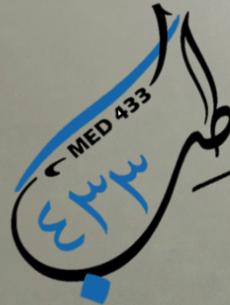


# Hand Injuries



Surgery Team  
MED 433



# Objectives :

Abbreviations	
FCU	Flexor carpi ulnaris
FCR	flexor carpi radialis
PL	palmaris longus
FDS	flexor digitorum profundus
FDP	flexor digitorum superficialis
MCP joint	metacarpophalangeal joints
PIP joint	proximal interphalangeal joints
DIP joint	distalinterphalangeal joints
FPL	flexor pollicis longus

[Color Index](#): Slides & Raslan's (  ) | [Doctor's Notes](#) | Extra Explanation | [Additional](#)

**The doctor didn't give us his slides. This work is based on Raslan's (Does not include the book)**

# Mind Map



It is highly recommended to see this video before going through the lecture:  
Anatomy of the hand : 11 minutes  
<https://www.youtube.com/watch?v=zyl6eoU-3Rg>

# 1. Introduction

- **Histroy:** (Important questions, you should ask every patient with hand complains)
- **Hand dominance**
- **Occupation**
- **Previous hand trauma or injury**
- **Smoking**
  - Patients who smoke have vasoconstriction of blood vessels and that makes connecting an amputated finger have a high chance of failing so the doctor must know before he goes into the OR. No point in wasting time, this procedure takes 6-8 hr so if the patient is a smoker from the beginning, say you can't.
- **Tetanus**
  - Make sure the patient is vaccinated, if not give him vaccination
  - Any open wound there is risk of infection (tetanus)
- **Acute vs. Chronic**
  - Acute e.g. Trauma, burns, laceration, fractures, dislocation, infection
  - Chronic e.g. Lumps , Carpal tunnel syndrome and nerve compressions, arthritis
- **Mechanism of injury and complaint**
  - Trauma, Laceration, Swelling or lump, Arterial or Venous injury, Dislocation, Infection, Numbness

# • Examination :

## 1. Inspection

- **Compare both hands** (always compare to a normal hand)
- Dorsum then volar (palmer) surface
  - Skin (Ulcers or lesions or color)
  - Swelling
  - Wasting
  - Position, normal position of hand if you put it on table: flexion cascade “the flexor tendons are stronger than extensor tendons”. If someone can't do this, there is injury to flexor tendons.

## 2. Palpation

- Feel Tenderness, sensation, temperature, Capillary refill

## 3. Check Movement

### o Move Range of Motion

- Passive, Active
- Examine FDS, FDP, & extensor tendons

### o Test Specific Nerves (Sensory + Motor)

- Median (sensation to lateral three and a half volar side)
- Ulnar (sensation to medial one and a half on the volar and dorsal side)
- Radial (lateral three and a half dorsal)



- The ulnar nerve is the most important nerve in the hand because it controls all action except opposition of the thumb by the median nerve
- Ulnar supplies all muscles except thumb muscles (Abductor pollicis brevis, flexor pollicis brevis, Opponens pollicis) and 2 lumbricals by the median nerve



- There are no intrinsic muscles on the dorsum of the hand all of them are on the volar surface.
- Radial nerve doesn't give any motor supply to hand, only sensation
- 2 groups of hand muscles:
  - Extrinsic: Originate from the forearm and insert in the hand
  - Intrinsic: Originate and insert in the hand

## How to examine FDS and FDP?

### FDS

The Flexor Digitorum Superficialis (FDS) inserts into the middle phalanx of each finger. It is tested by blocking the finger MCP joint and asking the patient to flex the PIP joint. To block the MCP joint, hold the proximal phalanx in extension just distal to the MCP joint, so that the MCP joint is unable to bend when the patient tries to flex the finger.



### FDP

The Flexor Digitorum Profundus (FDP) inserts into the distal phalanx of each finger. It is tested by blocking the finger PIP joint and asking the patient to flex the DIP joint. To block the PIP joint, hold the middle phalanx in extension just distal to the PIP joint, so that the PIP joint is unable to bend when the patient tries to flex the finger.



# 2. Hand Infections:

## Paronychia Infections:

- Most common hand infection.
- Infection of the nail bed or nail plate
- Present with redness around the nail
- Could be just cellulitis and redness or abscess
- Most common organism is **Staph. Aureus**



### Treatment:

- Antibiotics + warm saline soaking
- If there is abscess, or no response in 48 hours you must do **Incision and drainage**
- If there is an abscess then you must do incision and drainage
- If someone gets paronychia infection frequently (6 times a year) think of chronic infection
- Most common cause of chronic infection is candida (fungi) (especially in diabetics or immunocompromised)
  - **Treatment:**
    - o Suspect Candida so send swab
    - o If +ve, give oral antifungal or topical
    - o If no response then remove the skin and clean then graft



# Felon:

- 38% of all surgical infections (very common)
- Infection of the **finger pulp** (tip of the finger)
- This area is very sensitive **because it has many nerve endings**
- 2 point discrimination is maximal at this area (So when it develops an abscess between it and the skin it causes nerve compression and SEVERE PAIN (if paronychia infection not treated>affects nerve endings+fibers+not allow the space to be expanded)
- **Treatment:**
  - **Antibiotics + warm salt soaks**
  - If no response **incision and drainage**. Incision must be made from the side to not lose sensation



# Herpetic Whitlow:

- HSV type 1 vesicular eruption of the **finger tip**
- Vesicles that contain clear fluid
- Happens to children (biting nails) and **dentists (injured by teeth of infected patients)**
- Very painful, **Very contagious** (dentist should stop working for 10 days)
- **Treatment**
  - **acyclovir** (antiviral medication)





