



# Musculoskeletal Imaging of the Digits

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UCSD MSK Radiology

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# Musculoskeletal Imaging of the Digit

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- Anatomy & Internal Derangement
    - The Extensor System
    - The Flexor System
  - Soft Tissue Masses & Tumors
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# Musculoskeletal Imaging of the Digit

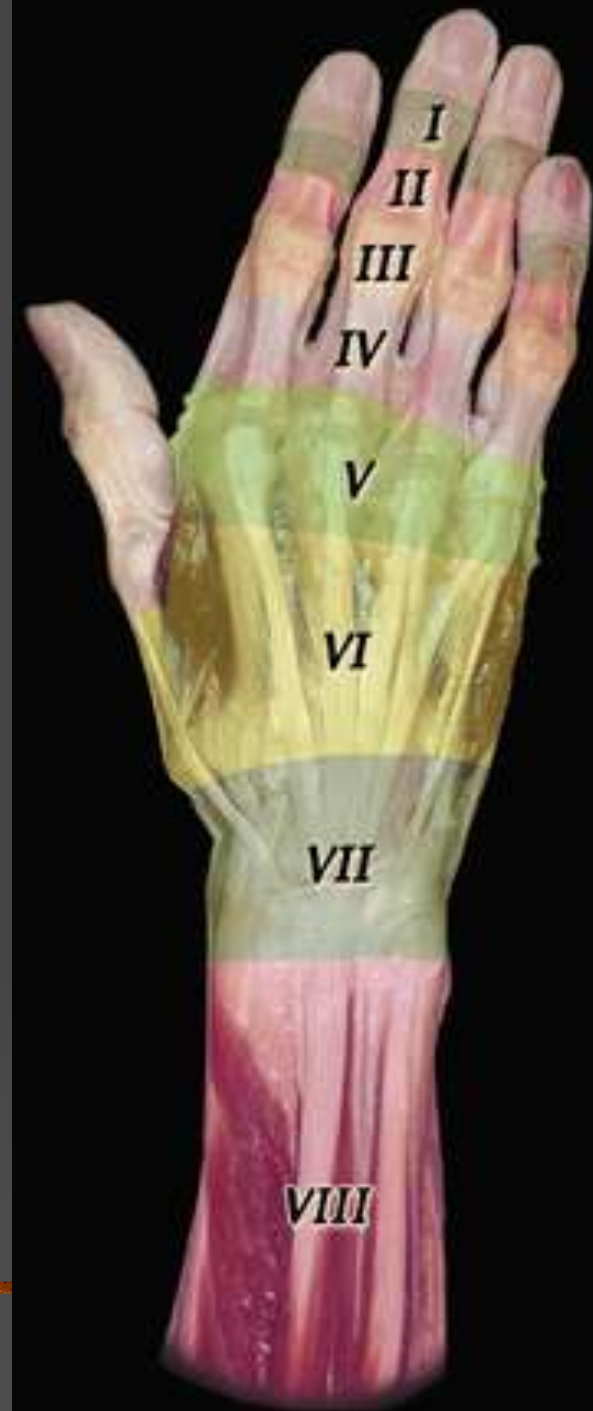
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- Anatomy & Internal Derangement
    - The Extensor System
    - The Flexor System
  - Soft Tissue Masses & Tumors
-

# Anatomy: The Extensor System

## Verdan Classification

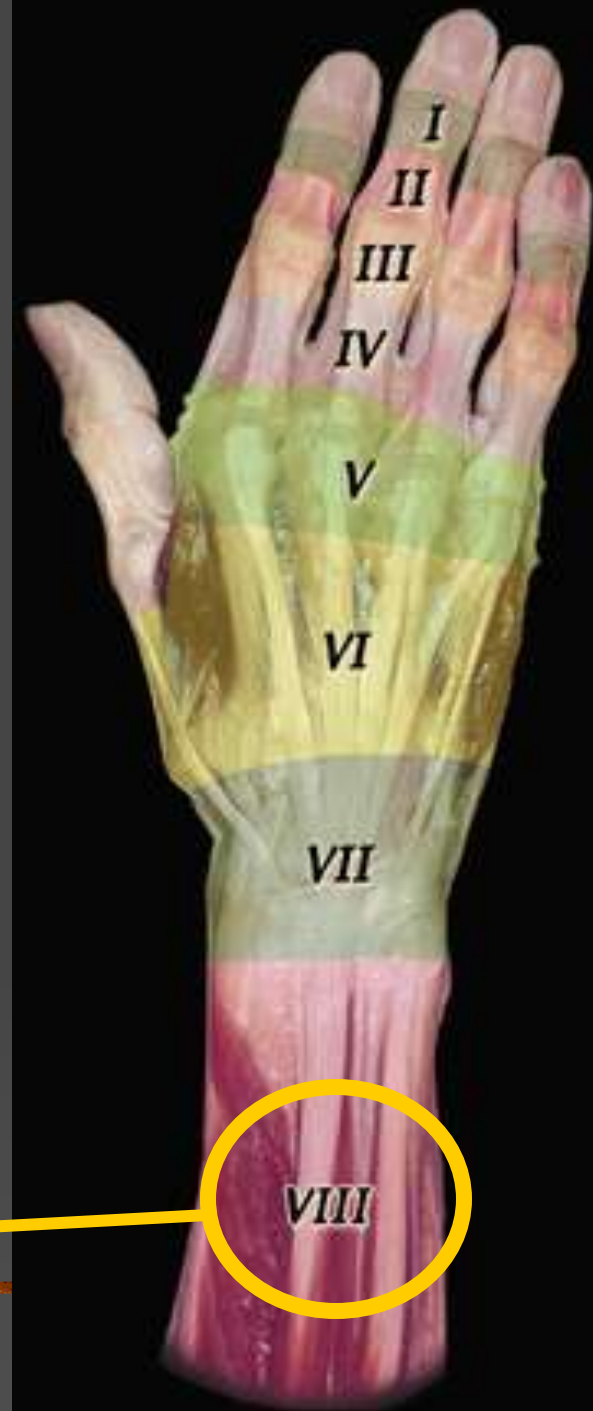
- Zone I: DIP
- Zone II: Middle Phalanx
- Zone III: PIP
- Zone IV: Proximal Phalanx
- Zone V: MCP Level
- Zone VI: Dorsum of the Hand
- Zone VII: Wrist Extensor Component
- Zone VIII: Extrinsic Muscles



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# Anatomy: The Extensor System

## Superficial Layer

1 = extensor carpi radialis longus

2 = extensor carpi radialis brevis

3 = extensor digitorum

4 = extensor digiti minimi

5 = extensor carpi ulnaris

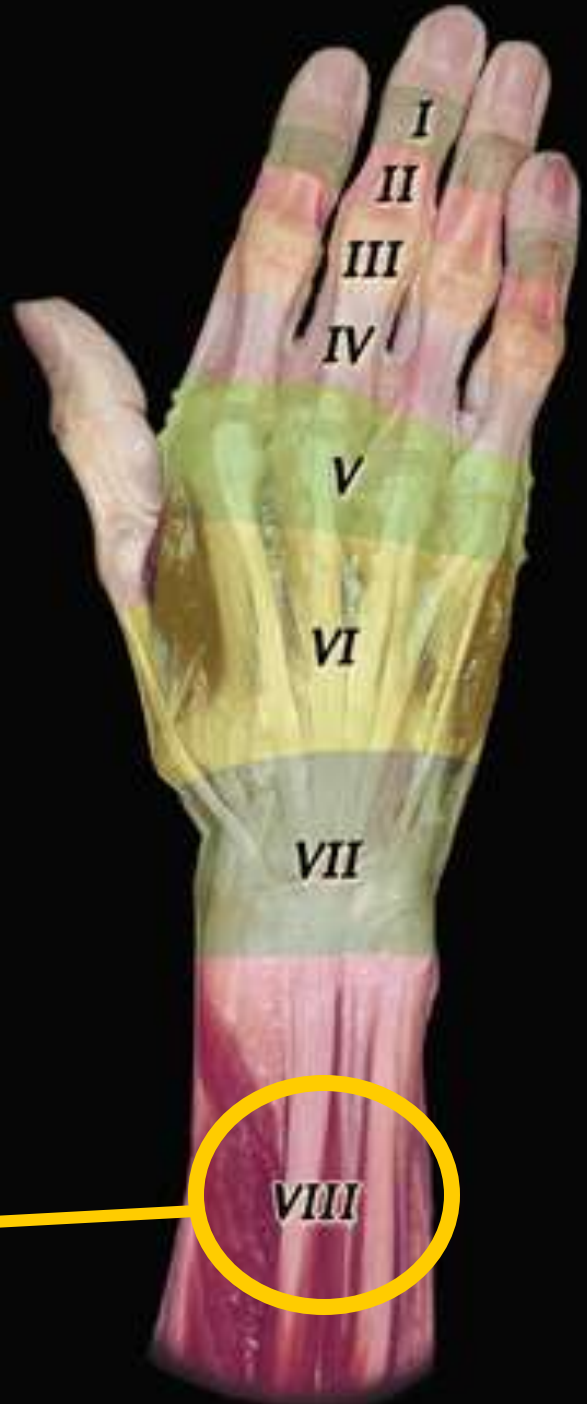
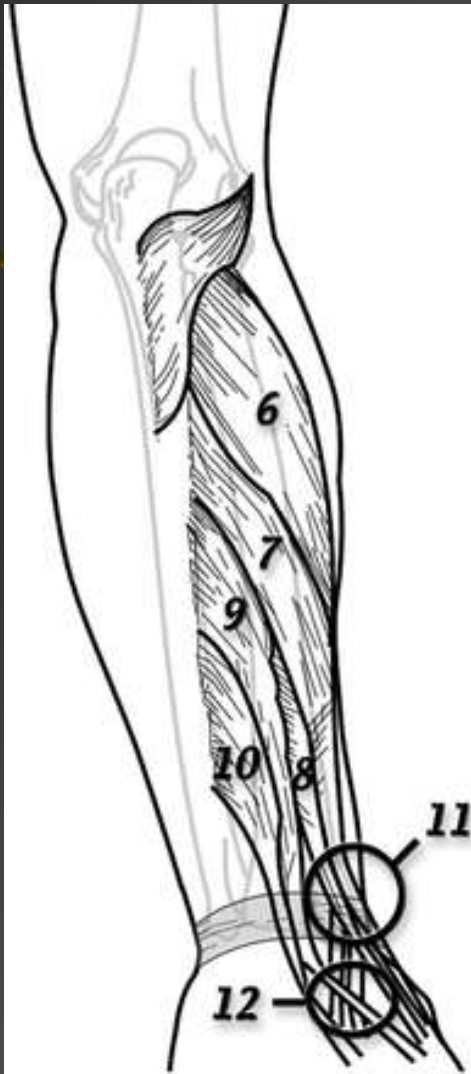


Zone VIII: Extrinsic Muscles

# Anatomy: The Extensor System

## Deep Layer

- 6 = supinator
- 7 = abductor pollicis longus
- 8 = extensor pollicis brevis
- 9 = extensor pollicis longus
- 10 = extensor indicis



Zone VIII: Extrinsic Muscles

# Anatomy: The Extensor System

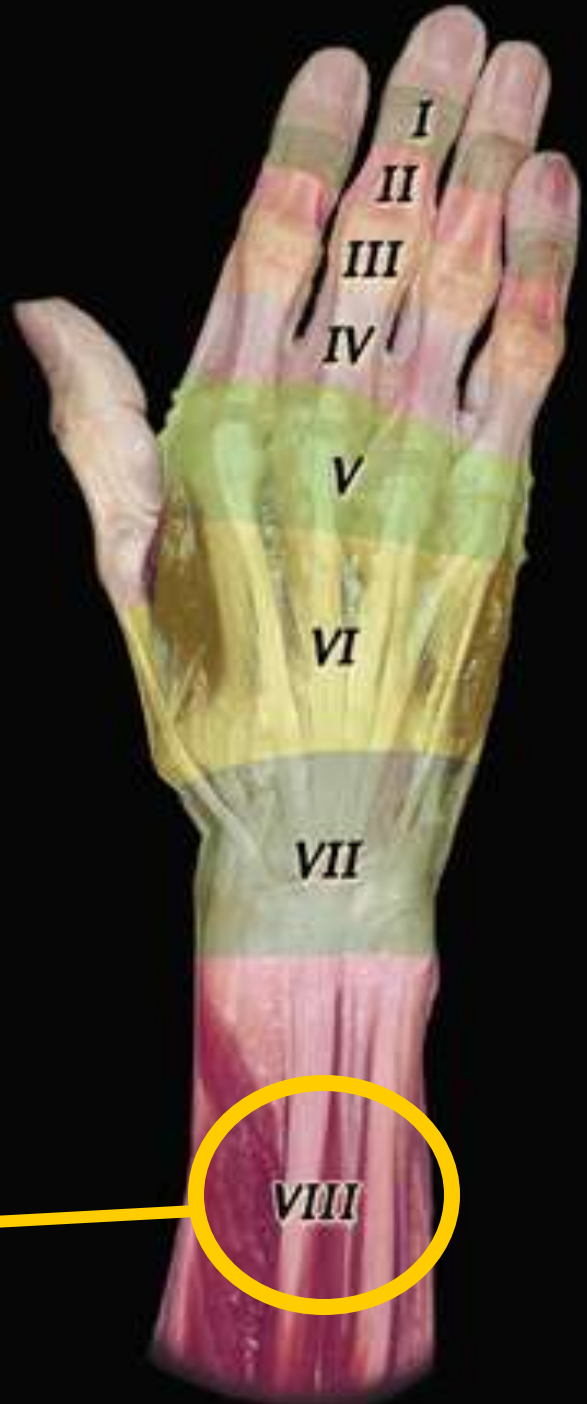
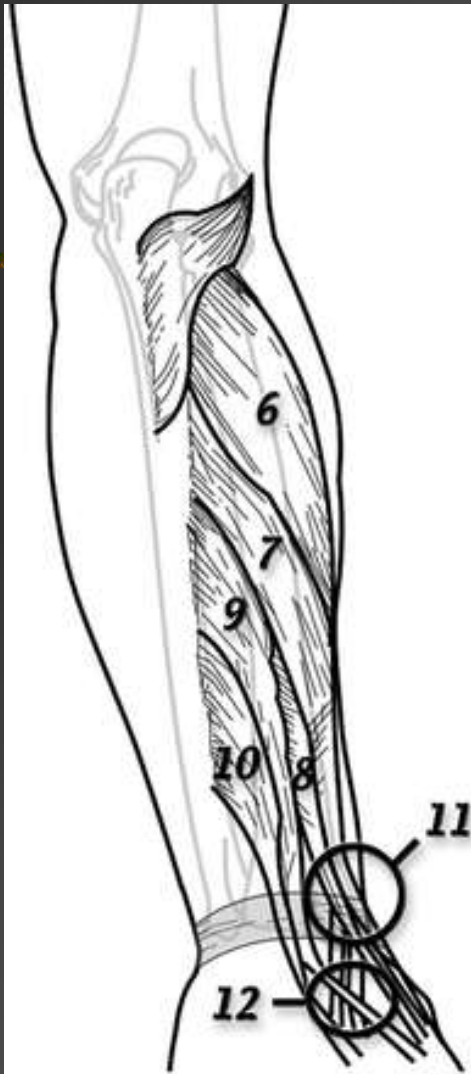
## Deep Layer

