INJURIES TO THE ARM, HAND, FINGERTIP AND NAIL

GENERAL MANAGEMENT PRINCIPLES:

SPECIFIC ISSUES SURROUND WOUNDS/LACERATION TO THE ARM AND HAND:

- Potential to injury the arteries, nerves, tendons that lie close to the skin
- Importance of hand function in daily and occupational life

INJURIES MAY BE CLASSIFIED AS COMBINATIONS OF:

- Closed crush
- Simple lacerations
- Open crush
- Partial amputation
- Complete amputation

HISTORY AND PHYSICAL EXAMINATION:

- SPECIFIC CONSIDERATIONS:
  - Age (less potential for recovery with elderly)
  - Occupation
  - Hand dominance
- EXAMINATION → begins with general inspection
  - Location of wound relative to major arteries, nerves and tendons
  - Exposed tendon or bone
  - Examine active motion and resistance to passive movement to assess motor function
  - The most distal pure MOTOR FUNCTION OF EACH MAJOR NERVE SHOULD BE TESTED AGAINST RESISTANCE

Table 47-1 Motor Testing of the Peripheral Nerves of the Upper Extremity

Nerve	Motor Exam
Radial	Dorsiflexion of wrist
Median	Thumb abduction away from the palm
	Thumb interphalangeal joint flexion
Ulnar	Adduction/abduction of digits

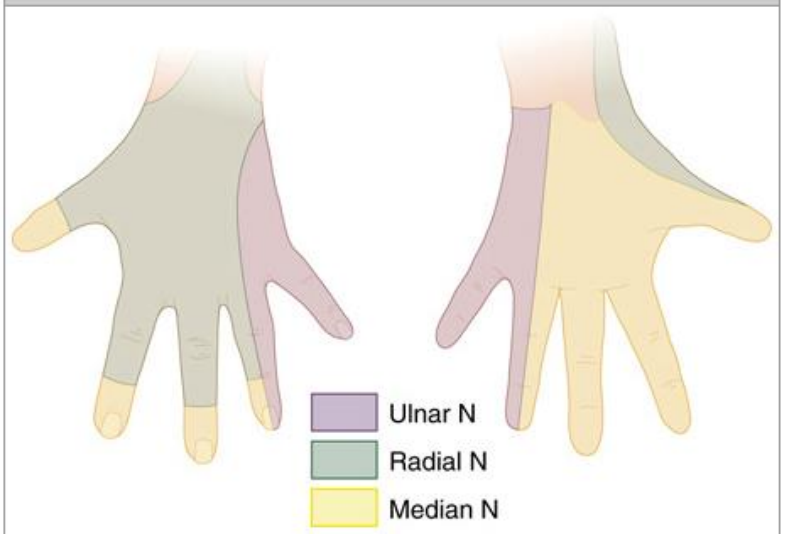
- Each tendon in and adjacent to the injured area should be individually assessed
  - FDS → can be examined by holding all other digits in extension and flexing the PIPJ against resistance
  - FDP → examined by holding the PIPJ in extension and flexing the DIPJ against resistance
  - Extension should first be attempted against gravity, then against resistance

    - WEAK, LIMITED OR PAINFUL MOVEMENT SUGGESTS PARTIAL INVOLVEMENT OF A TENDON
- SENSATION SHOULD BE ASSESSED USING THE MODALITIES OF PAIN OR TOUCH IN THE **MEDIAN, ULNAR AND RADIAL NERVE DISTRIBUTION:**

Table 47-2 Sensory Testing of Peripheral Nerves in the Upper Extremity

Sensory Nerve	Area of Test
Radial	First dorsal web space
Median	Volar tip of index finger
Ulnar	Volar tip of little finger

Figure 47-1.