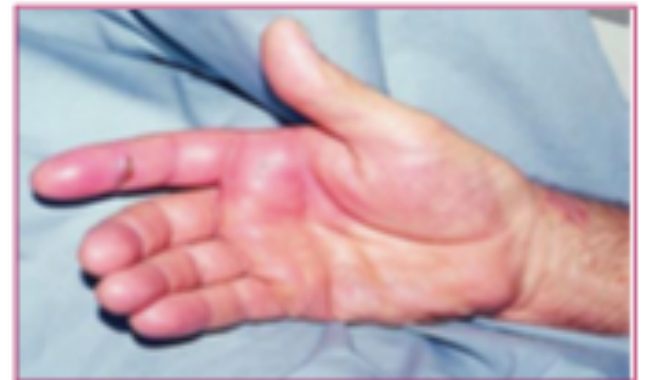
# Collar Abscess:

- Abscess of the **hand web-Space** (Connection point between the volar and dorsal parts)
- Presents with redness, swelling and abducted finger (unable to adduct)
- Patients with sin necrosis require MRI to check other spaces.
- **Treatment:**
  - Antibiotics if early with observation, as in or out patient
  - Incision and drainage in the OR (because it's complex area)



# Flexor Tenosynovitis:

- Infection of **flexor tendon at the synovial sheath.**
- Each finger has 2 flexor tendons; one moves PIP joint (attached to middle phalanx) which is the FDS, and the other moves DIP joint (attached to distal phalanx) which is the FDP.
- Infection of the flexor tendon sheath due to trauma (by sharp material or piece of wood, it affects DM or immunocompromised pts)
- Can extend to the forearm
- 4 signs:
  - Sausage-shaped fingers (due to creases swelling)
  - Held in Flexed position
  - Pain with passive extension (most diagnostic sign)
  - Tenderness along the tendon



## Treatment of Flexor Tenosynovitis :

- o Must be IMMEDIATE because of high risk of sepsis, necrosis and amputation
- o You have to do **incision and drainage** (if no improvement)
- o **Antibiotics**
- o **Catheter irrigation** (irrigate the sheath with saline)
- o If the infection is bad, it can cause thrombosis of artery, ischemia of nerve and insensate the fingers.



### Catheter irrigation

- You pass a catheter between 2 ends of the flexor sheath and you keep it there until the area is clean
- Until you clean out all the pus, if you are not happy leave this catheter in, take the patient to the ward and nurses will irrigate every 6hr and u will take it out after 48-72 hr.
- if you are still not happy with the wound, open the whole finger and clean then close loosely never close infected wound completely.

## Hand bites

- The problem with bites is that the saliva is full of bacteria
- **Human bites:** Staph, Strep, Eikenella  
(usually due to punching someone in mouth and teeth)

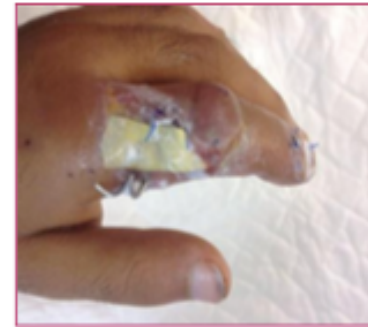
- **Dogs:**

- o **Pasteurella Multocida** (very dangerous), Staph, Strep
- o With street dogs, the most likely cause is rabies
- o All must get rabies treatment: IgG and rabies vaccine (5 injections in abdomen at day 1,3,7,14,28)

- **Cats:**

- o **More dangerous than dog bites** (more concentration of bacteria within the saliva)
- o **Pasteurella Multocida**
- o All of them should be admitted for IV antibiotics


- Most of dog & human bites respond well to **Augmentin Tetanus**
- If given the antibiotics and there's no response in 48 hours, we do **incision + drainage**
- Risk of developing Septic arthritis if not irrigated.



# 3. Necrotizing fasciitis:

- **Flesh eating disease of the soft tissue**
- Occurs in diabetics with low socioeconomic status (immunocompromised)
- Patients presents with infection and is unstable (hypotension , tachycardia, altered level of consciousness, and low urine output)
- Caused by **Group A B-hemolytic strep.**  
Infection of the fascia, with skip lesions on the skin
- **Has high mortality rate**

## Treatment:

- **Patient needs to be intubated and admitted to ICU**
- Needs **extensive debridement and IV Antibiotics**
- So stabilize the patient, take him to the OR, and open all of the infected area in which the fascia will look gray with a bad smell.
- Once you see a healthy area, skip and open again to make sure that there's no extension. Some patients don't respond to the 1<sup>st</sup> or 2<sup>nd</sup> **debridement**,  so **amputation** is the solution here to prevent further extension!

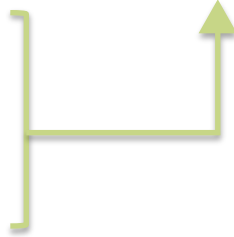


# 4. Flexor tendons:

## Anatomy:

❑ **There are 8 muscles with almost 12 tendons in the flexor (anterior) side:**

- FCU, FCR, PL: flex the wrist
- 4 FDS: flex PIP joint
- 4 FDP: flex DIP joint
- FPL: flex thumb
- Pronator teres and pronator quadrates: supination and pronation.



❑ **Origin and insertion:** Medial epicondyle to the forearm then develops tendons and goes through the carpal tunnel to insert into the hand and fingers

❑ **Nerve Supply**

All of them by the median nerve Except: FCU and medial 1/2 of FDP

## Mechanism of injury:

### CLOSED:

Completely flexed tendon and then sudden severe hyperextension of fingers.