**11 = first intersection**

Abductor pollicis longus & Extensor pollicis brevis

cross over the

Extensor carpi radialis longus & brevis



**Zone VIII: Extrinsic Muscles**

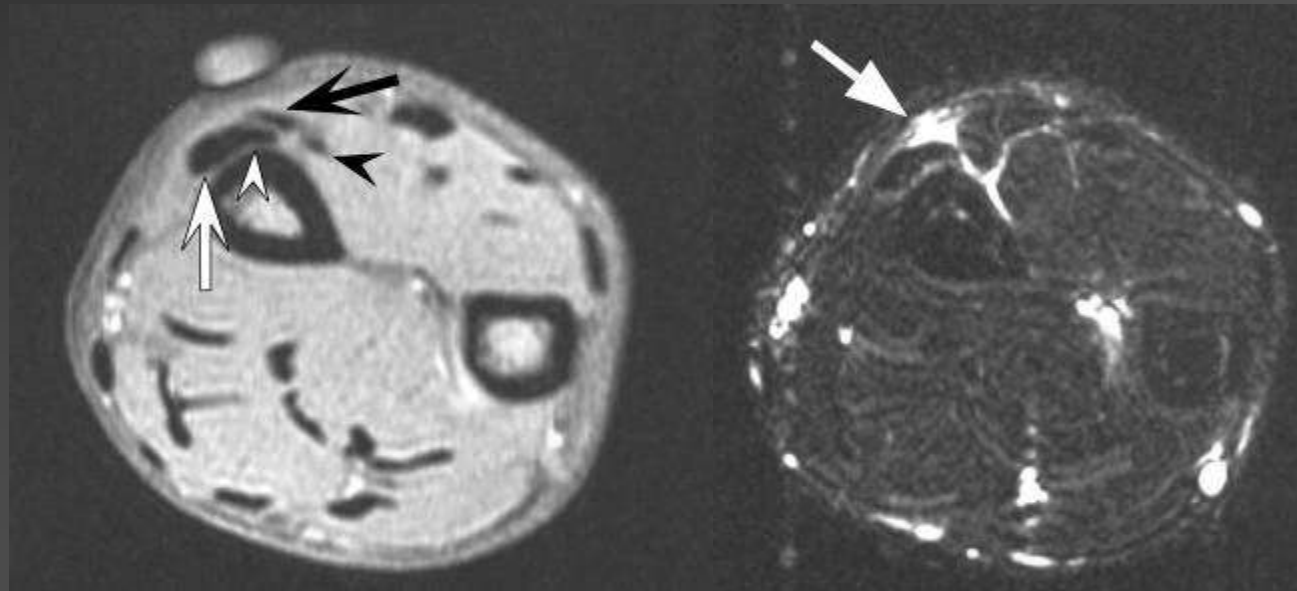


# Internal Derangement

## ■ Intersection Syndrome

- Inflammatory process affecting 2<sup>nd</sup> extensor compartment 4-8 cm proximal to Lister's tubercle at junction of zones VII & VIII

- Tendinosis
- Peritendonitis
- Adventitial Bursa Formation

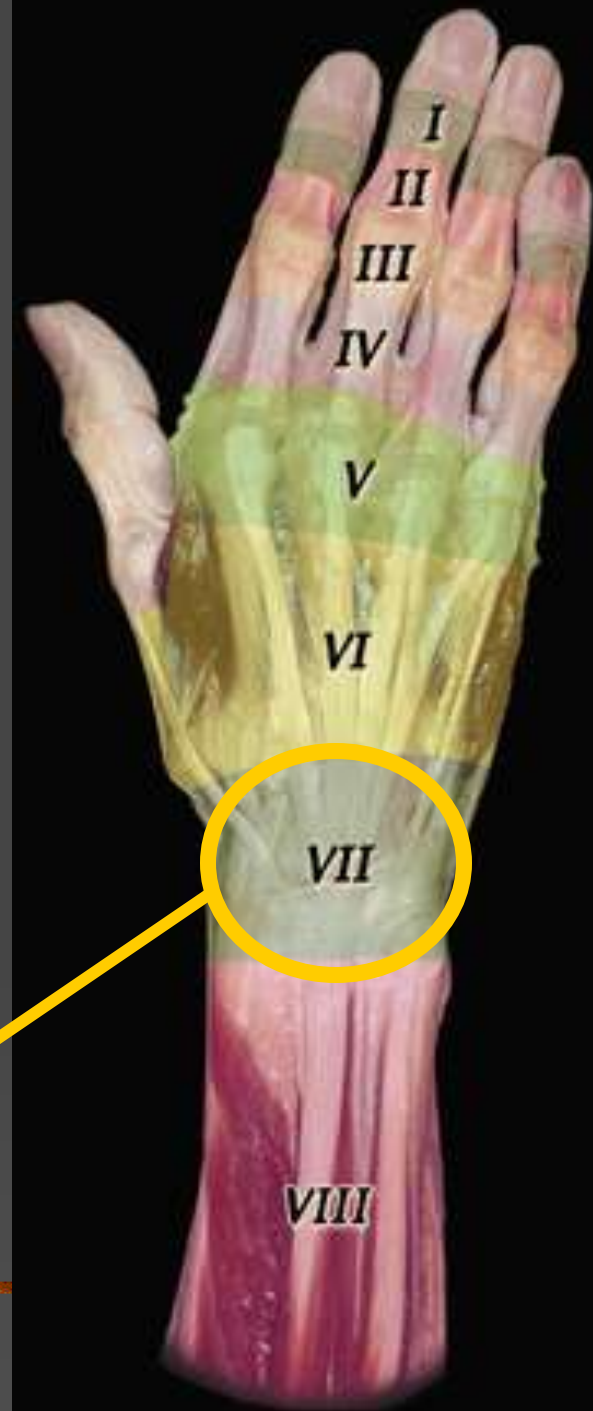


28 y.o. tennis player with tender distal forearm mass

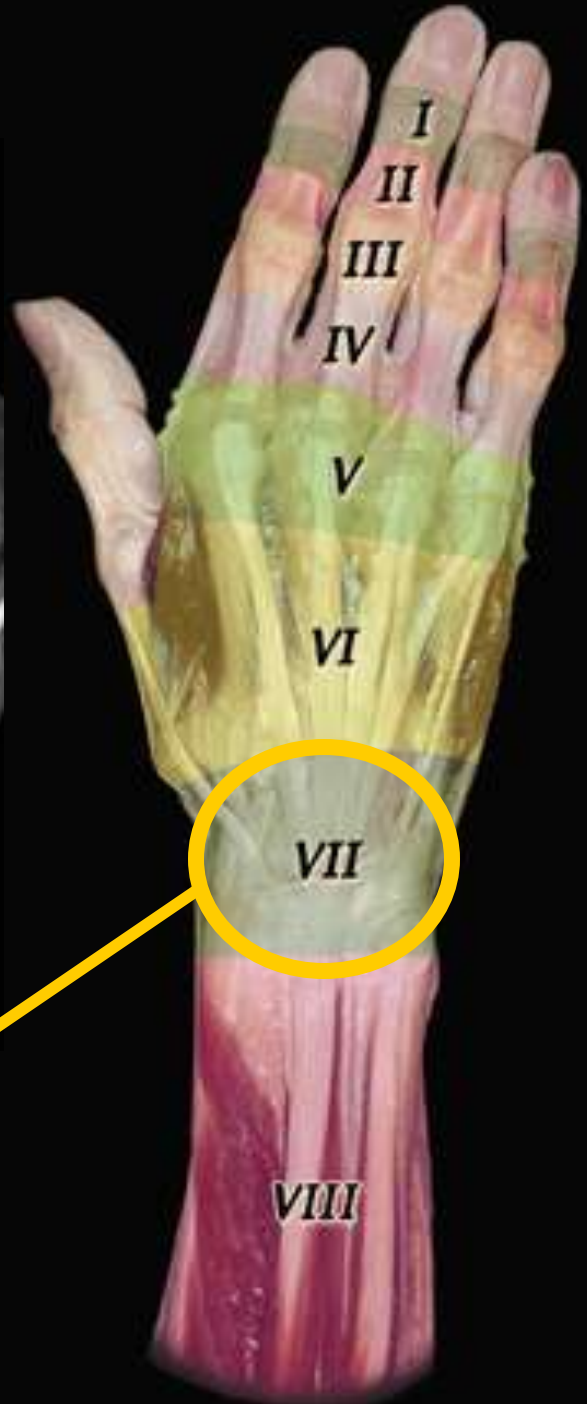
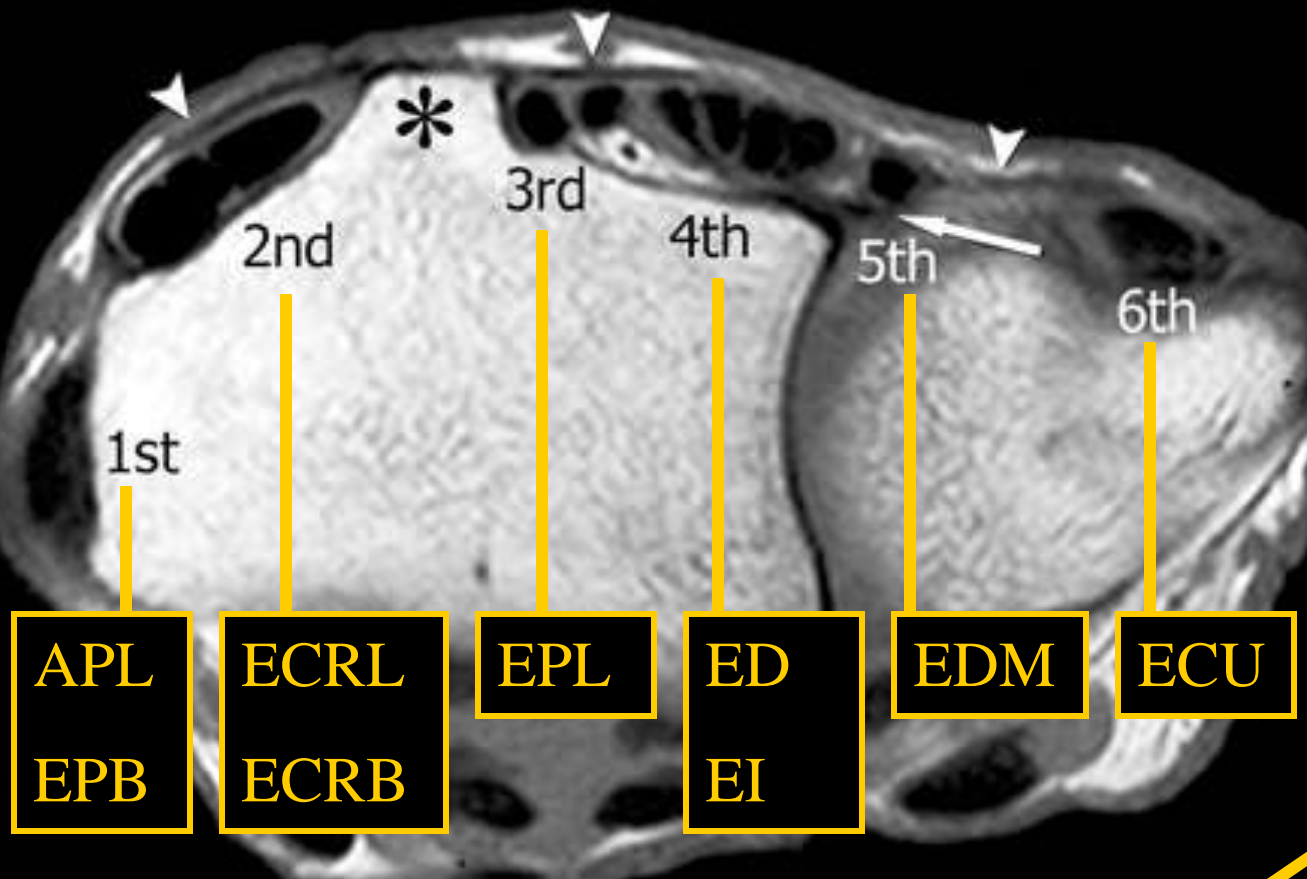
# Anatomy: The Extensor System

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# Anatomy: The Extensor System



Zone VII: Wrist Extensor Component

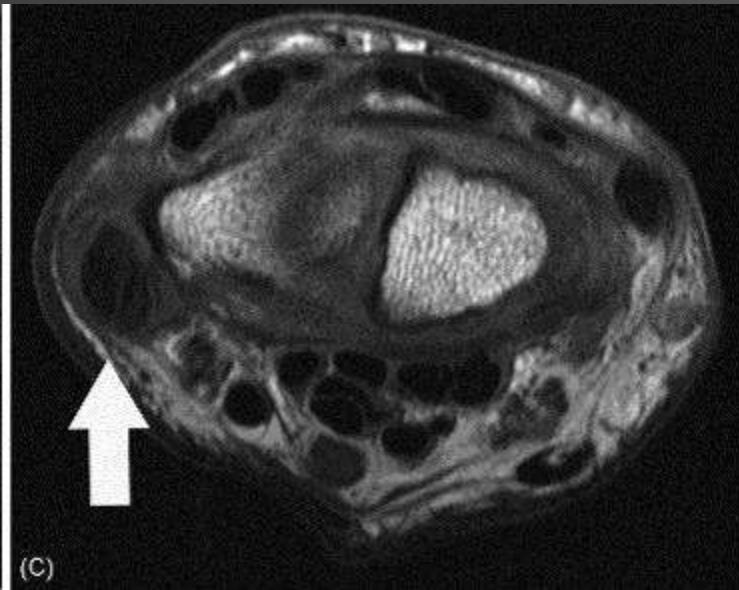
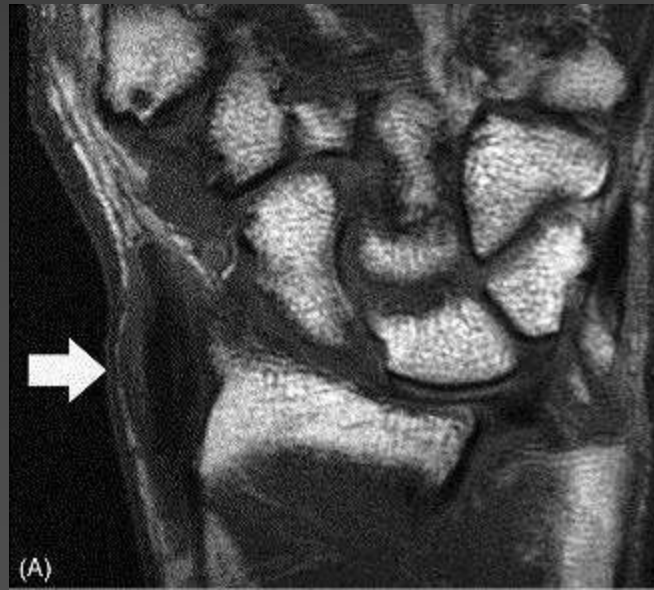
# Internal Derangement

## ■ De Quervain's Disease

- Tendonopathy and Tenovaginitis of 1<sup>st</sup> Extensor Compartment affecting APL & EPB at level of styloid process in zone VII
- Chronic repetitive Radial and Ulnar Deviation (Rowing, Racquet sports)