- For injuries DISTAL TO THE MIDPALM → assess digital nerve function with static TWO-POINT DISCRIMINATION LONGITUDINALLY → NORMAL ≤6mm
- Intact radial and ulnar pulses and capillary refill are usually adequate to exclude significant vascular injury
    - Refill times >3 seconds should raise suspicion for a significant vascular injury
    - Consult hand or vascular surgery if concerned

IMAGING STUDIES:

- Radiographic evaluation with AP, oblique and lateral films is indicated if bony injuries, retained radio-opaque foreign body or joint penetration is suspected
- US may be used for radiolucent FB
    - CT can both identify radiolucent objects and localise a FB in relation to surrounding anatomy

ADEQUATE VISUALISATION:

- ESSENTIAL FOR WOUND EVALUATION → consider tourniquet to stop bleeding to assess visualisation of the wound. Beware excessively high pressure and tourniquet times >15-20 minutes due to risk of NV damage
- Once visualisation is obtained, the injury can be examined for:
    - FOREIGN BODIES
    - TENDON INJURY
    - JOINT CAPSULE PENETRATION
- Examine hand and arm in a variety of positions, including the position of injury and a full, passive range of motion to avoid missing injuries that may move out of the field of view when the extremity is examined in a neutral position

WOUND DRESSING AND POSTREPAIR CARE:

- Once repaired, the wound should be covered with a nonadherent dressing and wrapped loosely with a soft dressing to allow for adequate circulation
- Certain injuries → especially large lacerations in close proximity to a joint and those with tendon involvement may be splinted for protection and limitation of pain
- Keep the injured extremity elevated above the level of the heart to reduce oedema
- Follow up check in 48-72 hours, with suture removal 7-10 days post injury
- PROPHYLACTIC ANTIBIOTICS ARE **NOT ROUTINELY INDICATED**
    - Consider for wounds that are potentially contaminated
        - Mammalian bites, ≥12 hours old, having exposed bone
        - Those with concurrent medial comorbidities (DM, CRF, PVD, immunosuppresion)
- INDICATIONS FOR ADMISSION:
    - Need for IV antibiotics
    - Need for operative intervention

<u>DORSAL FOREARM, WRIST AND HAND LACERATIONS:</u>

- THE FOREARM HAS SIX EXTENSOR COMPARTMENTS LOCATED DORSALLY, ALL OF WHICH ARE INNERVATED BY THE **RADIAL NERVE**
- Skin on the dorsum of the forearm and hand is THIN and lacks underlying tissue → allows skin avulsion to occur easily, making wound edge approximation difficult
- For deep wounds that penetrate through the muscle fascia and lacerate the muscle belly, closure of the fascial defect is generally recommended

<u>CLENCHED FIST INJURIES:</u>

- Patients with lacerations to the dorsum of the hand should be questioned about the possibility of a clenched fist injury or "FIGHT BITE"
    - Created by patient throwing a punch and impacting the front teeth, producing a small laceration over the DORSAL MCPJ

- After the fight, the patient is likely to extend the hand → DEEPLY INOCULATES ORAL BACTERIA INTO THE WOUND (the human mouth has 50 species of bacteria)
  - POLYMICROBIAL INVOLVEMENT IS TYPICAL (staph aureus most commonly, strep, corynebacterium, Eikenella)
  - Cover with antibiotics routinely (recommendations below relate to all human bites from ETG, both non-established and established infection)

Established infection

Infected tissue for Gram stain and aerobic and anaerobic cultures should be obtained before antibiotic therapy. Delaying primary wound closure should also be considered. For bites to the hand and face, early specialist surgical consultation is advised.

Use initially:

1 **piperacillin+tazobactam 4+0.5 g (child: 100+12.5 mg/kg up to 4+0.5 g) IV, 8-hourly**

OR

1 **ticarcillin+clavulanate 3+0.1 g (child: 50+1.7 mg/kg up to 3+0.1 g) IV, 6-hourly**

OR THE COMBINATION OF

2 **metronidazole 400 mg (child: 10 mg/kg up to 400 mg) orally, 12-hourly**

PLUS EITHER

1 **ceftriaxone 1 g (child: 25 mg/kg up to 1 g) IV, daily**

OR

2 **cefotaxime 1 g (child: 25 mg/kg up to 1 g) IV, 8-hourly.**

For patients with immediate hypersensitivity to penicillin (see Table 2.2), seek expert advice.

Change to oral therapy once patient is stable. If the infecting pathogen is uncertain, use:

amoxycillin+clavulanate 875+125 mg (child: 22.5+3.2 mg/kg up to 875+125 mg) orally, 12-hourly.