❑ EXAMPLES:

- **Fracture at site of insertion.**
- **Jersey Finger:** avulsion injury of FDP from insertion at base of distal phalanx

### OPEN:

❑ EXAMPLES

- Laceration: **Knife being the most common tool for it**
- Crush injury “American football players”
- Degloving injury.

# Verdan's 5 Zones of flexor tendons:

- ❑ Classified mainly to get an idea of the expected outcome after repair
- ❑ **Zones 3,4 and 5 have a good chance; as you go distally (zone 2), chances of full recovery are less because of the small space**

**Zone 1:** Only include FDP

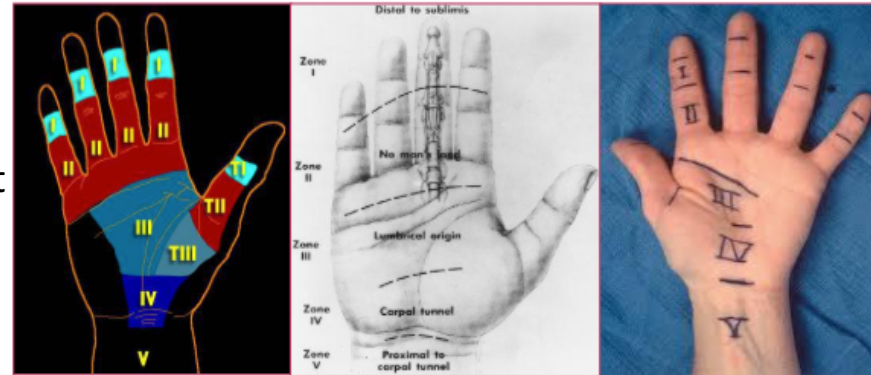
**Zone 2:** FDP&FDS

Extends from MCP joint to insertion of FDS

**Zone 3:** From distal area of carpal tunnel to MCP joint  
Dangerous because it also affects nerves and arteries

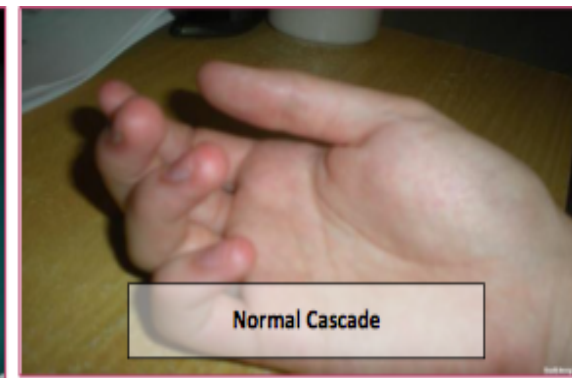
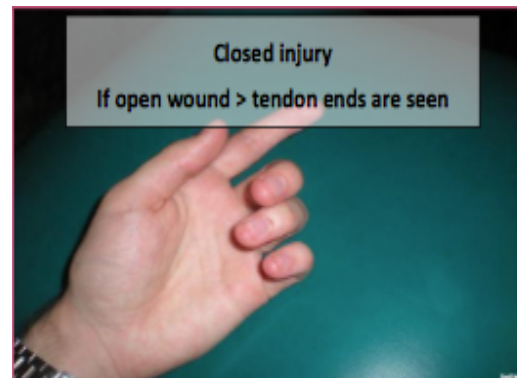
**Zone 4:** Area under carpal tunnel

**Zone 5:** The distal forearm



## Clinical Examination & Finding

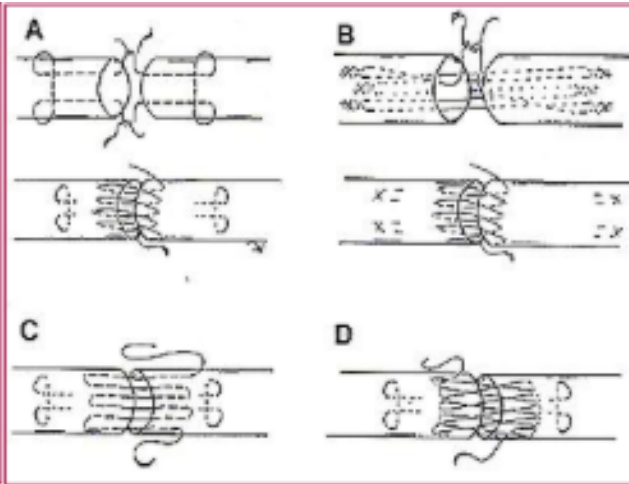
- **Loss of flexion cascade**
- Open wound most commonly
- Tendon could be visible in the wound
- **Inability to flex the digit at PIP or DIP**
- Always ensure there is no nerve or artery injury



Loss of normal cascade, which is flexion of fingers at rest, **notice the index** (lost the cascade due to flexor tendon rupture, leading to extensors taking over)

# Flexor Tendon Repair:

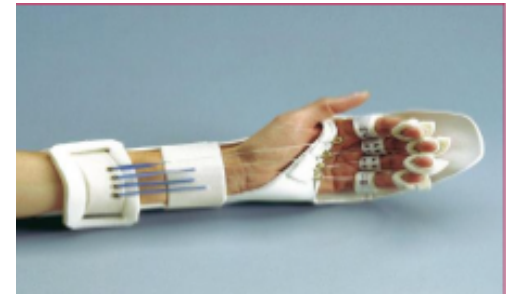
- More than 25 different techniques for the repair (Kessler repair is the most common used one).
- Explore the wound in OR in a zigzag fashion:
  - In OR; because this area has nerves and blood vessels
  - Zigzag not straight cut because it'll cause flexion contraction
- Find the 2 ends of the cut tendon and pull it out then insert needle
- Non absorbable sutures are preferred because of the poor blood supply



- A- Kessler suture
- B- Bunnell suture
- C- Modified Kessler suture
- D- Pulvertaft weave suture

# Flexor Tendon Splints:

- Must be used to protect the repair for at **least 4-6 weeks**.
- Some patients take off the splints and present with tendon rupture.
- Allowing them to do FLEXION ONLY, because extension could release the suture.