### MRI Features:

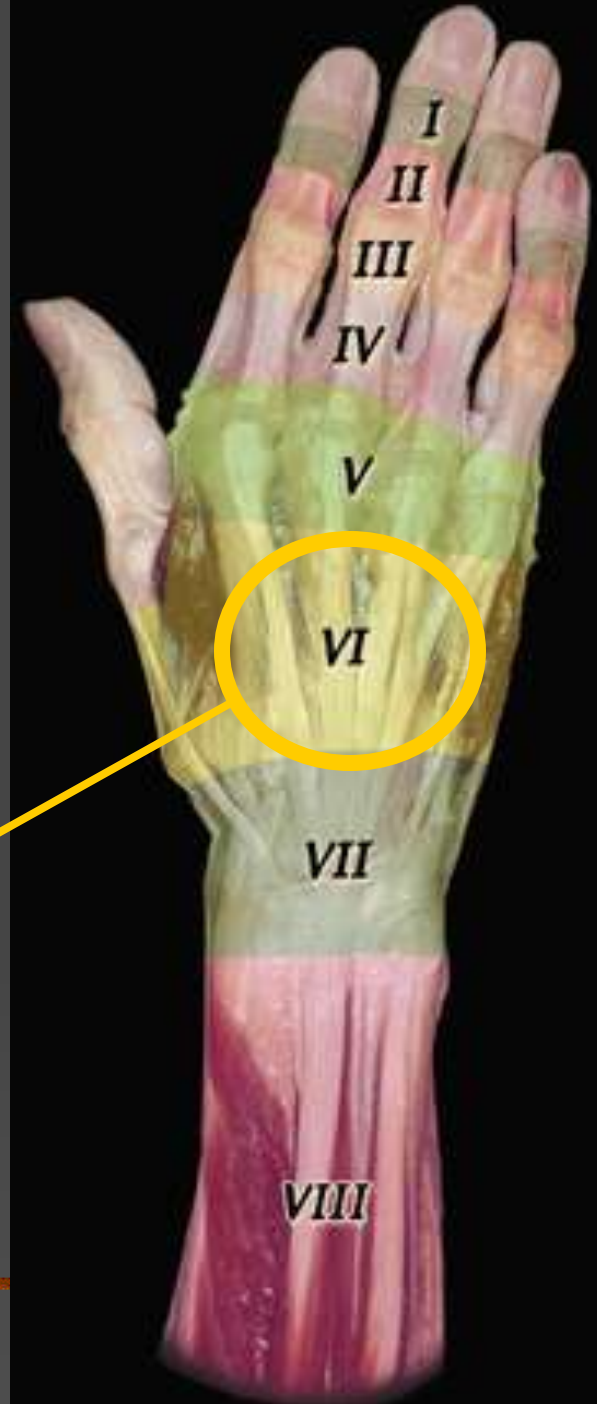
- Tendon Thickening
- High Intrasubstance Signal
- Fluid in Tendon Sheath
- Adj. Soft tissue edema



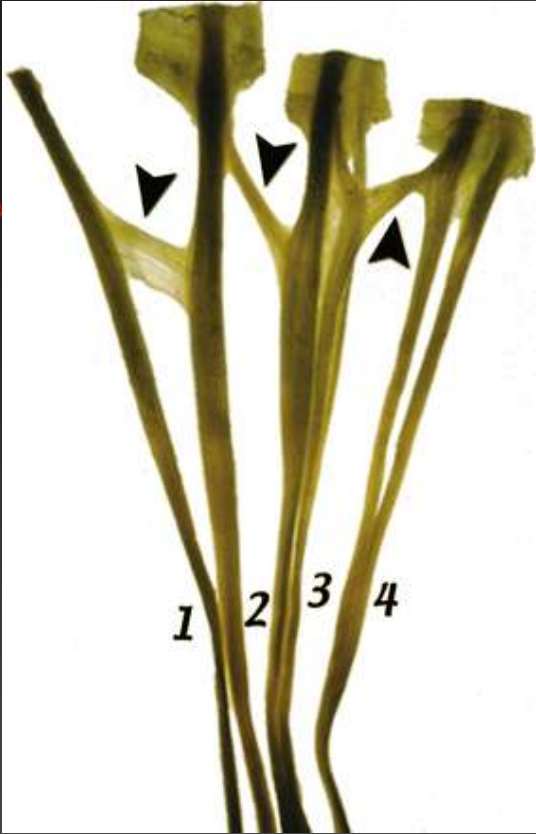
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# Anatomy: The Extensor System



## Zone VI: Dorsum of the Hand

Extensor retinaculum and Intertendinous tendons anchors the Extensor tendons in place and restricts motion.

# Anatomy: The Extensor System

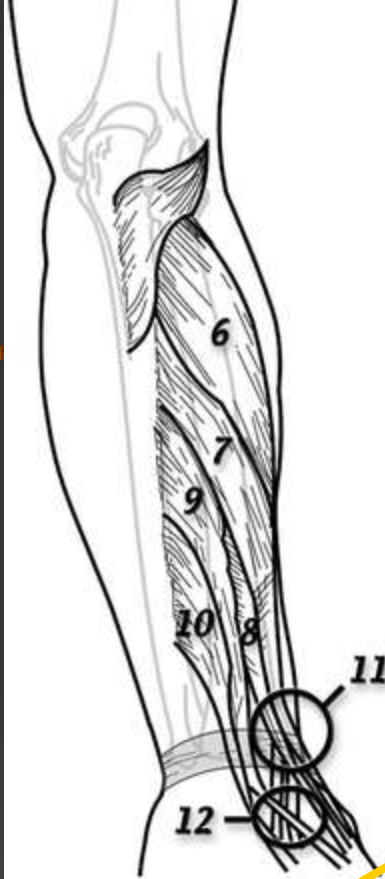
**12 = second intersection**

**Extensor Pollicis Longus**

**crosses over the**

**Extensor carpi radialis  
longus and brevis**

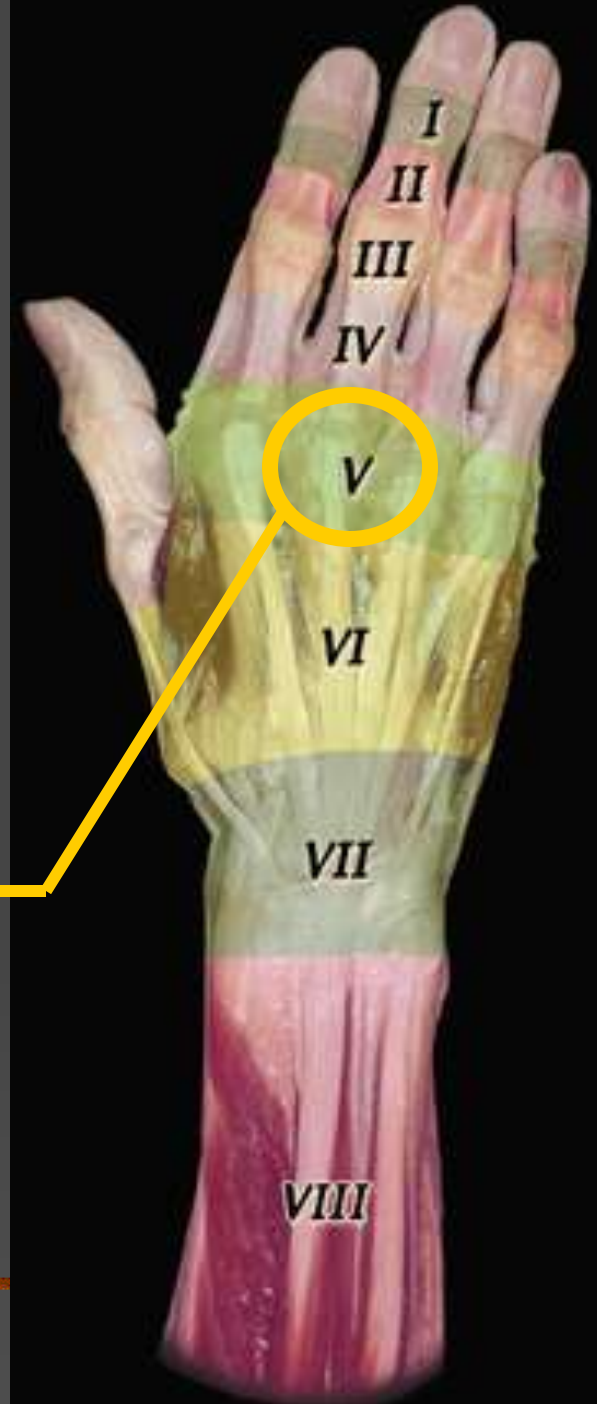
**Zone VI: Dorsum of the Hand**



# Anatomy: The Extensor System

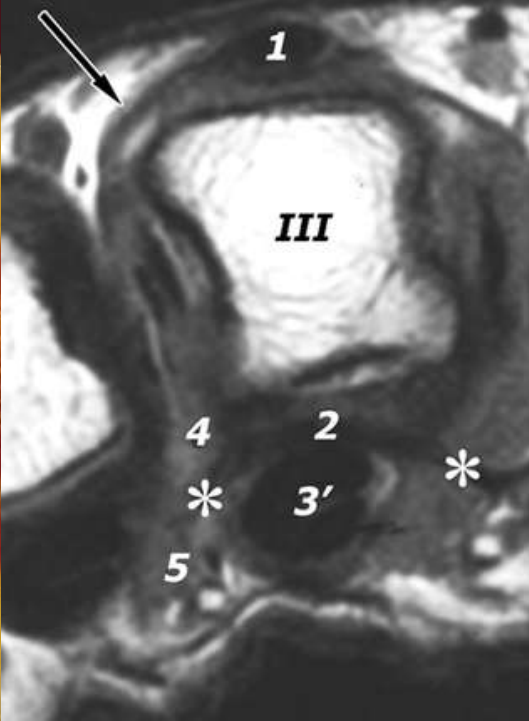
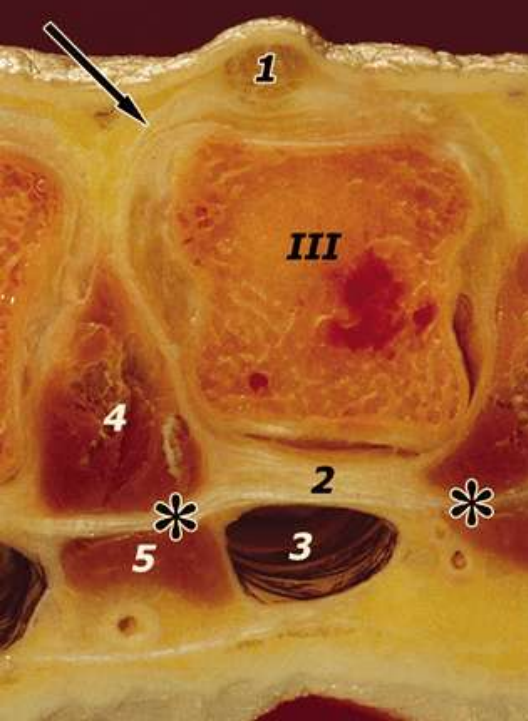
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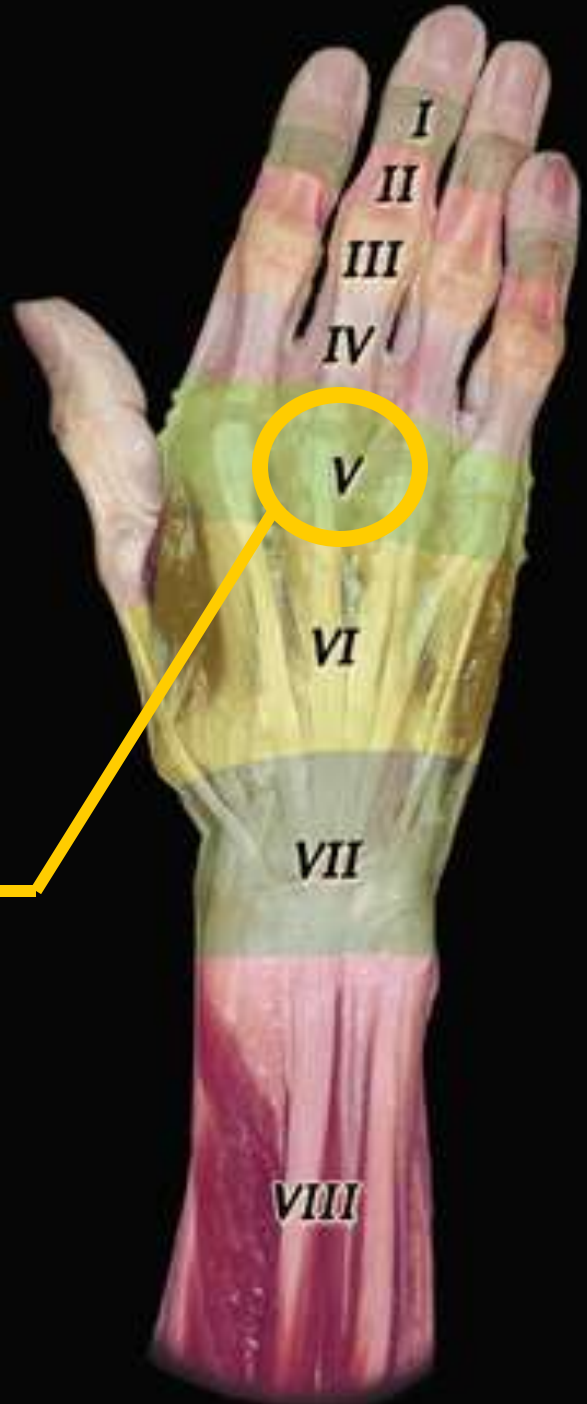