For patients with penicillin hypersensitivity (see Table 2.2), use:

1 **moxifloxacin 400 mg (child: 10 mg/kg up to 400 mg) orally, daily**

OR THE COMBINATION OF

2 **metronidazole 400 mg (child: 10 mg/kg up to 400 mg) orally, 12-hourly**

PLUS EITHER

1 **doxycycline 200 mg (child more than 8 years: 5 mg/kg up to 200 mg) orally, for the first dose, then 100 mg (child more than 8 years: 2.5 mg/kg up to 100 mg) orally, daily**

OR

2 **trimethoprim+sulfamethoxazole 160+800 mg (child more than 2 months: 4+20 mg/kg up to 160+800 mg) orally, 12-hourly.**

Infection not established

Low risk

Antibiotics may not be necessary for mild wounds not involving tendons or joints that can be adequately debrided and irrigated and that are seen within 8 hours.

High risk

Wounds having a high risk of infection include:

- wounds with delayed presentation (8 hours or more)
- puncture wounds unable to be debrided adequately
- wounds on hands, feet or face
- wounds with underlying structures involved (eg bones, joints, tendons)
- wounds in the immunocompromised patient.

Presumptive therapy is necessary; use:

amoxycillin+clavulanate 875+125 mg (child: 22.5+3.2 mg/kg up to 875+125 mg) orally, 12-hourly for 5 days.

If commencement of oral therapy will be delayed, give:

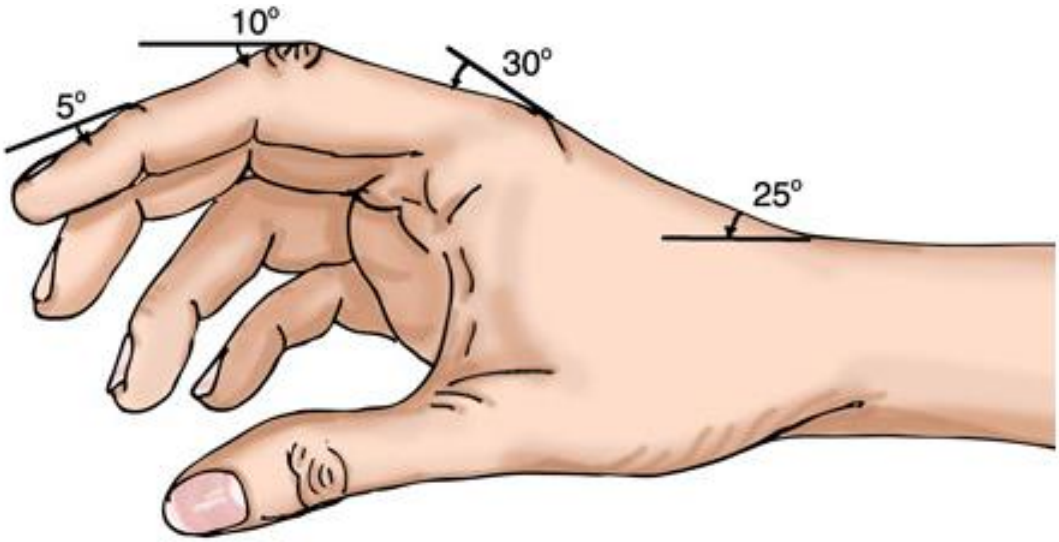
procaine penicillin 1.5 g (child: 50 mg/kg up to 1.5 g) IM, as a single dose, followed by amoxycillin+clavulanate as above.

For patients hypersensitive to penicillin, use one of the oral regimens recommended for established infection for 5 days.

Tetanus prophylaxis (Table 2.19)

