeding should be dealt with intraoperatively.

There is some support for the use of chloramphenicol antibiotic ointment for simple lacerations as there is no added injury from sutures and some benefit from its antibacterial properties (Pasapula and Strick, 2004). More complex injuries with exposed bone inherently carry a higher potential for infections even with the use of autologous nails.

Most commonly the nail is sutured; this usually involves using another 5.0 nylon or Ethilon stitch secured from proximal to the eponychial fold and crossing distally to the hyponychium or fingertip as a figure of eight (*Figure 6*). If the nail is unavailable or extensively traumatized petroleum gauze, e.g. Jelonet, can be used in a similar fashion. The procedure is completed with use of a finger splint and bulky non-adherent gauze dressing to protect the digit and provide a barrier to infection.

Patient follow up

The use of prophylactic antibiotics (e.g. co-amoxiclav) for soft tissue injuries is an ongoing debate and local guidelines should be followed. Antibiotic use depends on the mechanism (human or animal bite) and degree of injury sustained (joint or bone

Figure 5. Diagrammatical interpretation of nail bed repair. a. Removal of the nail plate using sharp scissors to elevate and lift the nail off. b. The underlying nail bed laceration can be visualized and (c) repaired with interrupted absorbable Vicryl rapide. d. The cleaned nail plate is reinserted in the eponychial fold and lateral nail folds.

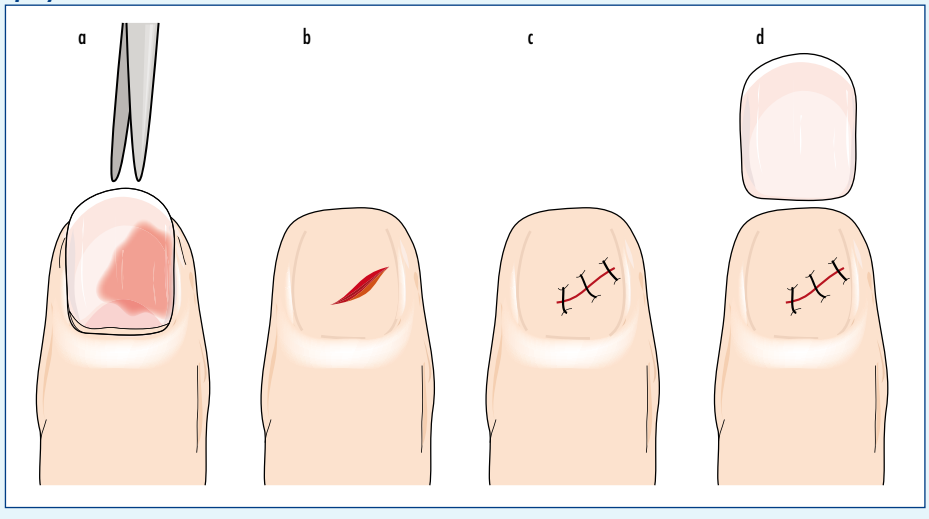
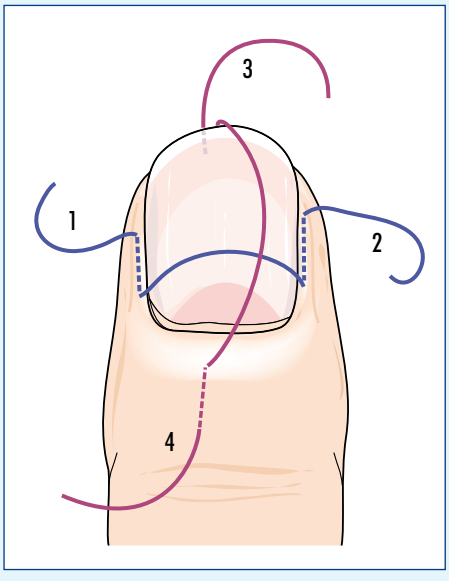