# 5. Replantation

## Indications & Contraindications:

Takes 6-8 hours and chance of failure is 40%.  
And the patient can't work for 3-6 months



### INDICATION



- Amputated thumb:** It provides 60% of hand Function
- Children:** The risk of loss is higher than adults.
- Multiple digits:** You try to fix 2-3 so he can hold things.
- Partial or whole hand:** Because they have a lot of function problems.



### CONTRAINDICATION




- Life threatening injury**  
(you have to care and focus in what is more important)
- Sever chronic illness**
- Multilevel injury**
- Severely crushed injury**
- Single digits:** Because the patient will not have functional defects.
- Severe contamination**
- Avulsion injury:** Finger gets pulled out; artery needs to be reattached at wrist level.

# General principles for replantation:

- Resuscitate the patient
- **Preserve amputated part in cold water not directly on ice (frostbites)**
- **Warm ischemia time = must operate within 6-8 hours. If cold = within 12-24 hours (longer) \***
- Successful replant after 28 hours: The longer its preserved, the better.
- X-ray the hand and the amputated part: **Make sure no fractures because in that case you can't replant it**
- Consent for vein, nerve, tendon and skin graft

## Prepare the amputated part:

- 1<sup>st</sup>: Shorten the bone => Arthrodesis “artificial induction of joint ossification between two bones by surgery”.
- 2<sup>nd</sup>: Repair flexor and extensor tendon
- 3<sup>rd</sup>: Repair Digital artery 4<sup>th</sup>: vein and 5<sup>th</sup>: nerve
- 6<sup>th</sup>: Skin closure +/- skin graft

 No muscles in finger (only tendons) so it will survive in case of ischemia more than 6 hours.

\* Warm ischemia time: time interval between traumatic amputation of a limb or part and its placement on ice.

\* Cold ischemia time: the time between the placement of a traumatically amputated body part in ice and the time of surgical replantation.

\* Ischemia time = warm ischemia time + Cold ischemia time



# Complications of replantation:

In surgery, mostly:  
Pale color = problem with blood perfusion = Artery  
Blue (Cyanosis) = problem with drainage = Vein

## ☐ WHITE FINGER:

- **No blood Flow (Low arterial flow)**
- Technical or non- technical
- **If patient is a smoker don't bother to replant** (will have a poor blood perfusion and replantation fail)
- What to do ?
  - o Ensure the patient is warm and well-hydrated
  - o Prevent hypotension
  - o Loosen dressing and remove sutures
  - o Re-Explore and check arteries if all doesn't work

## ☐ BLUE FINGER:

- Veins are not draining (Low venous flow)
- What to do ?
  - o Elevate limb
  - o Loosen dressing and Remove sutures
  - o **Leeches: Special worms used in case of venous congestion, suck the blood and relieving the congestion (picture)**
  - o Remove nail
  - o Heparin injections
  - o Re-Explore



# 6. HAND FRACTURES

## Unstable fracture

- Cannot be reduced closed or cannot be held reduced without fixation (while stable one, are able to resist deforming forces)
- 30% risk of infection in open fracture including open Distal Phalanx fracture:
  - Reduced to 3% with antibiotics
  - The distal phalanx fracture with subungual hematoma (bleeding in nail) should be considered an open fracture
  - Healing for phalangeal fracture takes 4 weeks, whereas 5-6 weeks for metacarpal fracture.

## Acceptable Hand Fracture:

- Tuft distal phalanx
- AP displaced metaphyseal fracture in children
- Metacarpal neck fracture (Based on degree of angulation)
  - <15 degree in index and middle finger
  - <30-40 degree in ring and little finger
- Metacarpal base fracture
  - Adult < 20 angulation
  - Children < 40 angulation