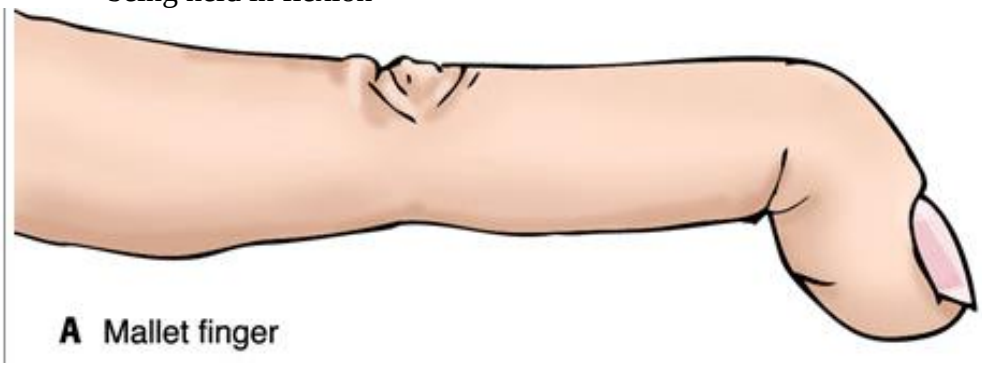
Time since vaccination	Type of wound	Tetanus toxoid vaccine [NB1]	Tetanus immunoglobulin
History of 3 or more doses of tetanus toxoid vaccine			
less than 5 years	all wounds	no	no
5 to 10 years	clean minor wounds	no	no
	all other wounds	yes	no
greater than 10 years	all wounds	yes	no
Uncertain vaccination history or less than 3 doses of tetanus toxoid vaccine			
	clean minor wounds	yes	no
	all other wounds	yes	yes

- RADIOGRAPHY SHOULD BE PERFORMED ON AL LCLOSED FIST INJURIES TO EVALUATE FOR:
    - Embedded teeth
    - Air in the joint/soft tissues
    - Fractures
- Patients who delay evaluation and develop obvious infection require exploration, open irrigation and debridement in the OT as well as IV antibiotics (see above)
- Lacerations from closed fist injuries should not be sutured, but allowed to heal by secondary intention
- SPLINT IN THE POSITION OF FUNCTION (POSI SPLINT, SEE BELOW)

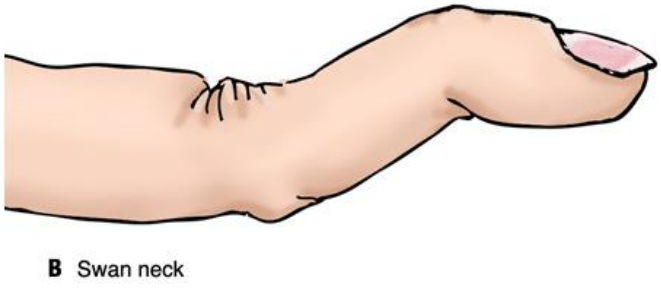


EXTENSOR TENDON LACERATIONS:

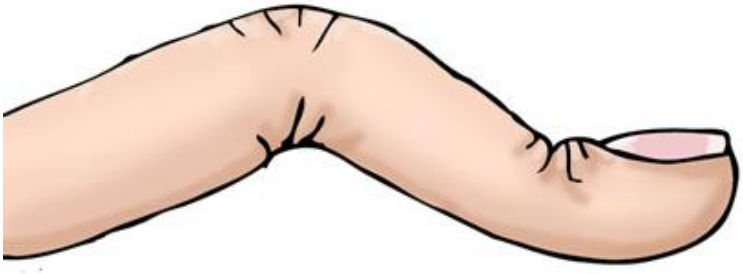
- Dorsal skin of the hand is thin and feely mobile, allowing for extensive range of motion for all joints → examine the hand in a neutral position and in the postion of injury to avoid missing a tendon injury
- COMPLICATIONS CAN BE SEEN WITH DISRUPTED EXTENSOR MECHANISMS:
    - MALLET FINGER → inability to extend the DIPJ, resulting in the joint being held in flexion



- SWAN NECK DEFORMITY (hyperextension of the PIPJ), caused by complete disruption of the terminal extensor mechanism and subsequent proximal and dorsal displacement of the lateral bands. Often results from unrepaired mallet finger.



- BOUTONNIERE DEFORMITY → hyperflexion of the PIPJ with hyperextension of the DIPJ → usually a delayed complication after injury to the PIPJ



