

# Penetrating Soft Tissue Injuries to the Hand. Clinical Practice Skills.

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## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nail bed/plate injuries.
  - Post injury infections.
- ◆ Amputations.
- ◆ Simple and Complex Skin Lacerations.
- ◆ Partial Thickness Tendon Lacerations.
- ◆ Full Thickness Tendon Lacerations.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Open Fractures
- ◆ Combined Injuries
- ◆ Grease Gun Injuries, Nail Gun Injuries.
- ◆ Chemical Exposure

## Penetrating Soft Tissue Injuries to the Hand.

- ◆ Nailbed Injuries
  - Anatomy
  - Injury Patterns
  - Treatment
  - Outcomes
  - "Late reconstruction of the nailbed is unpredictable, and frequently little, if any improvement is obtained." - Elvin Zook, M.D.

## Penetrating Soft Tissue Injuries to the Hand.

Nailbed Injuries – Anatomy



◆ From Netter's Atlas of Anatomy, 1990.

## Penetrating Soft Tissue Injuries to the Hand



◆ Netter's Atlas of Anatomy, 1990.

## Penetrating Soft Tissue Injuries in the Hand

- ◆ Nailbed Injuries – Mechanisms.
  - Doors most common mechanism, followed by smashing between two objects, and saws.
  - Long finger, being the longest and most exposed, is the most frequently injured.
  - Ring, index, little and thumb in that order.
  - Caused by compression of the relatively fragile nailbed between the relatively hard nailplate and distal phalanx.
  - A true laceration is rare, usually amputation occurs.

## Penetrating Soft Tissue Injuries to the Hand.

- ◆ Nailbed Injuries – Pattern
  - Subungual hematoma with intact nailplate.
  - Nailbed laceration with damaged nailplate.
    - ◆ Stellate laceration vs. linear repairable laceration.
    - ◆ Irreparable nailbed injuries with tissue defects.
  - Nailplate displacement dorsal to eponychial fold, avulsive type injury.

## Penetrating Soft Tissue Injuries to the Hand



- Zook EG, Brown RE: The Perionychium, pg 1356. In In Green DP, Hotchkiss RN, Pederson WC (eds): Green's Operative Hand Surgery, 4<sup>th</sup> edition. Churchill Livingstone, Philadelphia, 1999.

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## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Injuries – Diagnosis and Evaluation.
  - History, i.e. mechanism, age of injury, previous injuries, last tetanus.
  - Examination
    - ◆ Start away from zone of injury, i.e. rest of hand.
    - ◆ Probably most important is making sure extensor and flexor tendons intact.
    - ◆ Rare to have any ischemia.
    - ◆ Sensory examination shows disturbance, but usually just nerve contusion. Even if it is a laceration of a nerve, distal to the lunula it is very hard to actually repair and will likely result in an imperceptible deficit.
  - X-rays (pretty much mandatory).

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Injuries – Treatment
  - Digital block, finger tourniquet if you dare (Be Careful!)
    - ◆ 20 cc of a 50/50 mixture of 1% lidocaine and 0.5% marcaine in two 10 cc syringes with 25 gauge 1.5 inch needles. No epinephrine (although this dogma is now being questioned).
    - ◆ Wipe with alcohol and paint with betadine.
    - ◆ Volarly inject just above flexor tendon sheath at distal palmar crease about 5cc.
    - ◆ Dorsally inject from bordering metacarpal to bordering metacarpal with 10 cc.
    - ◆ Patient should be 100% comfortable, if not inject more, usually needed volarly.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Lacerations
  - Digital Nerve Block.



Netter's Atlas of Anatomy, 1990.

## Penetrating Soft Tissue Injuries to the Hand



- ◆ Zook EG, Brown RE: The Perionychium, pg 1357. In In Green DP, Hetchkiss RN, Pederson WC (eds): Green's Operative Hand Surgery, 4<sup>th</sup> edition. Churchill Livingstone, Philadelphia, 1999.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Subungual Hematoma with Intact Nailplate.
  - Guidelines used to be if greater than 50% of nail surface, remove nailplate and repair.
  - Now more inclined to just trephine for comfort, even if greater than 50% of nail surface.