Figure 6. Once the nail plate is reinserted it is used as a splint. To hold it in situ a figure of eight suture can be used. Two methods include use of a single or double stitch. In the latter a suture is inserted along the lateral nail fold (1) for ~5 mm then taken over the nail plate and sutured along the opposite nail fold (2) for ~5 mm. These are knotted together over the nail. A second suture is similarly used but sited proximal to the eponychium (4) and taken distally over the nail through the fingertip distally (3) for ~5 mm and knotted off accordingly. In the single suture method either one of the sutures alone can be used, most opting to use the purple suture but crossing the sutures to create a figure of eight centred over the nail plate. Adapted from Sydney Hand Surgery Clinic (2008).



exposure) and factors including diabetes mellitus, immunosuppression and cardiac valve disease that put these patients at more risk of systemic effects (Misra et al, 2005). Evidence for the use of antibiotics differs and there is a lack of consensus beyond these scenarios although an overall benefit of antibiotic use has been shown and is advocated by the authors.

Evans and Pollock (1973) looked at wound infection rates in a range of scenarios from clean to contaminated wounds and found a significant reduction in infections if given prophylactic antibiotics, but this has not always been reproducible. Others, including a large meta-analysis of acute soft tissue hand injuries, could not show any significant differences in infection rates especially if adequate surgical debridement is performed (Misra et al, 2005). The most important factor in preventing postoperative infection is good wound care to reduce bacterial load.

In more extensive fingertip injuries the distal interphalangeal joint needs splinting for 4–6 weeks, using a mallet or thermoplastic loose-fitting splint or slightly larger size to avoid constriction of the fingertip from postoperative oedema. These only immobilize the distal interphalangeal joint, allowing metacarpophalangeal and proximal interphalangeal joints to be mobilized thus reducing oedema and stiffness around these joints and reducing the need for physiotherapy. These have superseded the use of aluminium splints (Zimmer splint) which are difficult to use and cumbersome.

At each follow-up visit the finger should be thoroughly irrigated with 0.9% saline or a solution of 50:50 dilute hydrogen peroxide and 0.9% saline to keep the wound clean. The finger should be followed up in 3 days time to look for early signs of infection or haematoma and to change the dressings. At 2 weeks both the suture over the nail plate and the skin sutures are removed.

Complications and outcomes

Complications should always be mentioned to patients. They include abnormal nail growth and deformities including nail fold destruction, complete or partial lack of new nail growth, infections and scarring, splitting, ridging or parrot beak deformity if distal tissue support to the nail bed is lost (Gellman, 2009). Nail bed injuries heal well with appropriate management but the patient should be told that completed nail growth may take 6 months to 1 year. The residual nail can remain in situ for several months before the new nail plate replaces it.

Simple lacerations that are repaired with accurate apposition of the nail bed usually provide the patient with a normal nail. However, severe crush injuries or avulsion-type injuries are likely to develop ridging and other nail deformities and thus carry a poorer cosmetic prognosis. Tuft fractures are associated with up to 50% of nail bed injuries (Guy, 1990; Roser and Gellman, 1999) and secondary nail deformities are more common with these injuries. Nail deformities can lead to functional problems for patients and secondary trauma as they rub and catch. All these can be limited or prevented with careful repair of the nail bed.

Conclusions

Fingertip and nail bed injuries are a common presentation to the emergency department and if not treated and managed adequately can lead to significant morbidity and functional impairment. This may subsequently require more complex surgical management with often less than ideal results. Some of these injuries can be managed in an emergency department setting, with specialist help, by any doctors who have the responsibility and opportunity to provide this care. Early appropriate management as highlighted in this article is a prerequisite for a successful outcome, and should be part of all junior doctors' skill sets. **BJHM**

KEY POINTS

- Nail bed injuries are an extremely common presentation to the emergency department and are often poorly managed.
- Managing nail bed injuries early, appropriately and carefully prevents secondary complications including infections and nail deformities.
- Thorough irrigation of the wound is needed to help visualize and remove any contaminating material and enable examination of any active bleeding, subungual haematoma or avulsion of the nail and any underlying nail bed laceration.
- Approximate the underlying laceration as closely as possible under minimal tension.
- Simple lacerations that are repaired with accurate apposition of the nail bed usually provide the patient with a normal nail.