C Boutonniere

- CLOSED INJURIES → SPLINT WITH THE DIGIT IN EXTENSION AND REFER TO HAND SURGEON. IF OPEN → OT URGENTLY

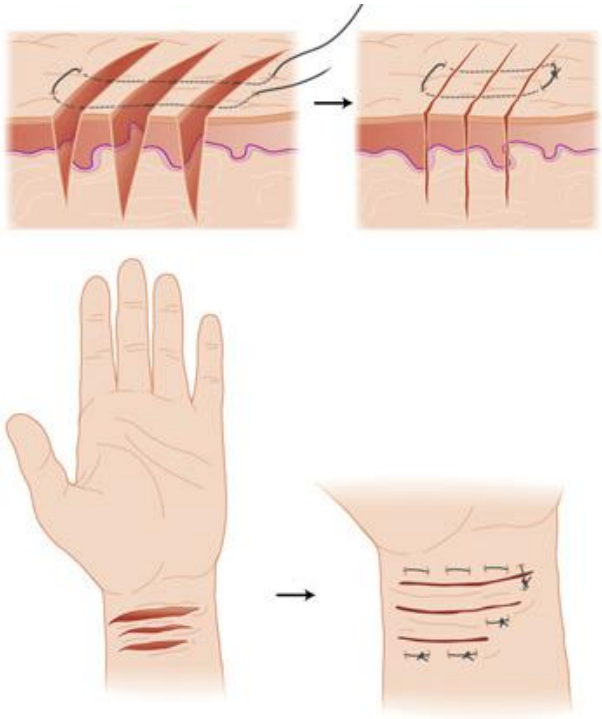
VOLAR FOREARM, WRIST AND HAND LACERATIONS:

- Patients with volar wrist lacerations should be questioned about suicidal intent
- THERE ARE 12 FLEXOR TENDONS INNERVATED BY THE MEDIAN AND ULNAR NERVES THAT CROSS THE WRIST

Table 47-4 Flexor Tendons in the Forearm

Flexor Tendon	Function
Flexor carpi radialis	Flexes and radially deviates wrist
Flexor carpi ulnaris	Flexes and ulnarly deviates wrist
Palmaris longus	Flexes wrist
Flexor pollicis longus	Flexes thumb at MCP and interphalangeal joints
Flexor digitorum superficialis	Flexes index, long, ring, and little digits at MCP and PIP joints
Flexor digitorum profundus	Flexes index, long, ring, and little digits at MCP, PIP, and DIP joints

- Injuries in the elbow region may affect the radial and ulnar nerves, which are in close proximity to the lateral and medial epicondyles respectively
- If considering placement of deep sutures (i.e. absorbable), beware of the increased risk of infection
- Injuries that involve more than one parallel laceration, classic for suicide attempts may require HORIZONTAL MATTRESS SUTURES TO CROSS ALL LACERATIONS for closure to prevent compromising the vascular supply of the island of skin



PALM LACERATIONS:

- Palmar skin is thicker than dorsal skin and has an underlying connective tissue fascial layer, maying it much more adherent to bone
- Because tendons, nerves and arteries course through this area, palm lacerations have GREAT POTENTIAL TO DAMMAGE THESE DEEP STRUCTURES through small and innocuous appearing lacerations
    - Careful assessment of flexor tendon function and two-point discrimination is important

FLEXOR TENDON LACERATIONS:

- Flexor tendon injuries are usually repaired in OT by a hand surgeon because of the complexity of the anatomy
    - Early consultation is important → many will want to repair flexor tendons no later than 12-24 hours after injury
    - If operative repair is going to be delayed, clean wound appropriately, skin closed and affected extremity splinted to prevent contracture of the surrounding muscles
    - Urgent repair is important, as post injury scarring and tendon retraction make flexor tendon repairs more difficult after 10-14 days
        - Rapid repair also recommended to restore vascular and synovial flow to the area to maximise healing
- Patients with suspected partial flexor tendon lacerations should also have follow up because unrepaired partial FDS disruption can produce a trigger finger