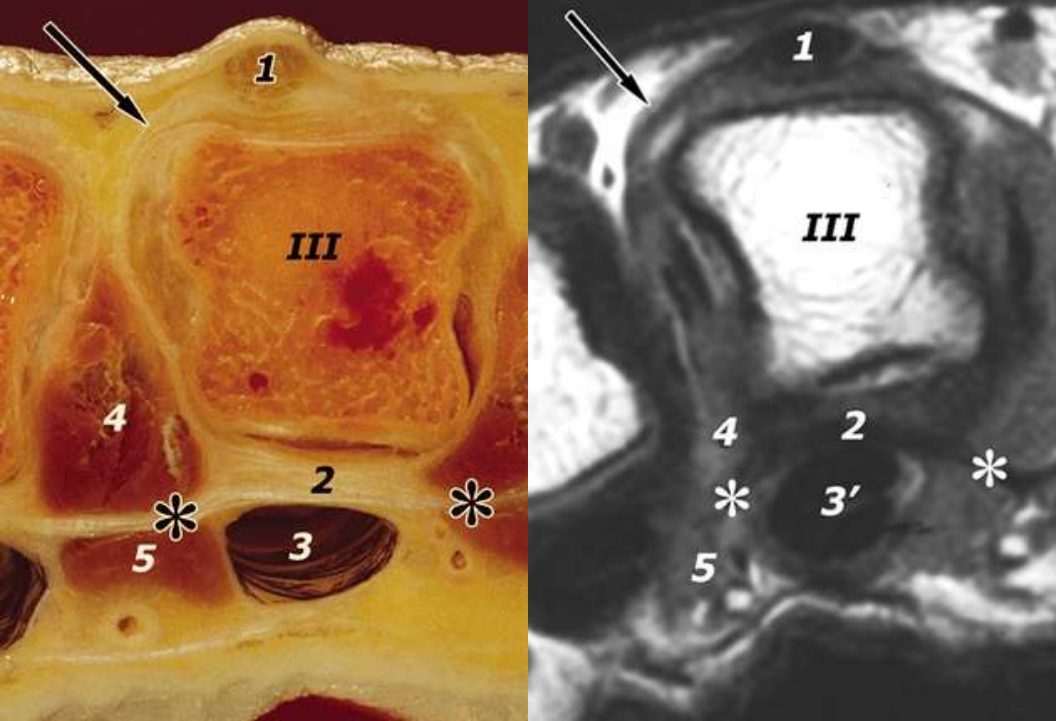
# Anatomy: The Extensor System



Zone V: MCP Level



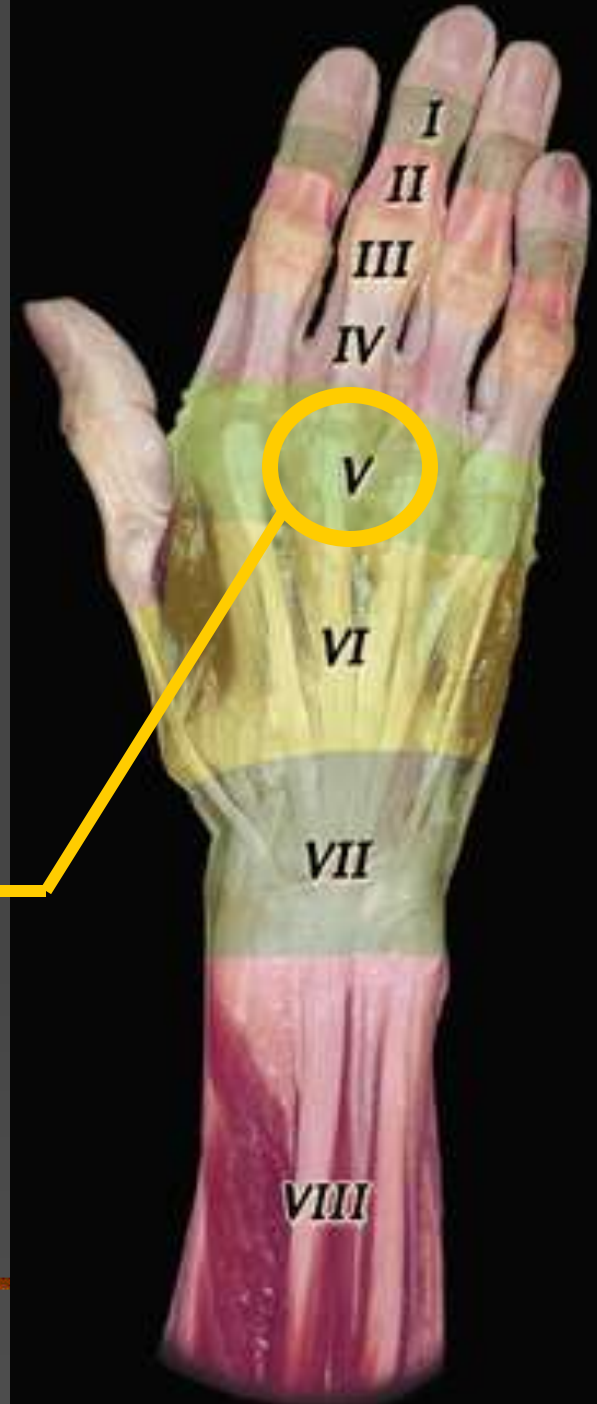
# Anatomy: The Extensor System



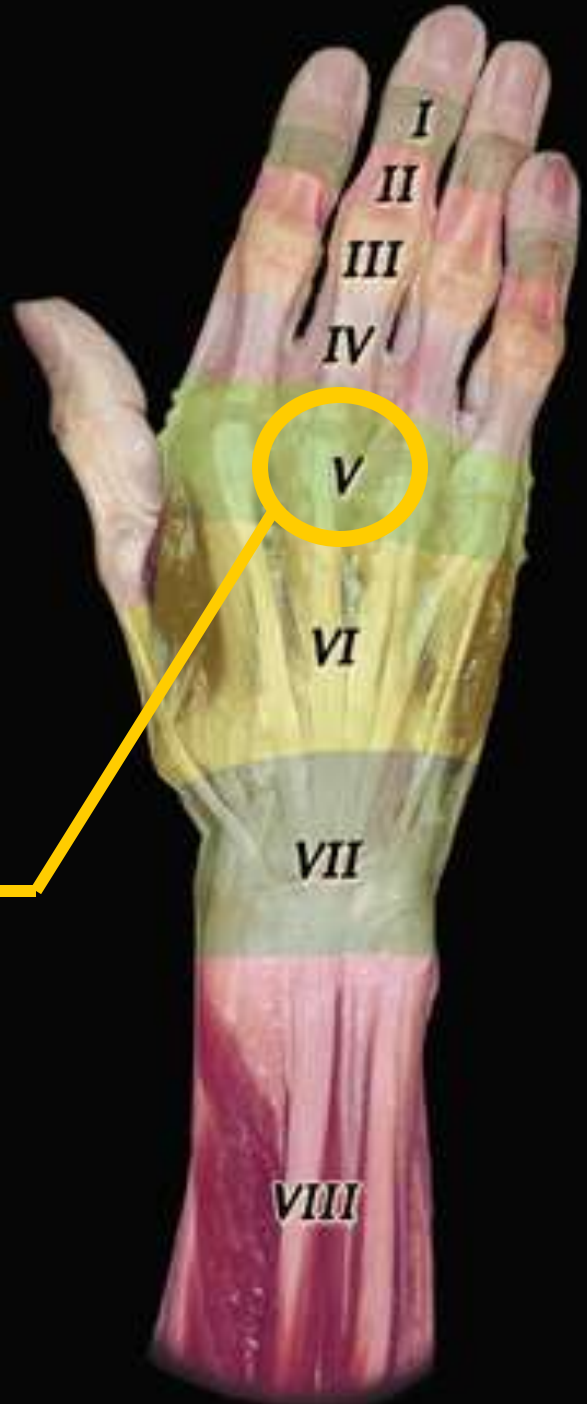
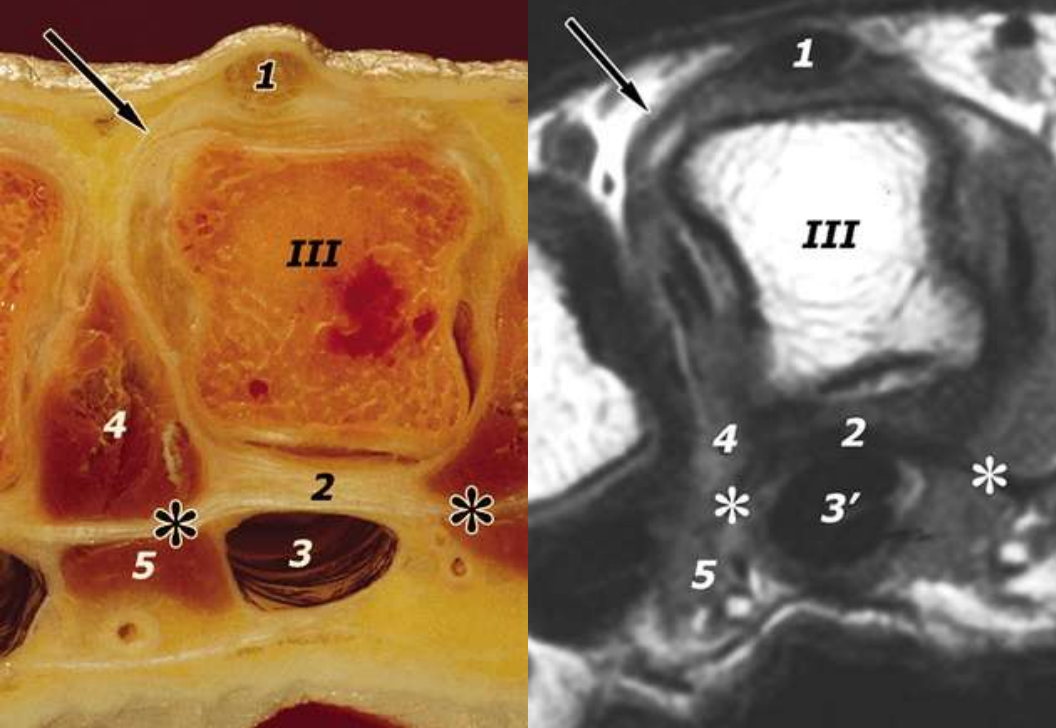
Zone V: MCP Level

## Extensor Hood:

- Extends finger to level of proximal phalanx
- Stabilizes Extensor tendon
- Limits Proximal Excursion



# Anatomy: The Extensor System



**Zone V: MCP Level**

## Extensor Hood:

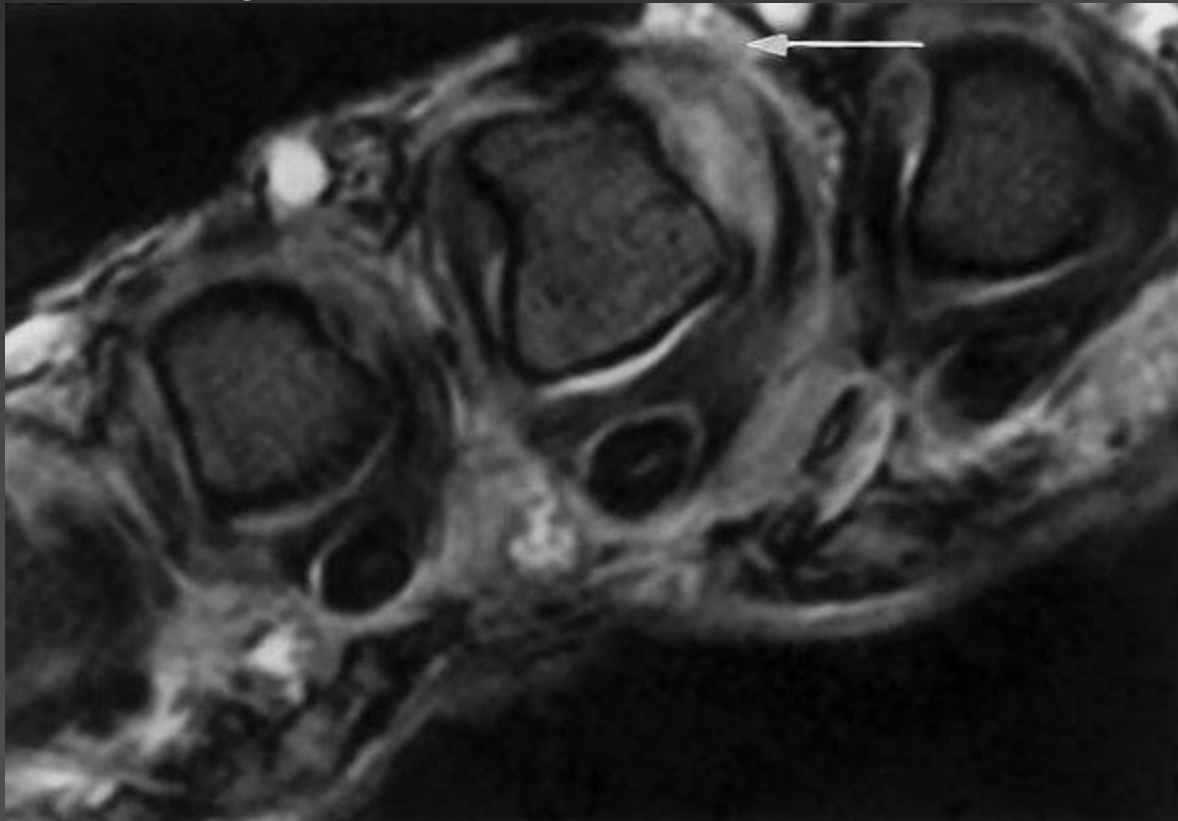
- Sagittal Band –
  - Dorsal attachment to extensor tendon sheath
  - Volar attachment to plantar plate of flexor tendon sheath

## The Extensor System

# Internal Derangement

## ■ Extensor Hood Injury

- Partial tear of radial sagittal band of the extensor hood in the middle finger.



# Anatomy: The Extensor System

## Verdan Classification

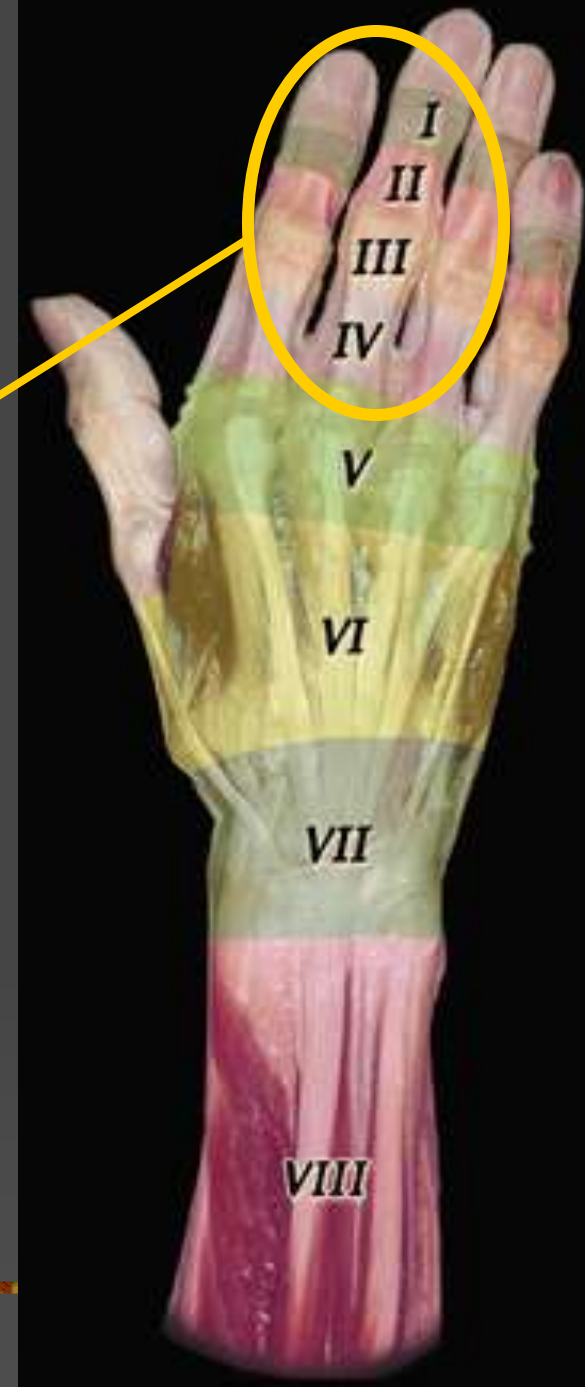
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# Anatomy: The Extensor System

## Verdan Classification

- |           |                  |
|-----------|------------------|
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# Anatomy: The Extensor System

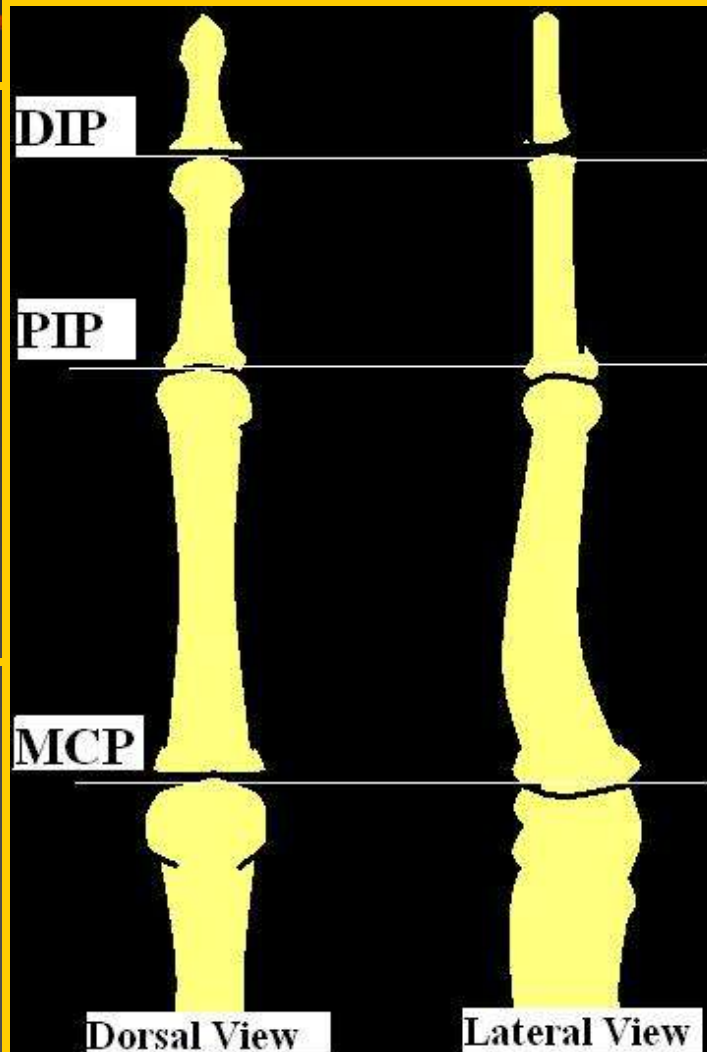
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# Anatomy: The Extensor System