– Seaberg DC, Angelos WJ, Paris PM: Treatment of subungual hematomas with nail trephination: a prospective study. Am J Emerg Med 9:209-210, 1991.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Injuries – Exploration and Repair.
  - Most important part is having a good gofer.
  - Paint finger with betadine and use fenestrated drape.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Injuries – Exploration and Repair
  - Inspect, wash out with 10% betadine solution and repair.
  - Remove nailplate with freer or small clamp, be gentle can further damage nailbed and actually avulse portions of it.
  - 5-0 chromic on a spatula type ophthalmic needle.

## Penetrating Soft Tissue Injuries to the Hand

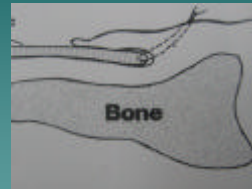
- ◆ Nailbed Injuries – Repair.
  - Scrub nailplate, dip in betadine and reinsert in nailfold.
  - ◆ Sutures to secure in that position, remove in 1-2 weeks.
    - Can be placed to anchor
  - ◆ Nail will usually fall off in 1 to 3 months.

## Penetrating Soft Tissue Injuries to the Hand.



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## Penetrating Soft Tissue Injuries to the Hand



- ◆ Sutures used to anchor nailplate into nailfold.
- ◆ Horizontal mattress starting dorsal to nail fold, go through nailplate and exit again through dorsal nailfold.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Replacement of nailplate to serve as scaffold for nailbed repair.



## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Injuries – Associated Distal Phalanx Fracture.
  - Approximately 50% incidence.
  - Technically speaking this is an open fracture.
  - Most are not treated in an operating room setting and are washed out in the ER.
  - I have not seen a case of osteomyelitis, yet.
  - With the very large number of injuries that occur this is impressive and probably a tribute to the very abundant blood supply present in the hand.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailbed Injuries – Associated Distal Phalanx Fractures.
  - X-rays important in all cases of nailbed injuries.
  - Vast majority can be managed nonoperatively with replaced nailplate acting as splint.
  - Gross deformity does need to be corrected to insure an adequate scaffold for future nailplate growth.
  - Include 10 days of po antibiotics.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ What to refer?
  - Displaced fractures that do not reduce with simple nail replacement.
  - Complex lacerations where soft tissue deficits preclude closure or at least approximation of nailbed tissue.
    - ◆ Save nail – can sometimes have portions of nailbed attached to it that can be used as graft material.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Simple Lacerations
  - Knife, glass or sharp metal object.
  - Make sure no nerve, tendon damage.
    - ◆ Nerve assesment best with two point discrimination, which is normally 5mm or better.
    - ◆ Check both the radial and digital nerve territories
    - ◆ Check active range of motion against resistance.

## Penetrating Soft Tissue Injuries to the Hand.

- ◆ Simple Lacerations
  - X-rays – are they necessary?
  - I always obtain, but probably not always necessary.

## Penetrating Soft Tissue Injuries to the Hand

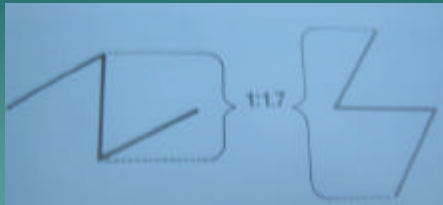
- ◆ Simple Lacerations Repair.
  - Usually field block with 1% Lidocaine will suffice.
  - 3-0, 4-0 nylon.
  - Suture removal appointment allows for second look to assure tendon nerves intact.
  - If laceration crosses flexion crease at right angle may need z-plasty at a later date.

## Penetrating Soft Tissue Injuries to the Hand



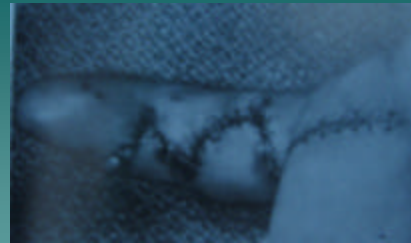
◆ Green's Operative Hand Surgery, 4<sup>th</sup> edition.

## Penetrating Soft Tissue Injuries to the Hand



• Green's Operative Hand Surgery, 4<sup>th</sup> edition, 1999.