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Brown DL, Borschel GH (2004) *Michigan Manual of Plastic Surgery.* Lippincott Williams and Wilkins, Philadelphia

Evans C, Pollock AV (1973) The reduction of surgical wound infections by prophylactic parenteral cephaloridine: A controlled clinical trial. *Br J Surg* **60**: 434

Fassler PR (1996) Fingertip injuries: evaluation and treatment. *J Am Acad Ortho Surg* **4**(1): 84–92

Fieg EL (2002) Management of nail bed lacerations. *Am Fam Physician* **65**(10): 1997–8

Gellman H (2009) Fingertip-nail bed injuries in children: current concepts and controversies of treatment. *J Craniofac Surg* **20**(4): 1033–5

Guy RJ (1990) The etiologies and mechanisms of nail bed injuries. *Hand Clin* **6**(1): 9–19

Jackson EA (2001) The V-Y plasty in the treatment of fingertip amputations. *Am Fam Physician* **64**(3): 455–9

Johnson M, Comaish JS, Shuster S (1991) Nail is produced by the normal nail bed: a controversy resolved. *Br J Dermatol* **125**(1): 27–9

Meek S, White M (1998) Subungual haematomas: is simple trephining enough? *J Accid Emerg Med* **15**(4): 269–71

Mills SE (2007) Nail. In: Conejo-Mir C, Requena L, eds. *Histology for Pathologists.* 3rd edn. Lippincott Williams and Wilkins, Philadelphia: 29–54

Misra A, Iqbal M, Misra S (2005) The use of antibiotics in simple soft-tissue trauma. *Plast Reconstr Surg* **115**(1): 332–3

Pasapula C, Strick M (2004) The use of chloramphenicol ointment as an adhesive for replacement of the nail plate after simple nail bed repairs. *J Hand Surg Br* **29**(6): 634–5

Rose EH, Norris MS, Kowalski TA, Lucas A, Fleegler EJ (1989) The "cap" technique: Nonmicrosurgical reattachment of fingertip amputations. *J Hand Surg* **14**(3): 513–18

Roser SE, Gellman H (1999) Comparison of nail bed repair versus nail trephination for subungual hematomas in children. *J Hand Surg Am* **24**(6): 1166–70

Schiller C (1957) Nail replacement in finger tip injuries. *Plast Reconstr Surg* **19**(6): 521–30

Seaberg DC, Angelos WJ, Paris PM (1991) Treatment of subungual hematomas with nail trephination: a prospective study. *Am J Emerg Med* **9**(3): 209–10

Strauss EJ, Weil WM, Jordan C, Paksima N (2008) A prospective, randomized, controlled trial of 2-octylcyanoacrylate versus suture repair for nail bed injuries. *J Hand Surg Am* **33**(2): 250–3

Sydney Hand Surgery Clinic (2008) Anatomy. www.sydneyhandsurgeryclinic.com.au/anatomy.asp (accessed 22 January 2011)

Varitimidis SE, Dailiana ZH, Zibis AH, Hantes M, Bargiotas K, Malizos KN (2005) Restoration of function and sensitivity utilizing a homodigital neurovascular island flap after amputation injuries of the fingertip. *J Hand Surg Br* **30**(4): 338–42

Wang QC, Johnson BA (2001) Fingertip injuries. *Am Fam Physician* **63**: 1961–6

Yeo CJ, Sebastin SJ, Chong AK (2010) Fingertip injuries. *Singapore Med J* **51**(1): 78–86