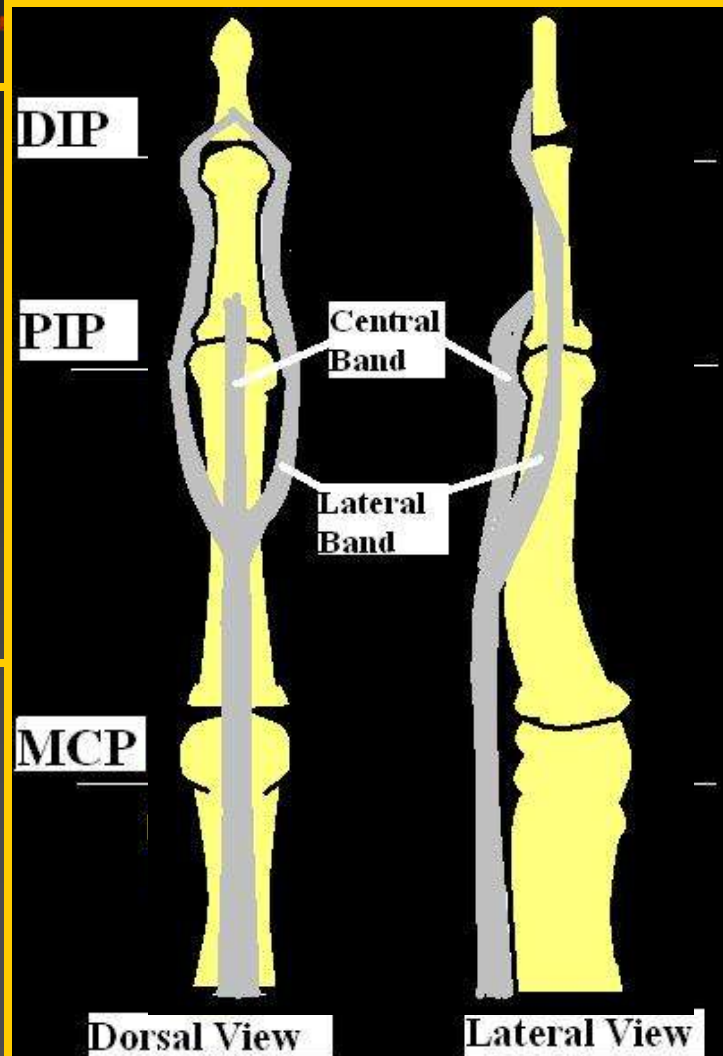
## Extensor Tendons

Zone I: DIP

Zone II: Middle Phalanx

Zone III: PIP

Zone IV: Proximal Phalanx





# Anatomy: The Extensor System

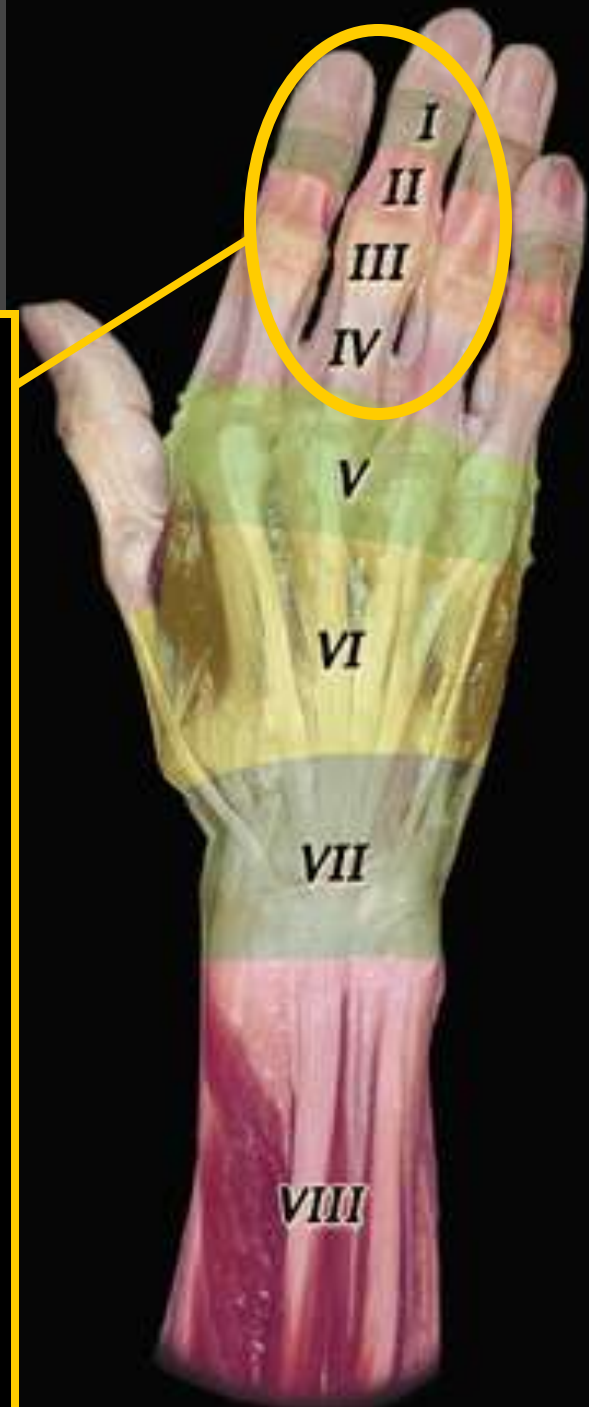
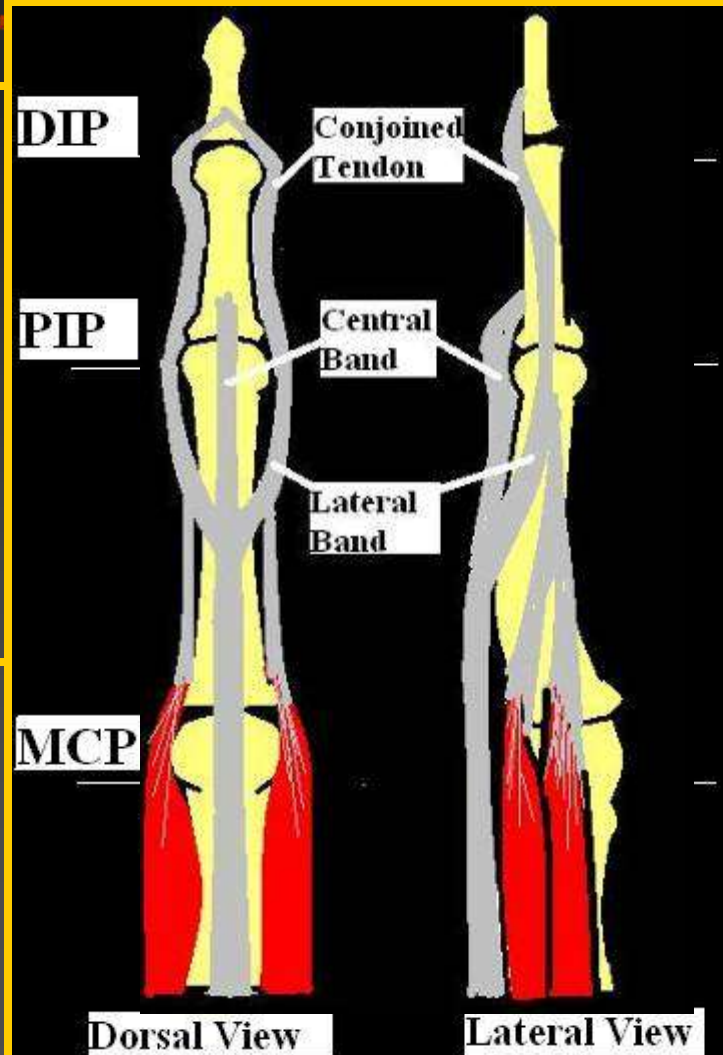
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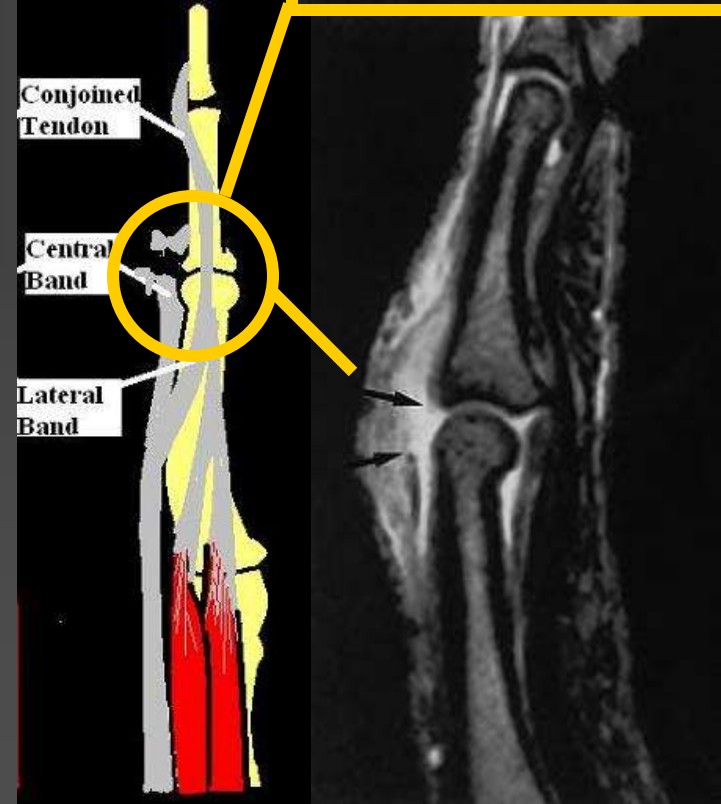
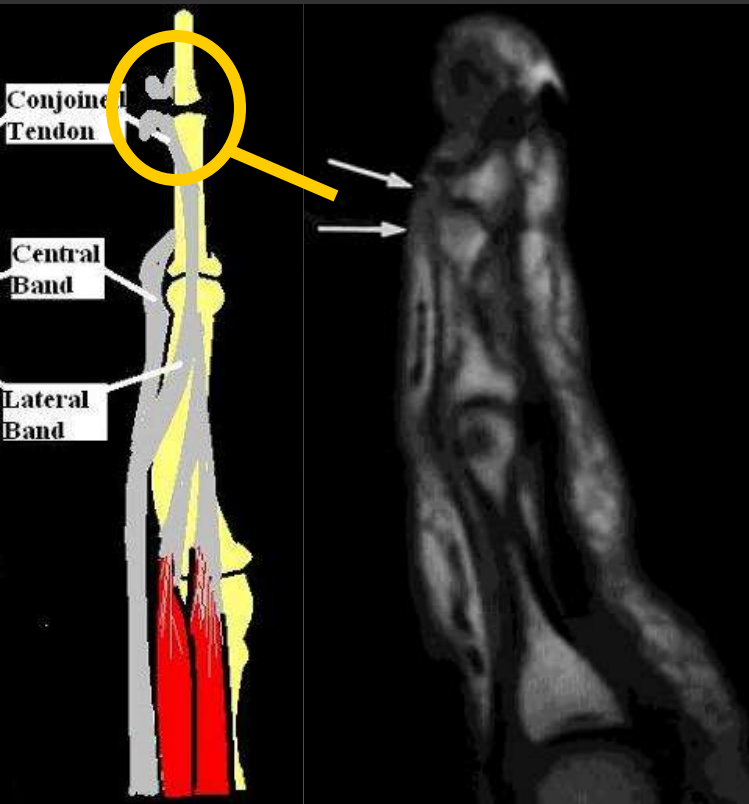
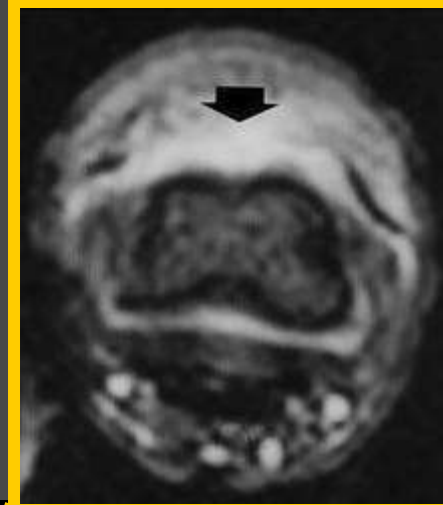


# The Extensor System

## Internal Derangement:

### ■ Open Injuries : MRI

- <50% tendon width: Conservative splinting
- >50% tendon width: Primary Surgical Repair

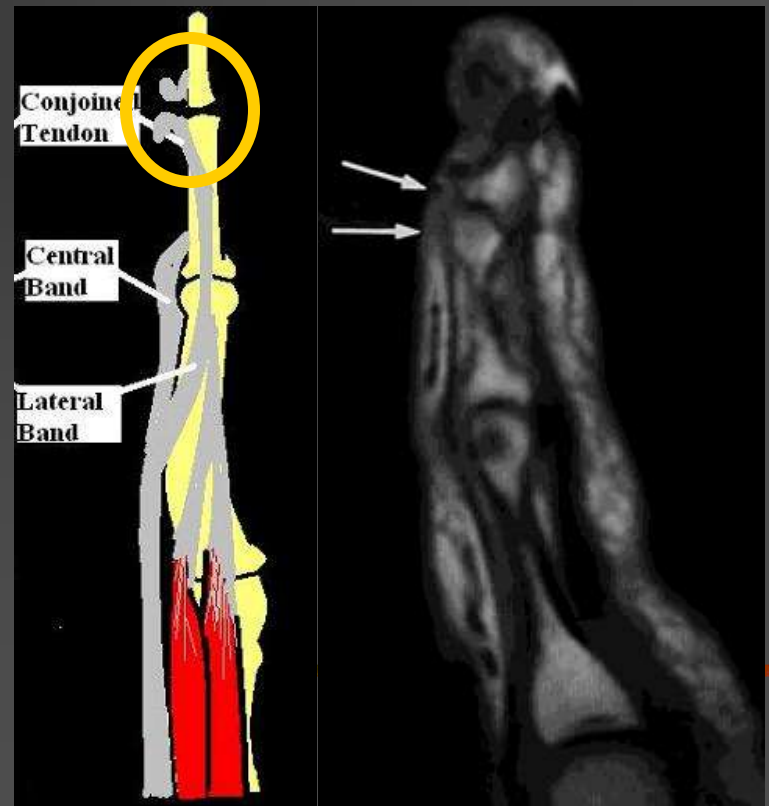
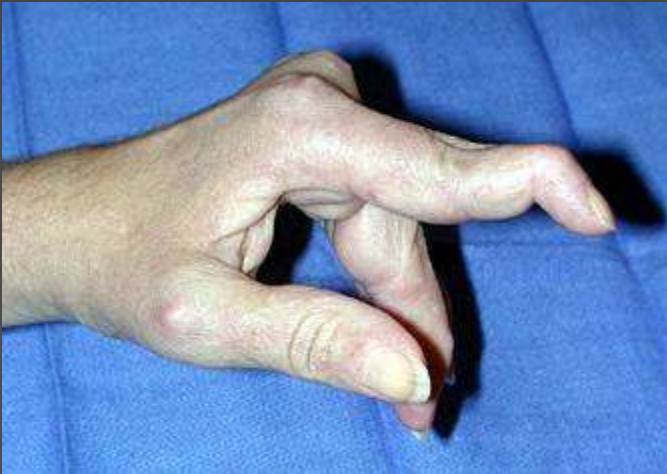


# The Extensor System

## Internal Derangement

### ■ Closed Injury: Mallet Finger

- Forced flexion Injury at Zone I- DIP joint
- Detachment of conjoined tendon from the base of the distal phalanx.
- Swan Neck Deformity:
  - DIP Flexion
  - PIP Hyperextensionfrom retracted extensor mechanism



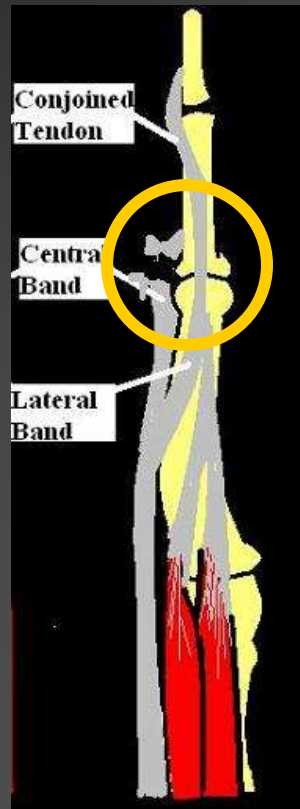
# The Extensor System

## Internal Derangement

### ■ Closed Injury: Boutonniere Deformity

- PIP Flexion injury and injury to the Central Band at or near its point of attachment at the base of the middle phalanx (Zone II / Zone III).