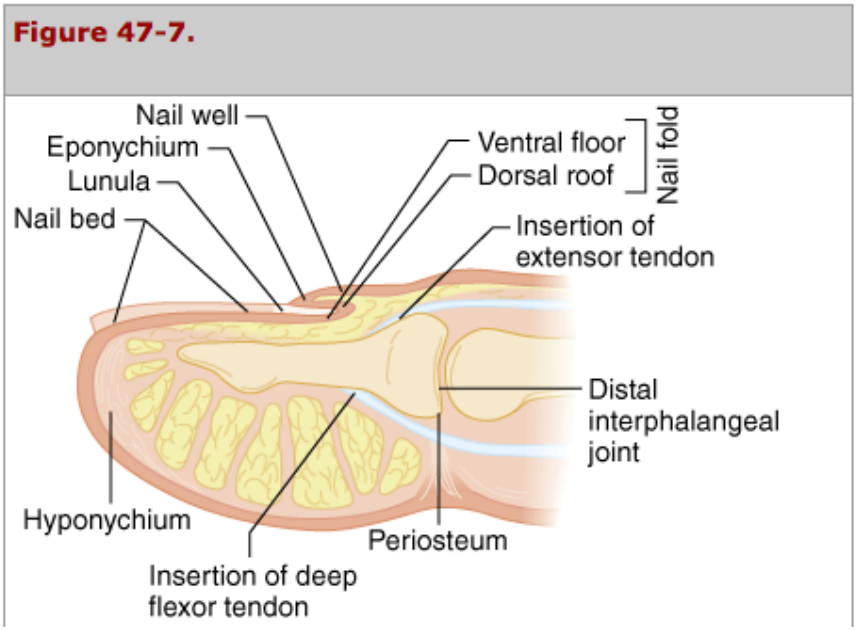
FINGER LACERATIONS:

- IN GENERAL → isolated finger lacerations are straightforward injries to examine and repair
- Vascular status is checked by capillary refill and sensory nerve status is checked by static two point discrimination
- Simple interrupted sutures with 5-0 nonabsorbable sutures provide adequate closure for most digital lacerations
- Deep finger lacerations may include partial or complete amputations of the digit → involve consultation of a hand surgeon to discuss the possibility of replantation
    - Consider in children, injuries to the thumb, multiple digit amputation and single digit amputation proximal to the insertion of FDS
    - Strongest contraindications to replantation → crush/avulsion injuries, because NV damage to amputated digit is significant and offers poor prognosis
        - Relative CI → multiple levels of injury, prolonged ischaemia time (>24 hours) or poor health/comorbidities

DIGITAL NERVE INJURIES:

- Suspected when static two-point discrimination is distinctly greater on one side of the volar pad than the other or when it is >10mm
- Can be repaired either acutely or weeks later → ensure follow up
- Nerve contusions typically heal in 12 days to 6 months
- Nerve transections due slightly better than crush injuries

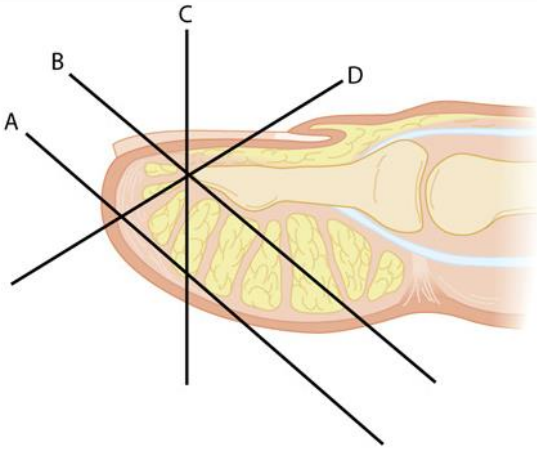
FINGERTIP INJURIES:



ANATOMY OF THE PERIONYCHIUM

FINGERTIP AMPUTATIONS:

Figure 47-8.



Fingertip amputations. (**A**) Volar angulation without bone exposure. (**B**) Volar angulation with bone exposure. (**C**) Transverse or perpendicular angulation with bone exposure. (**D**) Dorsal angulation with bone exposure.

- **DIGITAL TIP INJURIES WITH SKIN AND PULP TISSUE LOSS ONLY:**
  - Distal fingertip amputations that are <1cm2 in size without expose bone or nail bed involvement can usually be treated conservatively with serial dressing changes alone (see line A above)
  - Arrange follow up in 2 days for a wound check
  - Wound care vital to healing → soak the injured fingertip in warm water to which antiseptic has been added, once a day for 10 minutes
  - A split or full-thickness skin graft is another means of wound closure → consider in greater tissue loss
- **DIGITAL TIP INJURIES WITH EXPOSED BONE:**
  - If a significant loss of tissue at the fingertip causes exposure of the distal phalanx tuft, skin grafting will be unsuccessful because bone does not provide adequate vascularity to support donor tissue
  - Amputations that are angled either in a transverse or volar direction have LESS FAVOURABLE OUTCOMES (LINES B AND C)
  - Incomplete digital tip amputations, defined by the retention of the NV bundle as well as portions of the underlying bones are among the most difficult injuries to reconstruct → specialist referral
  - Although fingertip injuries are quite common inchildren, most require only conservative management allowing for rapid healing ability of the young
    - A completely amputated composite tip may be reattached to serve solely as a biologic dressing and parents should be informed that the tip might necrose, dry up and turn black as the underlying wound continues to heal