## Unacceptable Phalangeal Fractures:

### - (NEED SURGICAL FIXATION)

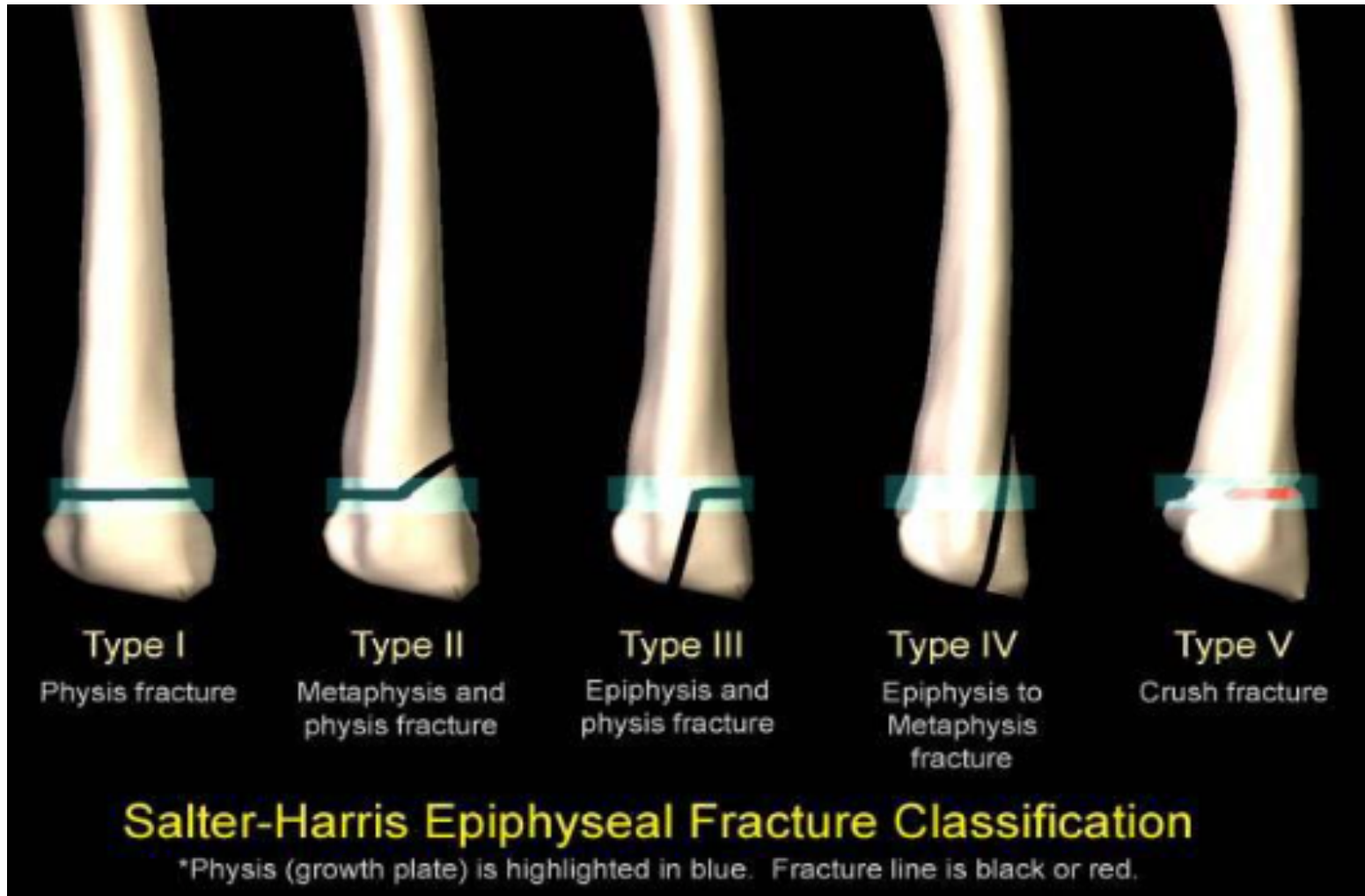
- Rotational angulation
- Severe dorsal angulation
- Lateral angulation

## Pediatric Hand Fractures (SOLTER HARRIS CLASSIFICATIONS)

- Fracture in child physis (growth plate) will affect growth. If the fracture in one side, after 6 years the patient will come with **angulation** of finger because one side grew and the other did not.

See the picture, next slide..

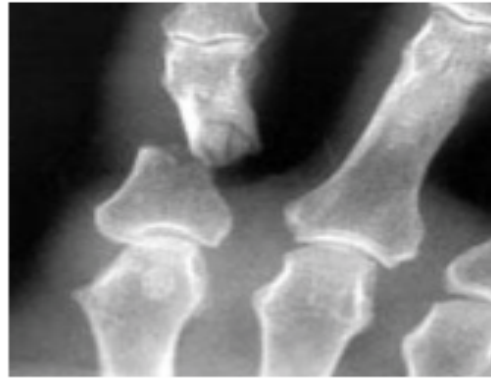
Type (incidence)	Description
I (6%)	Transverse fracture through <b><u>physis</u></b> (the growth plate) only
II (75%)	Involving <b><u>physis and metaphysis</u></b> , sparing the epiphysis. (Away from joint)
III (8%)	Involving <b><u>physis and epiphysis</u></b> , sparing the metaphysis. (Goes to joint)
IV (10%)	Extends from <b><u>metaphysis</u></b> through <b><u>physis</u></b> into <b><u>epiphysis</u></b> (Above and below joint)
V (1%)	<b><u>Crush</u></b> injury to the <b><u>physis</u></b> (resulting in a decrease in the perceived space between the epiphysis and diaphysis on x-ray)



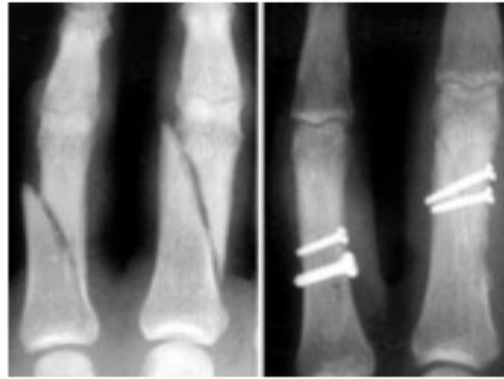
- **INDICATION FOR FIXATION (NON-ARTICULAR)**

- Angulation
- Rotation
- Shortening

# 6. HAND FRACTURES.. Cont.



1. Transverse fracture of proximal phalanx.



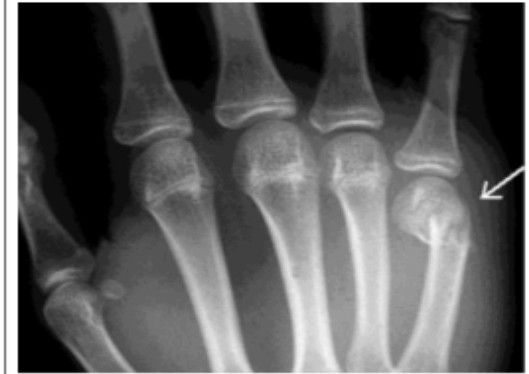
2. Spiral fracture



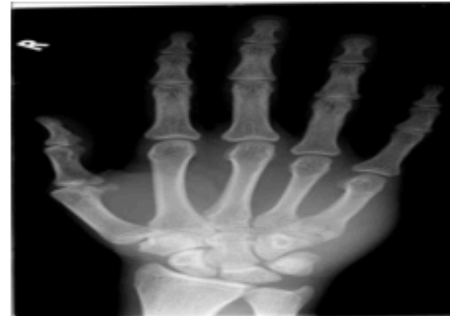
3. Gun shots and bone loss

- Fractures of metacarpal bone could involve Head, shaft or base

- Ask the patient where the area of maximum tenderness is, then look at this area on X-ray