Chronically, lateral bands migrate to a volar position relative to the axis of rotation of the PIP joint. flexion at the PIP and an increased tension on intact terminal extensor insertion to distal tuft base

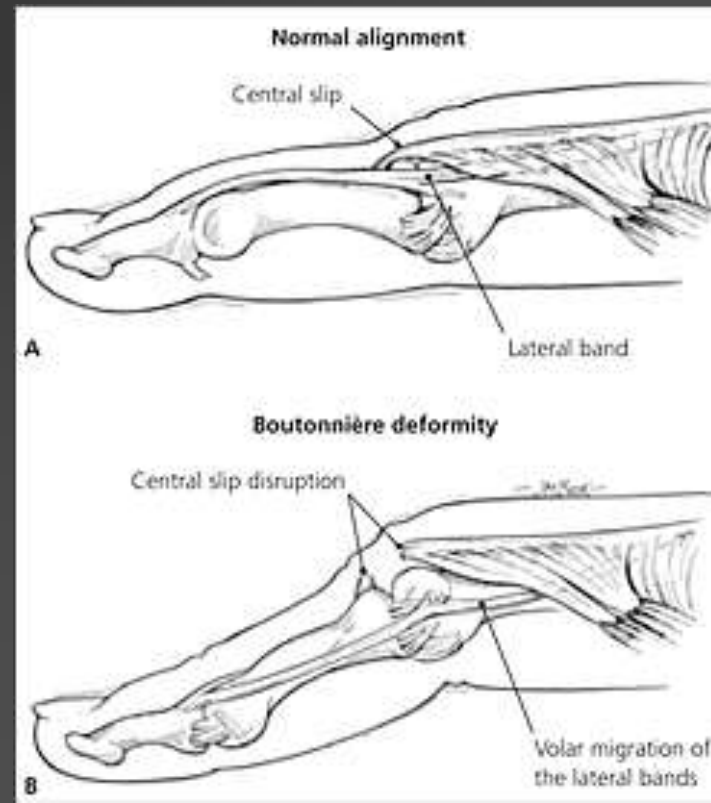


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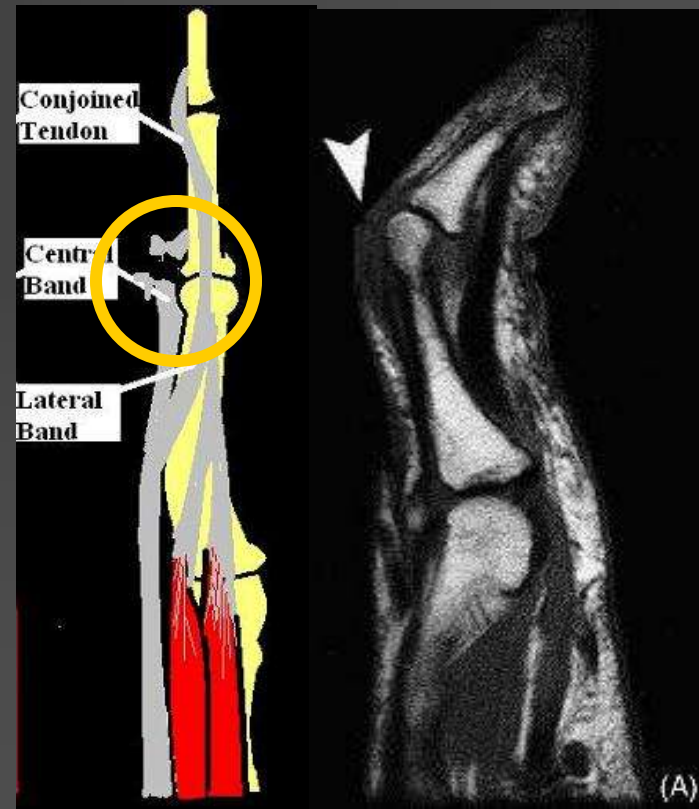


# The Extensor System

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# Musculoskeletal Imaging of the Digit

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# Anatomy: The Flexor System

## Verdan Classification

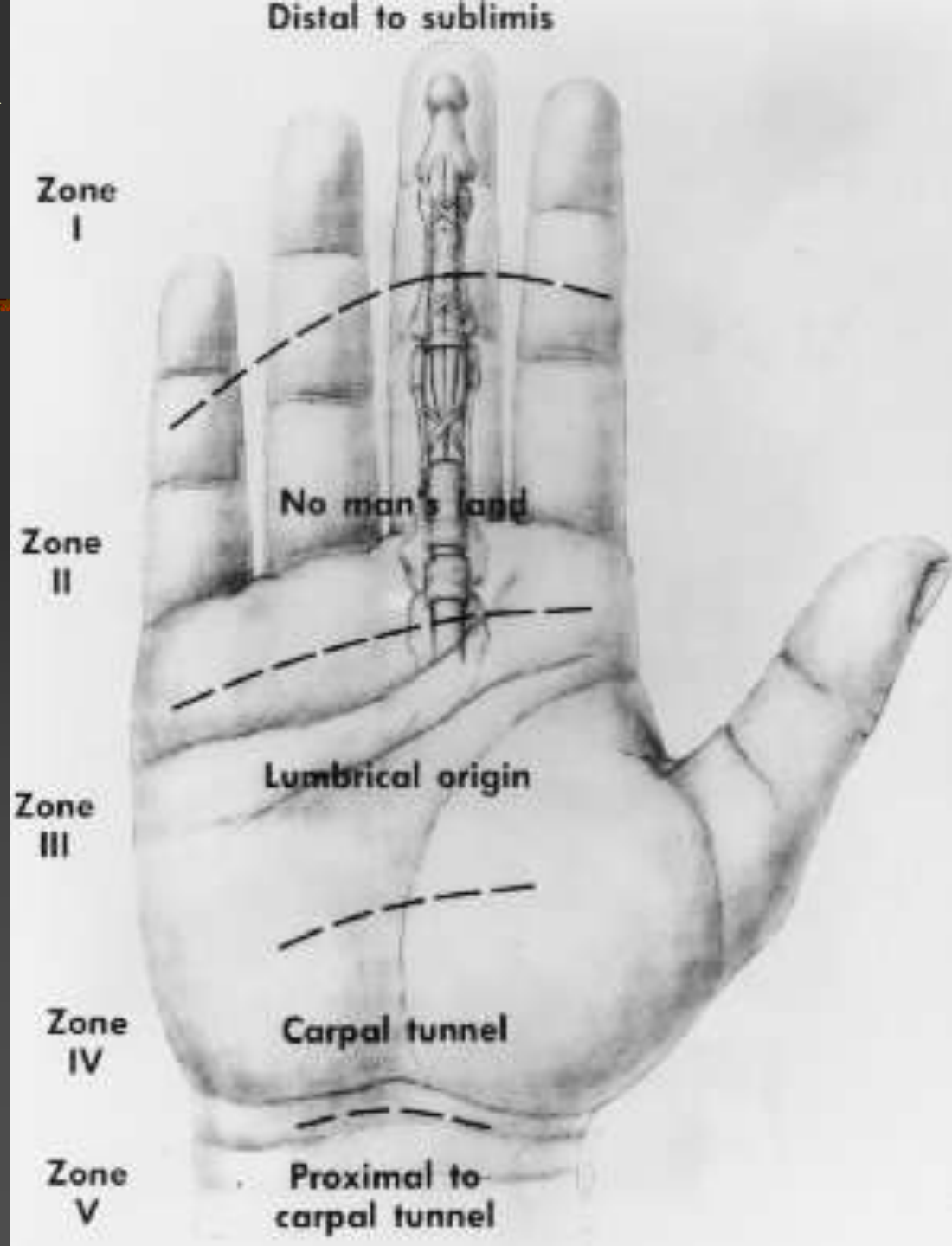
Zone I: Distal FDP to Distal FDS

Zone II: “No Man’s Land”  
Distal FDS to Distal  
Palmar Fold

Zone III: MCP (Proximal A1  
Pulley) to distal Flexor  
Retinaculum of the  
Carpal Tunnel

Zone IV: Carpal Tunnel

Zone V: Proximal to Carpal  
Tunnel





# Anatomy: The Flexor System

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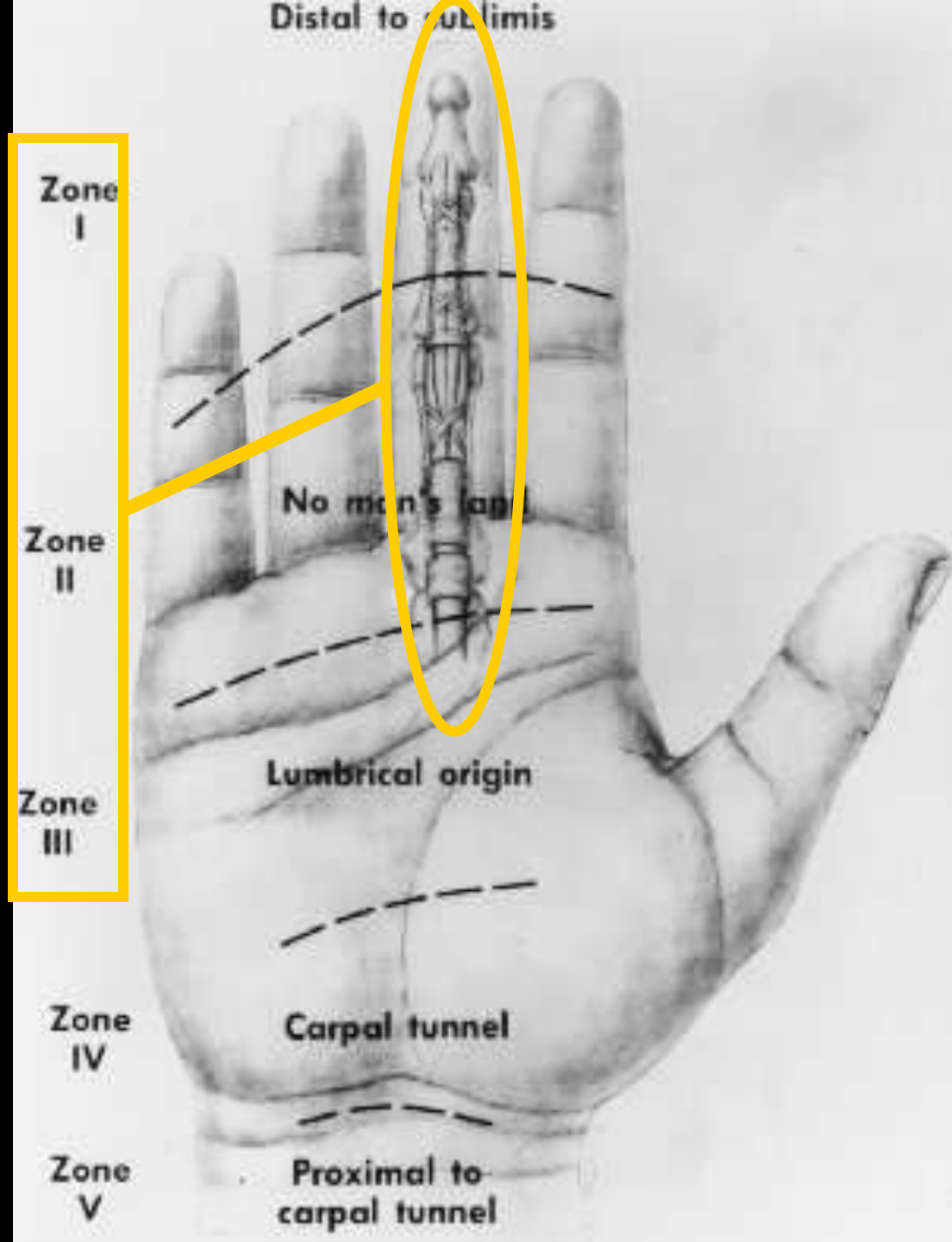
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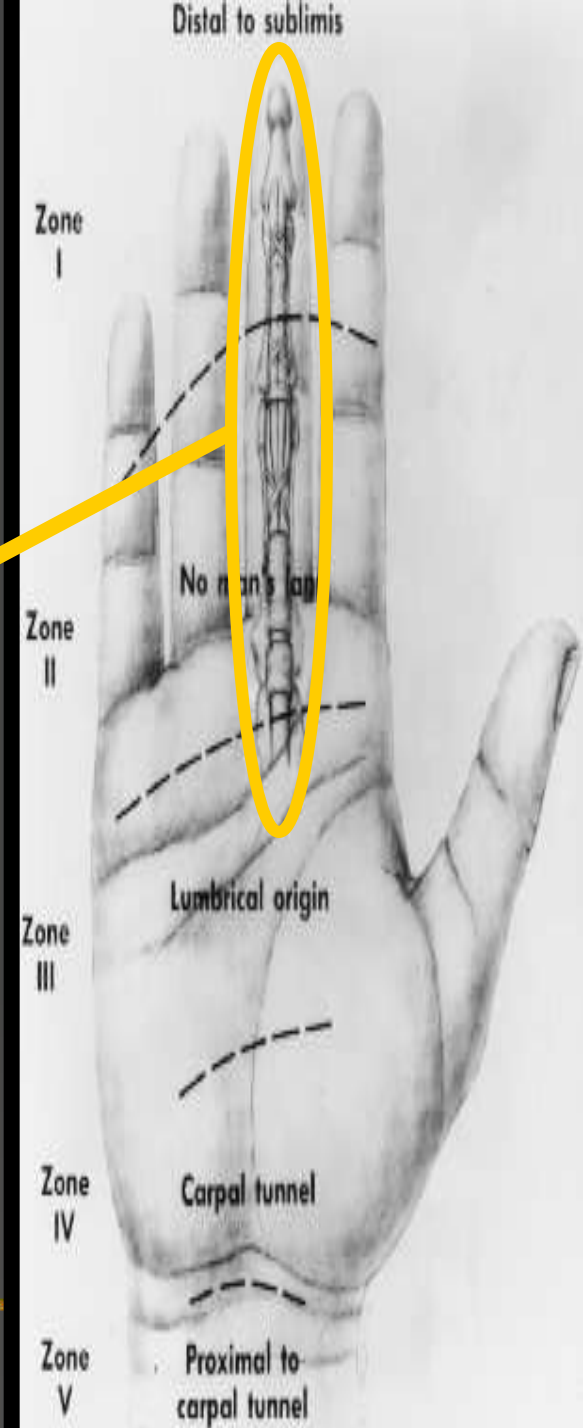
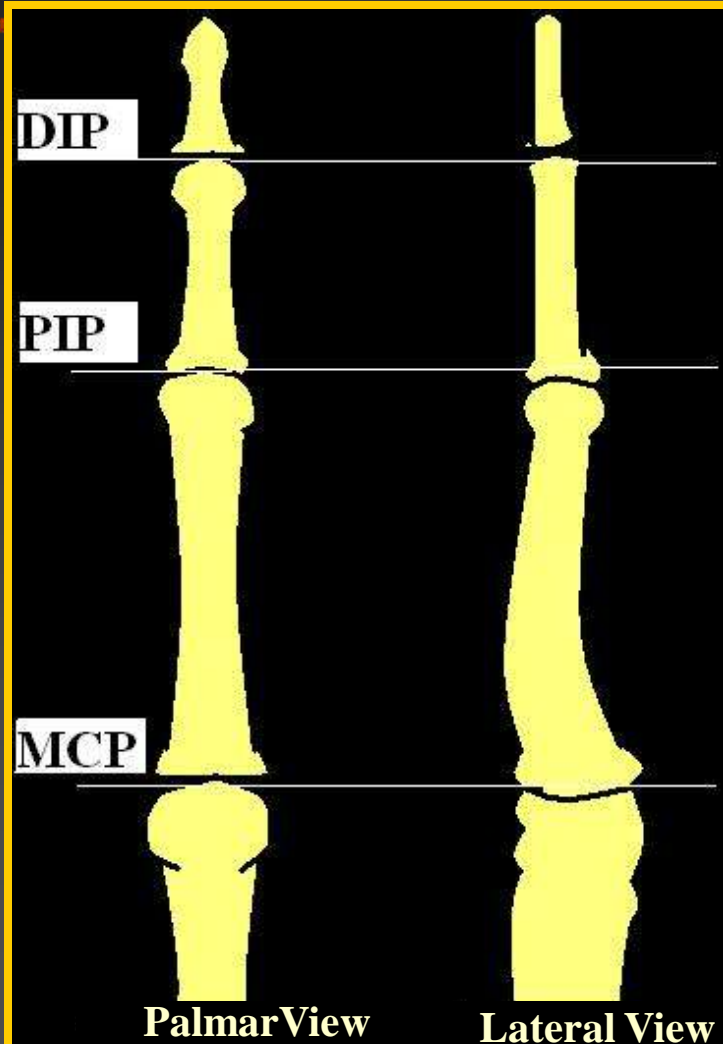
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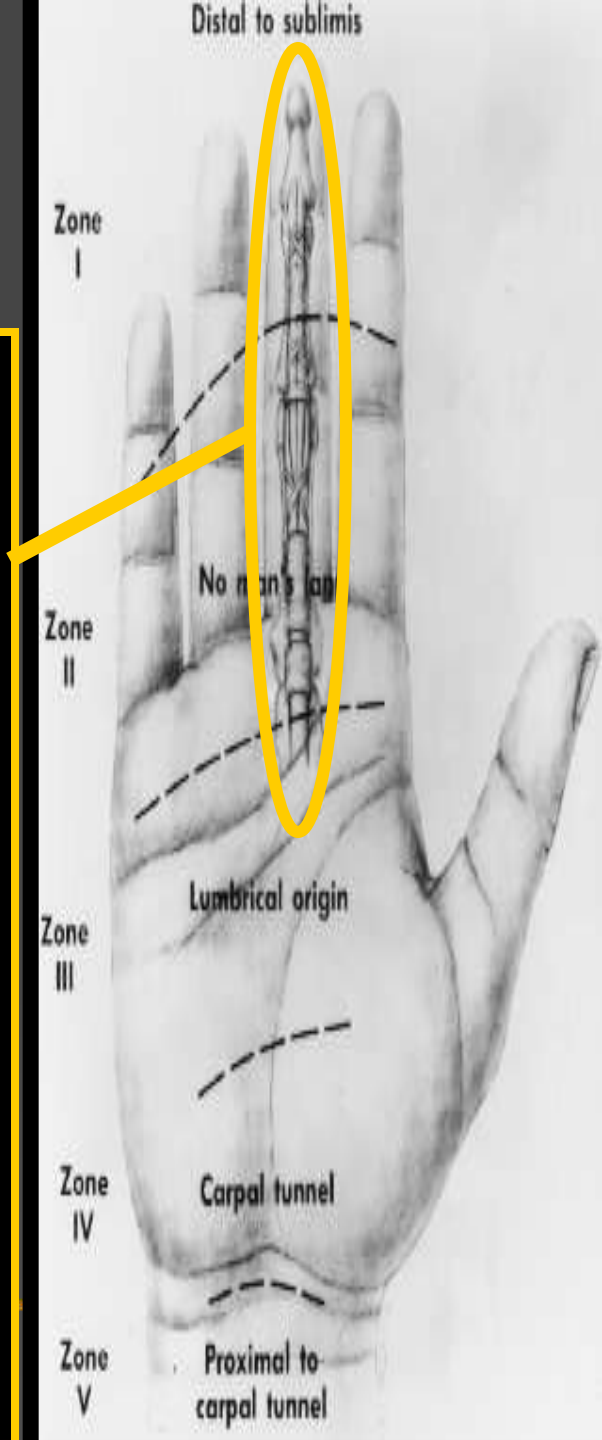
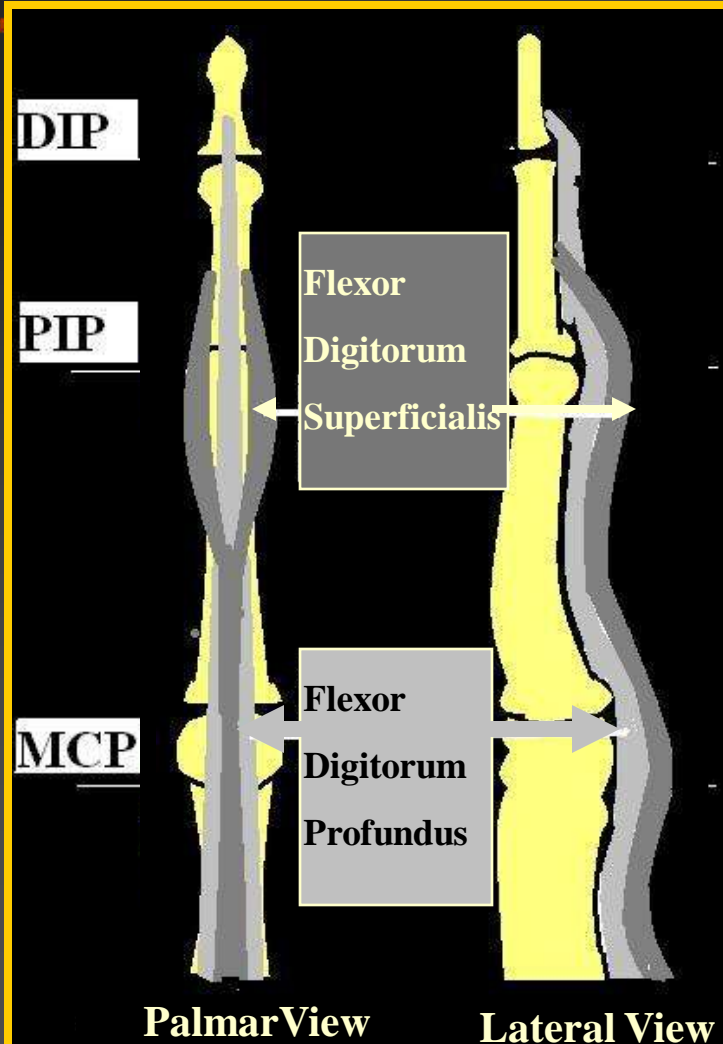
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# Anatomy: The Flexor System