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## Penetrating Soft Tissue Injuries to the Hand

- ◆ Complex Lacerations with Soft Tissue Loss.
  - Laceration that cannot be repaired primarily, i.e closed.
  - More common on the dorsum of the hand.
  - Blood supply usually will allow healing by secondary intention.
  - Exceptions are exposed bone, tendon (with no paratenon) or nerve where skin graft or rotational flap maybe necessary.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Amputations
  - Almost always exposed bone.



– Lister GD, Pederson WC: Skin Flaps, pg 1802. In Green DP, Hotchkiss RN, Pederson WC (eds): Green's Operative Hand Surgery, 4<sup>th</sup> edition. Churchill Livingstone, Philadelphia, 1999.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Limitless possibilities for coverage.
- ◆ Much enthusiasm for flaps, trend now is more toward skeletal shortening and closure.



• Green's Operative Hand Surgery, 4<sup>th</sup> Edition, 1999.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ "As we have gained more experience, we have performed fewer local and distant flaps to cover a small portion of exposed bone."
- Louis DS, Jebson PJL and Graham TJ: Amputations, pg 56. In Green DP, Hotchkiss RN, Pederson WC (eds): Green's Operative Hand Surgery, 4<sup>th</sup> edition. Churchill Livingstone, Philadelphia, 1999.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Amputations
  - Occasionally an amputation at the middle phalangeal level needs coverage to preserve superficialis insertion.
  - Without superficialis insertion not much point to preserving length in the middle phalanx as there will not be a motor tendon to flex the PIP joint.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Amputations
  - Many different very fancy ways to cover.
  - Skeletal shortening and primary closure with rongeur usually best method to manage at middle and distal phalangeal levels.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Amputations.
  - Primary closure with 4-0 nylon.
  - Significant capacity for healing by secondary intention.
  - If more than 30% of distal phalanx missing will likely get a hook nail deformity because of lack of support for the nailplate growth.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Amputations
  - Nerves usually distal to lunula not easily identifiable. Proximal to that should be retracted and transected.
  - Do not sew extensor tendon to flexor tendon or Quadriggeria effect may occur.
  - Lumbrical plus finger can also occur with paradoxical pip joint exentsion with flexion.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Replantation
  - Multiple digits and thumb.
  - Very rarely indicated in single digit, especially zone 2.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Open Hand Fractures
  - Distal phalanx most common.
  - Other than distal phalanx, should all be referred.
  - Sometimes hard to diagnose, if small puncture wound.
  - Usually abrasions will seal over versus "venous ooze" which occurs with fractures.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Open Hand Fractures
  - Initial treatment.
    - ◆ Tetanus.
    - ◆ Antibiotics.
      - IV while in hospital with rapid switch over to po's for lower grade injuries.
    - ◆ Washout within 8 hours of injury.
    - ◆ Fixation of unstable or displaced fractures.
      - External fixation, plate and screws, or k-wires.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Open Hand Fractures.
  - Prognosis and rate of deep infection (osteomyelitis) is most closely correlated to the extent of the initial soft tissue injury.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Combined Injuries

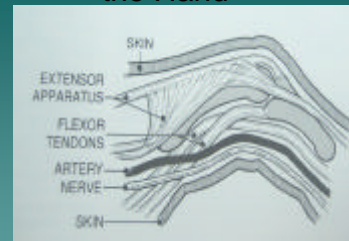
Traumatic injury to two or more separate, functionally relevant structural systems at a specific location.

Skil saw injuries are the perfect example.

Obvious referral.

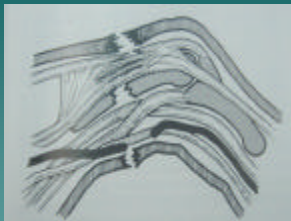
Much poorer prognosis than isolated injuries.

## Penetrating Soft Tissue Injuries to the Hand



- ◆ Picture of combined injuries.
  - Green's Operative Hand Surgery, 4th edition, 1999.

## Penetrating Soft Tissue Injuries to the Hand.



- ◆ Picture of Combined Injuries
  - Green's Operative Hand Surgery, 4th edition, 1999.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Grease Gun Injuries or High Pressure Injection Injuries
  - Paint, paint solvent or grease.
  - Severe injury, often underestimated at first look.
  - Needs immediate wide debridement.
  - Long term prognosis directly related to rapidity of treatment.
  - 28% amputation rate.