- \* It is an example of metacarpal neck fracture, Following punching the wall (scenario of a guy who broke up with his girlfriend, and madly punched the wall), usually involve 5<sup>th</sup> or 4<sup>th</sup> metacarpal.
- Treated non-surgically.

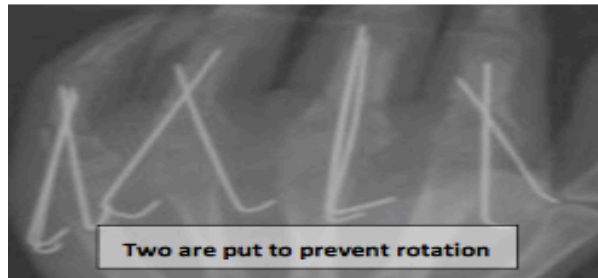
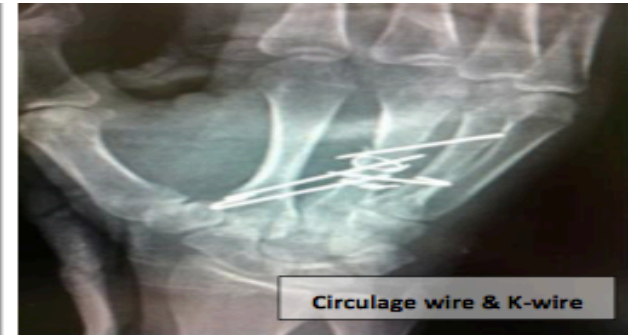
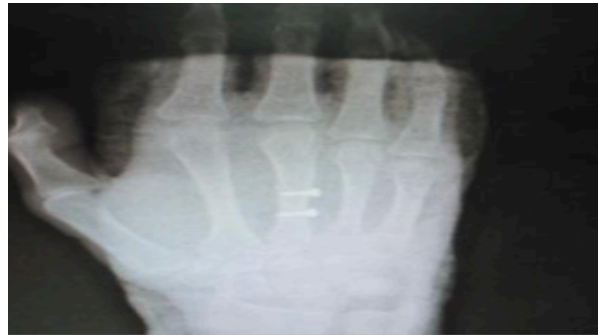


**BOXER'S FRACTURE\***

# Techniques of Fixation:

- 1<sup>st</sup>: Do x-ray; if it's reduced, then you don't need to fix it => Put Close reduction splint and if it held the fracture in place => Continue with non surgical treatment.
- If it doesn't stay in place (displaced again) => Close reduction => then K-Wire fixation
- If the above did NOT work => ORIF (Open Reduction Internal Fixation) using one of the following:
  - ✓ Lag Screw (Best one to fix spiral fracture)
  - ✓ Plate
  - ✓ Circulage wire

NOTE:  
You can do any combination of fixation techniques.



# 7. CARPEL TUNNEL SYNDROME:

## INCIDENCE:

- The most common nerve compression in the upper limb: 1 – 10% of the population
- As high as 60% in people with repetitive hand movement: Because high pressure on the tunnel

## Anatomy

- o Base (floor) is the bony carpal arch
- o Bridge (roof) is the flexor retinaculum (FIXED and does not expand in case of increased pressure )
- o Borders: scaphoid, trapezium, pisiform, triquetral.
- o **Contents of the tunnel: 9 flexor tendons and the median nerve.** (picture in slide 26)

## ETIOLOGY

Due to increase in volume of the content or reduction of the tunnel size. Common causes are:

- o **Acromegaly**
- o **Trauma**
- o **Osteoarthritis**
- o **Ganglion, Lipoma**
- o **Inflammation: Tenosynovitis, gout**
- o **DM, Thyrotoxicosis, Pregnancy**
- o **Congenital: Abnormal muscle, persistent median artery**

## SYMPTOMS:

- Pain (radiate to shoulder) and numbness
- Paresthesia in the median nerve distribution which is the Radial 3.5 digits
- Night pain: because people usually sleep on their hands, everything swells so they wake up at night, and in the morning with more numbness and pain
- Weakness
- Clumsiness

## CLINICAL FEATURES:

- **Weakness & wasting of the thenar muscles (when they hold something, it falls).**
- **Altered sensation in the median nerve distribution**
- **Positive Tinel's sign:** Tap over the carpal tunnel area of the wrist 5 or 6 times => tingling or paresthesia in the median nerve distribution
- **Positive Phalan test:** This position should be held for about 1 minute => numbness or tingling along the median nerve.
- **Reverse Phalan test** => The more severe the compression the faster the numbness