## Internal Derangement

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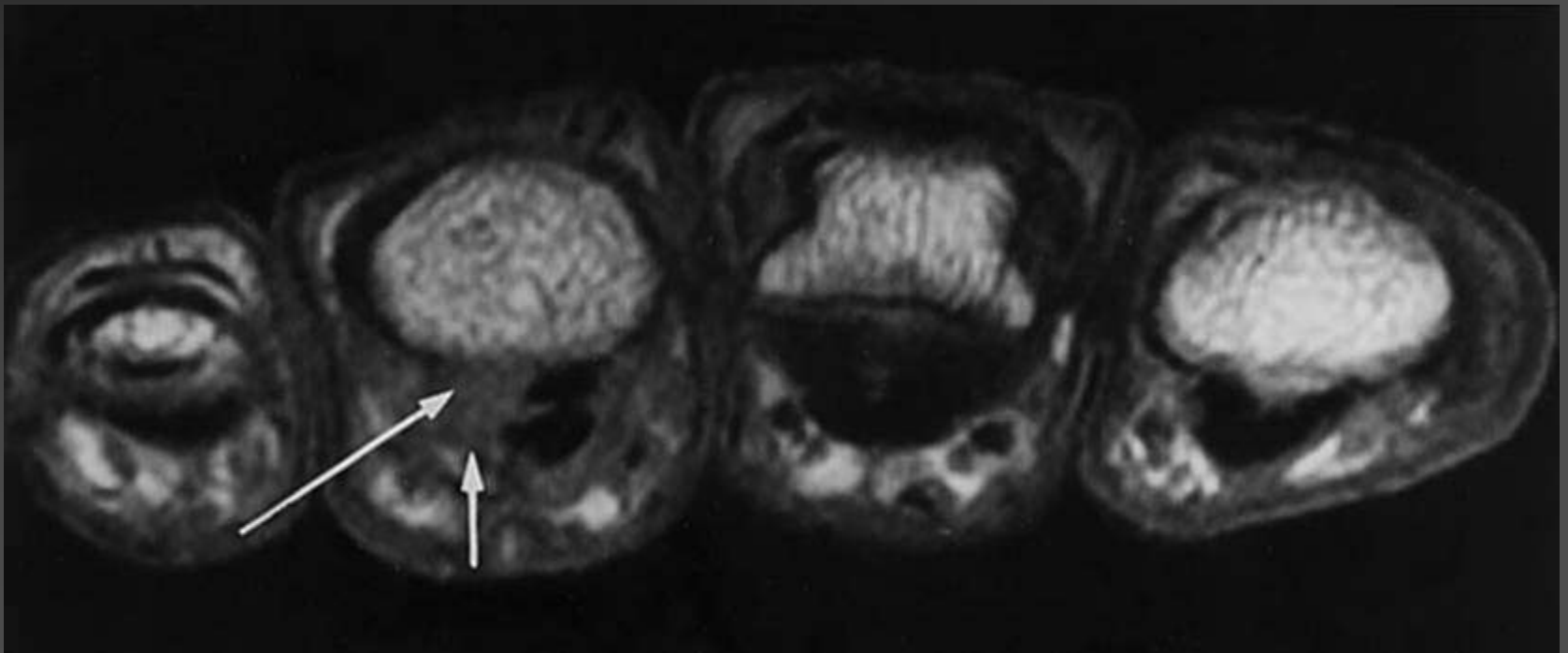
### Flexor Tendon Injuries

- **Open > Closed**
  - **Zone II Lesions: Most Frequent, Worst Prognosis**
  - **Tendon-bone attachment not as strong as Extensor system.**
    - **Higher degree of tendon retraction**
    - **Extent of gap between torn ends may be overestimated due to tendon retraction**
  - **Isolated FDS avulsion Uncommon**
-

# Anatomy: The Flexor System

## Internal Derangement

### OPEN Flexor Tendon Injuries: Partial Tear



Anatomy: The Flexor System

## Internal Derangement

**OPEN Flexor Tendon Injuries:  
Complete FDP Tear**



# Anatomy: The Flexor System

## Internal Derangement

**Closed Flexor Tendon Injuries:**

**Complete FDP Tear**

**Intact FDS**

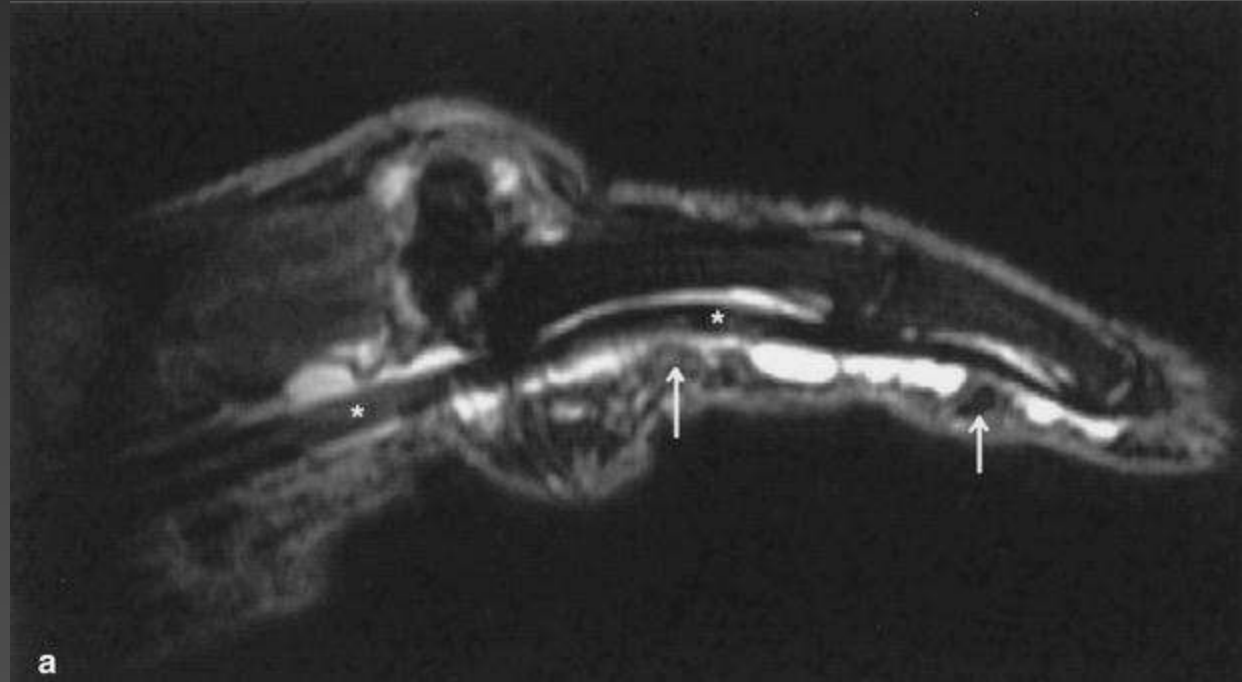
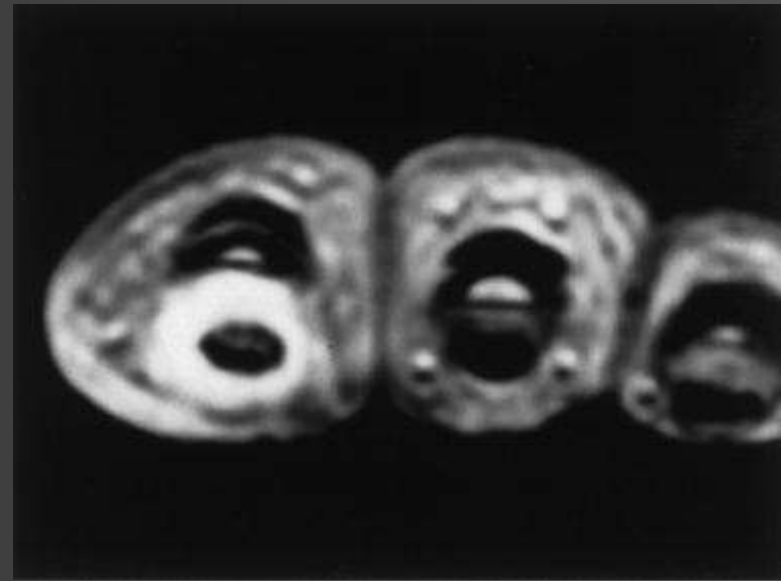


# Anatomy: The Flexor System

## Internal Derangement

### ■ Tenosynovitis

- Presence of fluid surrounding the tendon, inside the tendon sheath





# The Pulley System

- Fibrous anchors that tether the tendons to the osseous fingers.
- Required for accurate tendon tracking
- Facilitates finger flexion by maintaining close apposition of the tendon to bone