INJURIES INVOLVING THE NAIL AND THE NAIL BED:

- NAIL BED IS MADE UP OF THE GERMINAL AND STERILE MATRICES
    - Germinal matrix begins 3-5mm proximal and deep to the eponychium and extends distally to the lunula
- Distal tuft or phalanx fractures are associated with 50% of nail bed injuries → imaging mandated

SUBUNGUAL HAEMATOMA:

- Disruption of the blood vessels of the nail bed without fracture of the nail results in accumulation of blood under the nail
    - The area of haematoma is directly proportional to the degree of vascular damage
    - If the subungual haematoma covers >50%, treatment can be accomplished with TREPHINATION OF THE NAIL PLATE TO ALLOW FOR DECOMPRESSION AND DRAINAGE OF THE HAEMATOMA → do under digital nerve block
        - Produces a good to excellent outcome in most patients regardless of size, injury mechanism or the presence of underlying fracture
- Nail removal is recommended only if there associated nail avulsion or surrounding nail fold avulsion → HAND SURGEONS
- If an associated distal phalanx or tuft fracture coexists with a nail bed laceration, it usually manifests as an avulsion of the nail out of the proximal eponychial fold

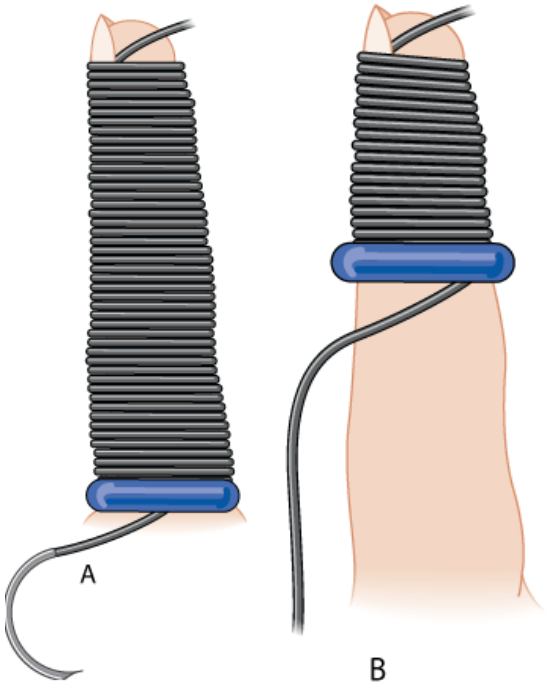
NAIL BED AVULSION INJURIES:

- An avulsion or crush injury may tear the nail completely away from the digit, with fragments of matrix tissue left on the underside of the avulsed digit → preserve if possible
- Consulation with hand/plastic surgeon as these wounds are complex and repair is technically challenging

RING TOURNIQUET SYNDROME:

- A tight ring encircling the proximal phalanx may become entrapped as a result of distal swelling → as the digit expands, venous outflow is restricted by the tight ring, producing more swelling → eventually leads to nerve damage, ischaemia and digital gangrene

- If perfusion compromised, RAPID REMOVAL IS WARRANTED BY CUTTING THE RING → IF NOT COMPROMISED, TRY SLOWER TECHNIQUES THAT PRESERVE THE RING
  - In all ring-preservation techniques, the hand should be elevated to encourage venous and lymphatic drainage (thus decreasing swelling)
  - Simplest technique is lubrication
  - Other technique is STRING TECHNIQUE → wrap 0-silk circumferentially around the finger, pass under the ring and then unwrap the string to advance the ring off the finger



- PIPJ is the widest point is the widest portion of the finger and the hardest to negotiate

- Rings should be CUT IN THE THINNEST AND MOST ACCESSIBLE SITE