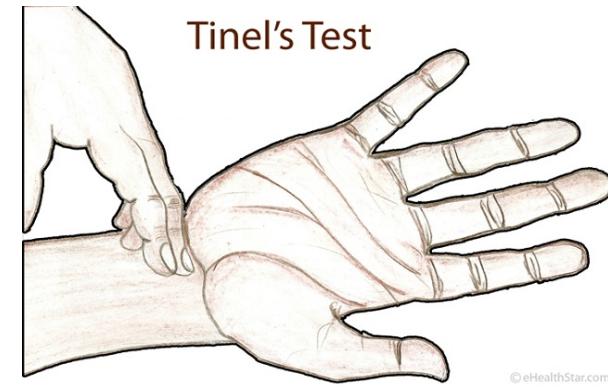


Reverse Phalen's Test



© eHealthStar.com

Tinel's Test



© eHealthStar.com

## INVESTIGATIONS:

- X-Ray, CT scan, MRI
- **Nerve conduction studies: Most common test used and most diagnostic**

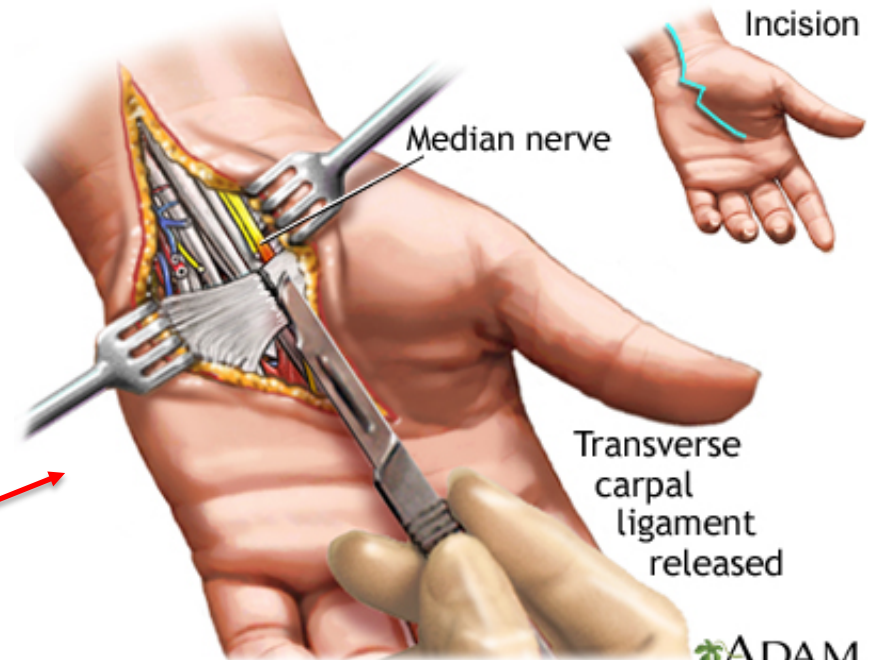
## TREATMENT: (Operative vs non-operative)

### ❑ **Non-Operative (Mild)**

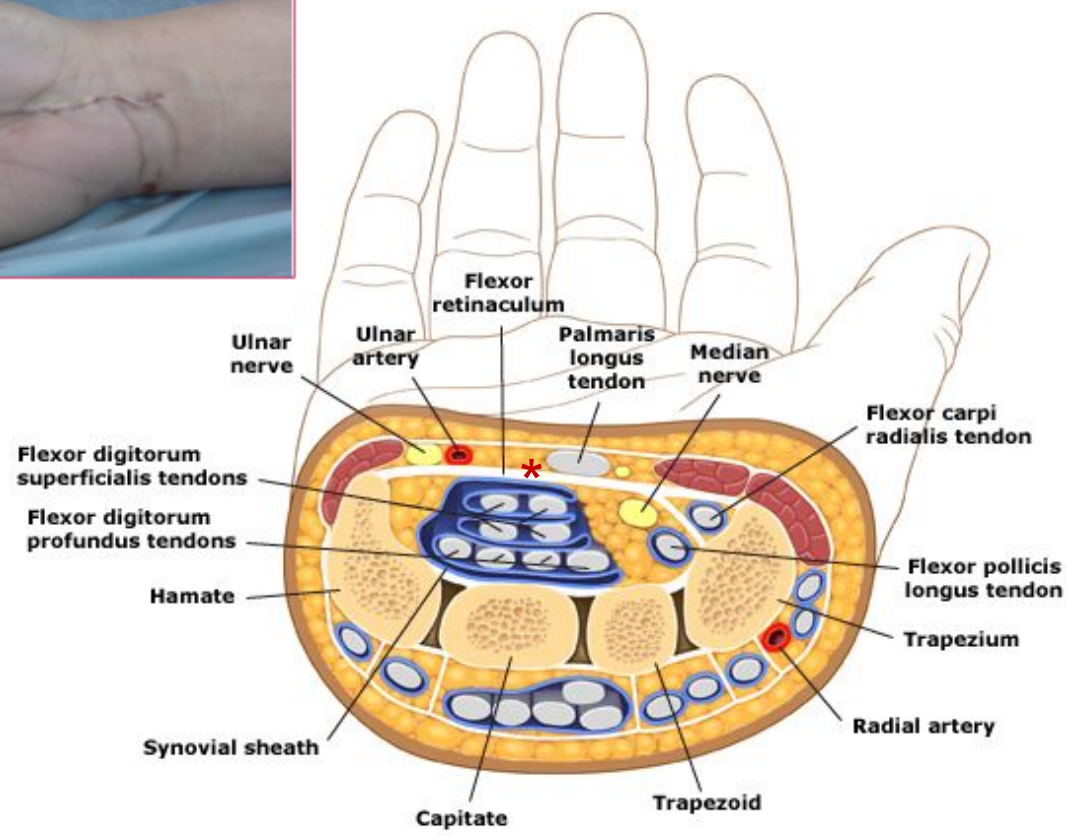
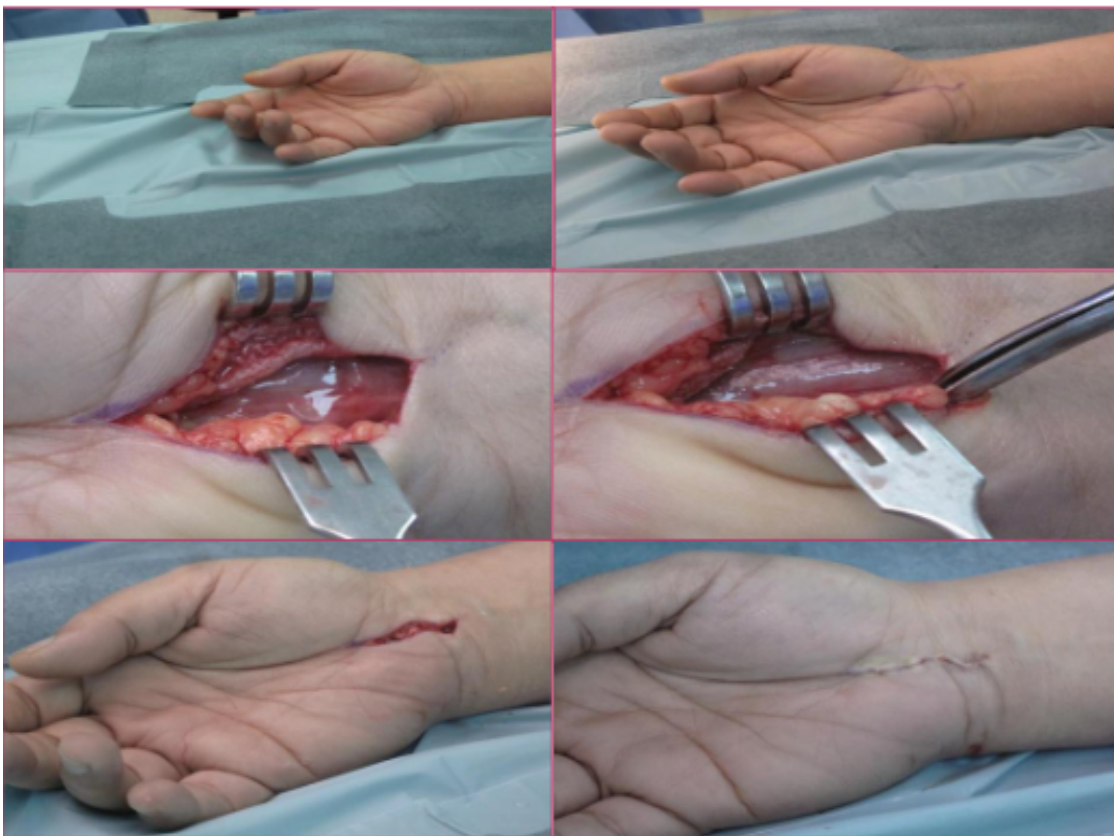
- **Splints** : Rests the hands but once stopped symptoms will return
- **NSAID's**
- **Steroid Injections** (risk of the injection in the nerve itself, causing more damage)