## Penetrating Soft Tissue Injuries to the Hand

### ◆ Grease Gun Injuries

- Increase of pressure within the closed space leads to tamponade, intravascular thrombosis and spasm of vessels create circulatory embarrassment, a chemical irritation provokes an acute inflammation
- An early, wide decompression and aggressive debridement with complete removal of foreign substances and necrosectomy is recommended in the acute stage and will improve prognosis and outcome.

## Penetrating Soft Tissue Injuries to the Hand



Ameya J, et al., High pressure injection injuries, *Emergency*, September 2005.

## High Pressure Injection Injuries



◆ Ameya J, et al., High pressure injection injuries, *Emergency*, September 2005.

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## Penetrating Soft Tissue Injuries to the Hand

### ◆ Chemical Exposures.

- Hydrofluoric Acid – Calcium Gluconate.

- ◆ Glass etching, semiconductor manufacturing and household rust removers.

- Elemental Sodium – Mineral Oil.

- ◆ Used in Meth labs.  $\longrightarrow$



## Hydrofluoric Acid Burn



Wilkes G. Hydrofluoric acid burns, eMedicine, November, 2005.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nail gun injuries.
  - Common in construction workers, weekend carpenters.
  - Usually non dominant hand injured.
  - Velocities as high as 1,400 feet per second.

- [David A. Williams, Robert L. Johnson, Curtis M. Hawkins; Nail gun injuries of the hand. American Family Physician. 1997;49:1303.](#)

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Nailgun Injuries.
  - Presence of copper barbs on nail complicates removal.
  - Potential for clothing contamination if fired through glove.
  - If both entry and exit wounds, use bolt cutter to remove remaining portion at entry site, then remove remaining portion through exit wound.

## Penetrating Soft Tissue Injuries to the Hand.

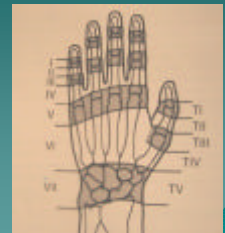
- ◆ Partial tendon lacerations.
  - You look in the wound and see something tendinous cut, but no definite range of motion deficit.
  - Current recommendations involve repair if more than 40% of tendon lacerated.
  - Very hard to quantify the damage.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Partial tendon lacerations.
  - My approach is to give the patient an option at exploration with the caveat that if they do not want an exploration they may rupture in the future and require immediate repair.
  - I have not seen much difference in the results if rupture is immediately repaired.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Complete extensor tendon lacerations.
  - Odd numbers over the joints.



- Doyle JR. Extensor Tendons - Acute Injuries. Pg 1996 In Green DP, Hotchkiss RN, Pederson WC (eds). Green's Operative Hand Surgery, 4th edition. Churchill Livingstone, Philadelphia, 1999.

## Penetrating Soft Tissue Injuries to the Hand

- ◆ Complete tendon lacerations.
  - Exam is usually very obvious with lack of active extension at distal joint level.
  - Exceptions include central slip laceration, where lateral bands can maintain full extension at pipjoint.
  - Another exception is where zone 6 (at the metacarpal level) junctura will maintain extension even though full thickness laceration.
  - Both of these type lacerations, when full thickness, should be repaired.

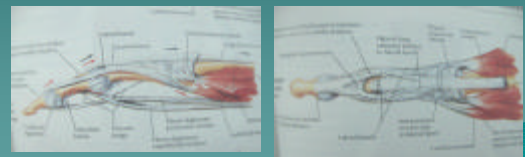
## Penetrating Injuries to the Hand



## Penetrating Soft Tissue Injuries to the Hand

- ◆ Diagnosing Complete Zone 6 Extensor Tendon Lacerations where junctura is maintaining full active extension.
  - Test for strength (after anesthetic for wound repair)
  - Test with other fingers flexed at MCP and compare to contralateral side.

## Penetrating Soft Tissue Injuries to the Hand Full Thickness Central Slip Lacerations.



## Penetrating Soft Tissue Injuries to the Hand

- ◆ Flexor Tendon Lacerations.
  - Usually not a subtle diagnosis.
  - When questionably partial I use the same approach.
  - Repair usually best if done within 10 days of injury.
  - Poor results in Zone 1 and 2 injuries.

THANK YOU