### ❑ **Operative (Persistent)**

- **All Open technique: The best approach**
- **Limited incision Technique**
- **Endoscopic Techniques:** Lots of reports of injuries to the median nerve







\* Surgical release of the transverse ligament provides high initial success rates (greater than 90%), with low rates of complication

# Summary

- ❖ The ulnar nerve is the most important nerve in the hand because it controls all action except opposition of the thumb by the median nerve.
- ❖ **PARONYCHIAL INFECTION is the most common hand infection**, commonly caused by staph aureus.
- ❖ **HERPETIC WHITLOW is very painful and contagious infection caused by HSV type 1**, happens to children or **dentists**.
- ❖ Injury to flexor tendons can be closed (Jersey finger or fracture) or open (laceration, crush or degloving)
- ❖ There are many ways for flexor tendon repair, Kessler repair is the most common used one.
- ❖ Amputated thumb, multiple digits, children and partial or whole hand amputation are indications of replantation.
- ❖ Complications of replantation can be due to **low venous flow (Blue finger)** or **poor arterial supply (white finger)**
- ❖ Rotational angulation, severe dorsal angulation and lateral angulation are unacceptable phalangeal fractures that requires fixation.
- ❖ It is an example of **metacarpal neck fracture, Following punching the wall (scenario of a guy who broke up with his girlfriend)**, usually involve **5th or 4th metacarpals**.
- ❖ Lag Screw, Plate and Circulage wire are different fixation techniques which can be combined together.
- ❖ Carpel tunnel syndrome (CTS) is the most common nerve compression in the upper limb with higher incidence in people who do repetitive movements.
- ❖ Pain and numbness, Weakness & wasting of the thenar muscles + positive Tinel, phalen's and reverse phalen's tests are the features of CTS.
- ❖ **Nerve conduction studies is the most diagnostic test to diagnose CTS.**



# MCQs

## **The true statement regarding tendon injuries in the hand is:**

- a) Flexor digitorum superficialis inserts on the distal phalanx
- b) Flexor digitorum profundus inserts on the middle phalanx
- c) The tendons of flexor digitorum superficialis arise from a common muscle belly
- d) The best results for repair of a flexor tendon are obtained with injuries in the fibro-osseous tunnel (zone 2)
- e) Loss of flexion cascade in hand, indicate flexor tendon damage

## **2. Which of the following statements regarding carpal tunnel syndrome is correct?**

- a) It is rarely secondary to trauma
- b) It may be associated with pregnancy
- c) It most often causes dysesthesia during waking hours
- d) It is often associated with vascular compromise
- e) Surgical treatment involves release of the extensor retinaculum

# Thank You..

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