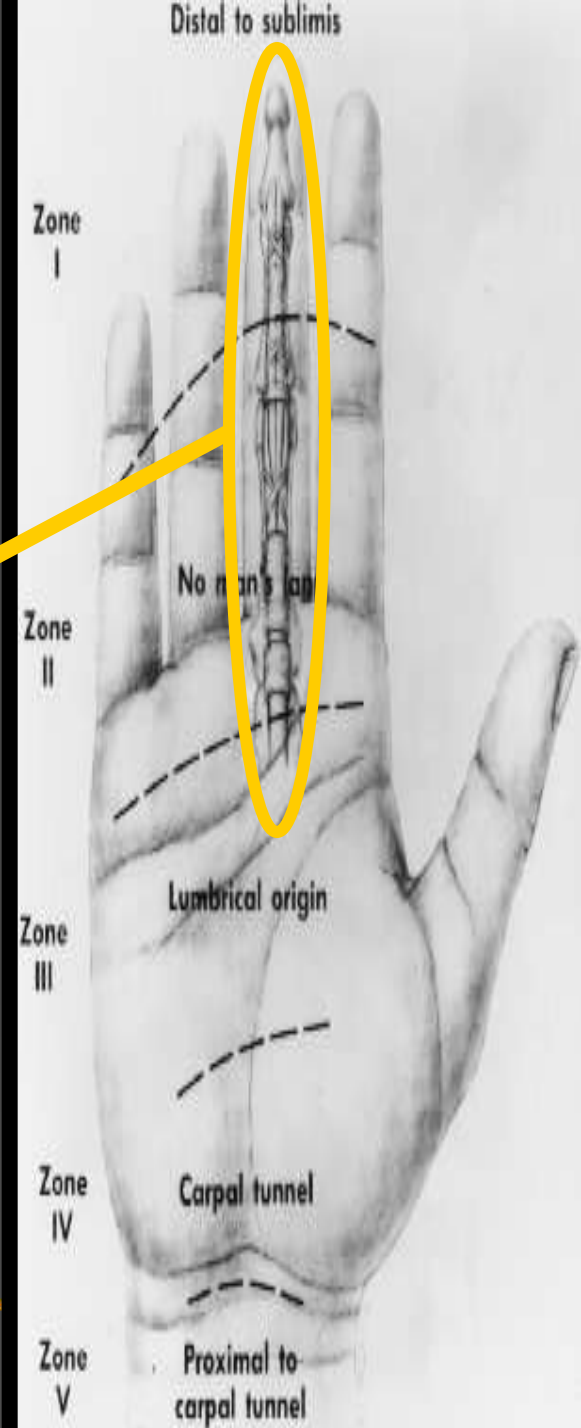
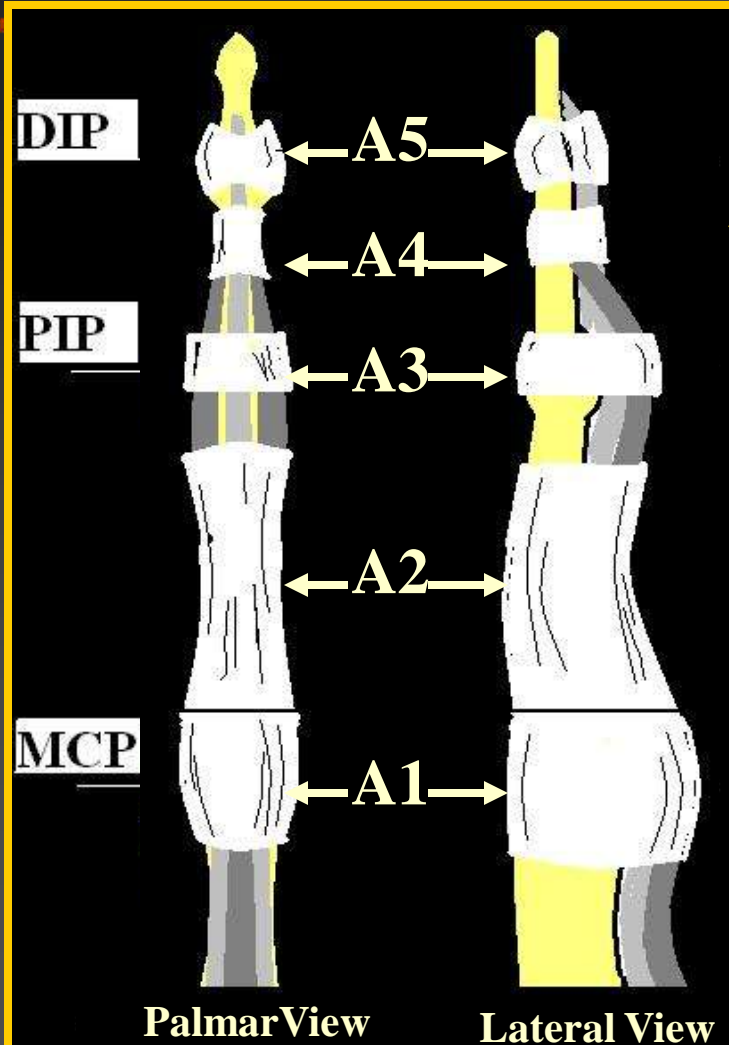
# Anatomy: The Flexor System

## Annular Pulleys

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**Zone III:** MCP (Proximal A1 Pulley) to distal part of Flexor Retinaculum of the Carpal Tunnel



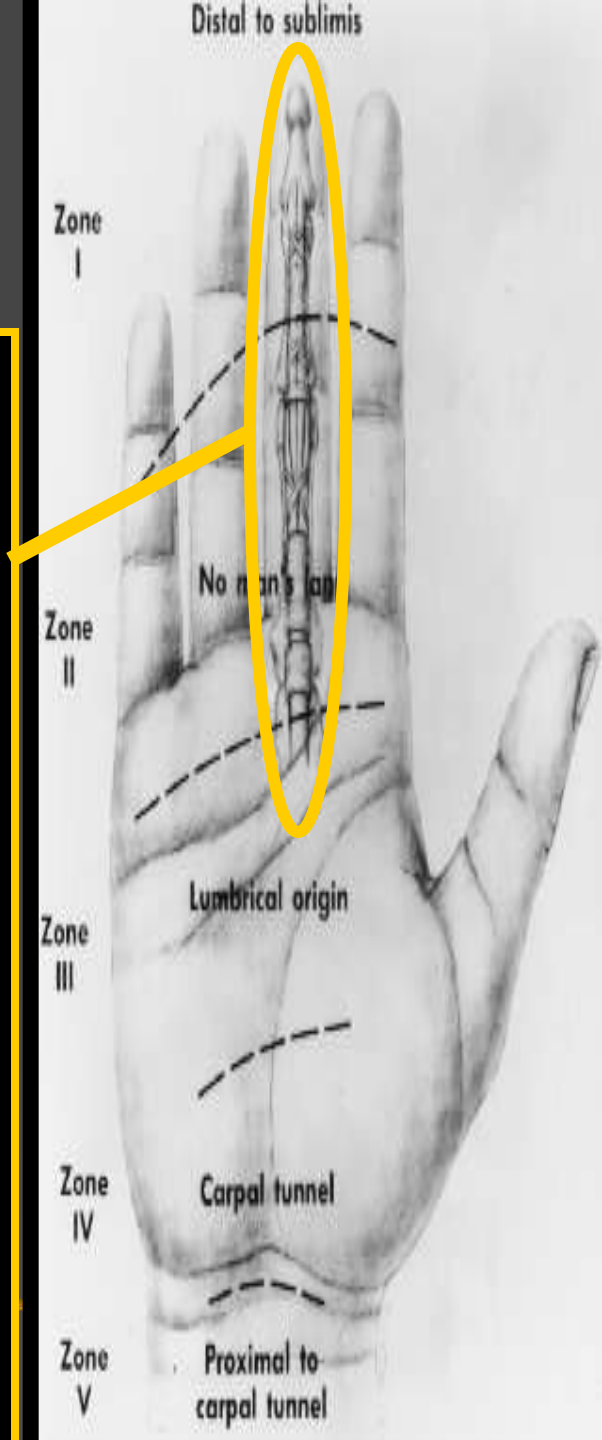
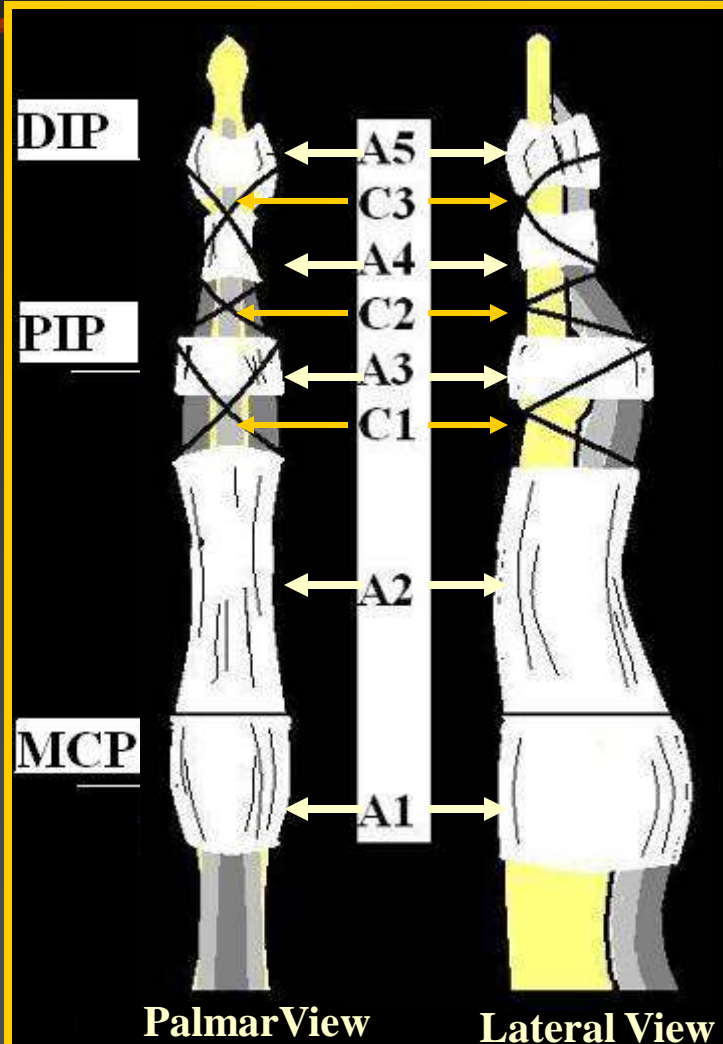
# Anatomy: The Flexor System

## Cruciform Pulleys

**Zone I:** Distal Insertion of FDP to Distal Insertion of FDS

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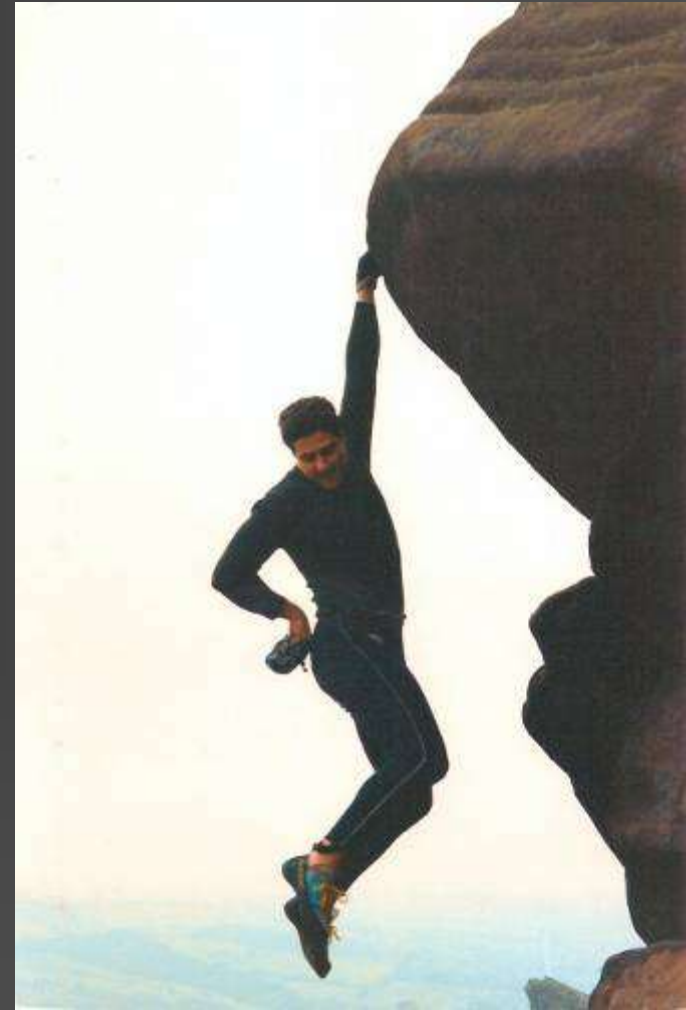


# The Pulley System

## Internal Derangement

### ■ Injuries of the Pulley System

- **Rock Climbing**
- **Forced Flexion of Fingers with:**
  - **MCP extension**
  - **PIP flexion**
  - **DIP extension**



**Places Extensive Stress on the A2 & A3 pulley**

# The Pulley System

## Internal Derangement

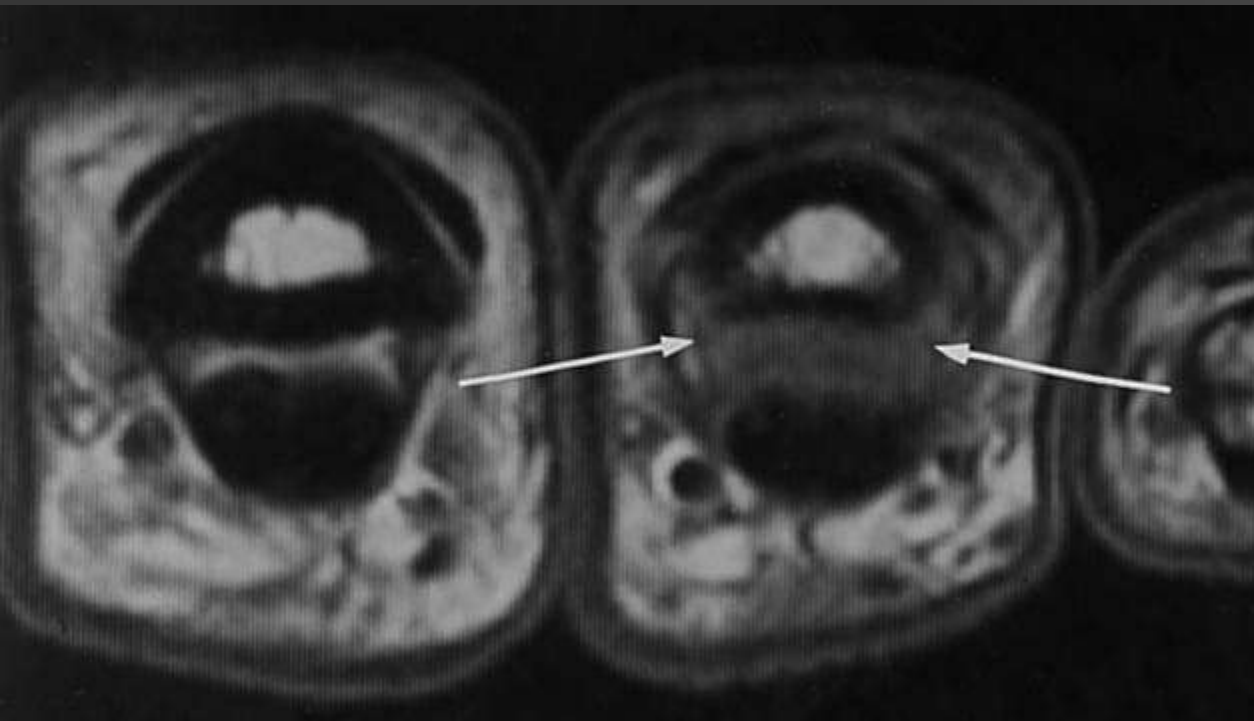
- Increased gap between flexor tendons and bone
- Indirect Sign of A2 pulley lesion
- “Bow-String Sign”



# The Pulley System

## Internal Derangement

- Partial A2 Pulley lesion
- Increased signal of the A2 pulley



# Anatomy: The Flexor System

## Internal Derangement

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### Flexor Tendon Repair

According to Strickland et al.

- Injuries involving  $\leq 60\%$  of tendon cross sectional area should not be repaired
  - Injuries involving  $\geq 60\%$  repair with traditional core suture method supplemented with epitendinous suturing
-

# Musculoskeletal Imaging of the Digit

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# Finger: Soft Tissue Masses & Tumors

## ■ Synovial Cyst

- Herniation of the synovial membrane through joint capsule.

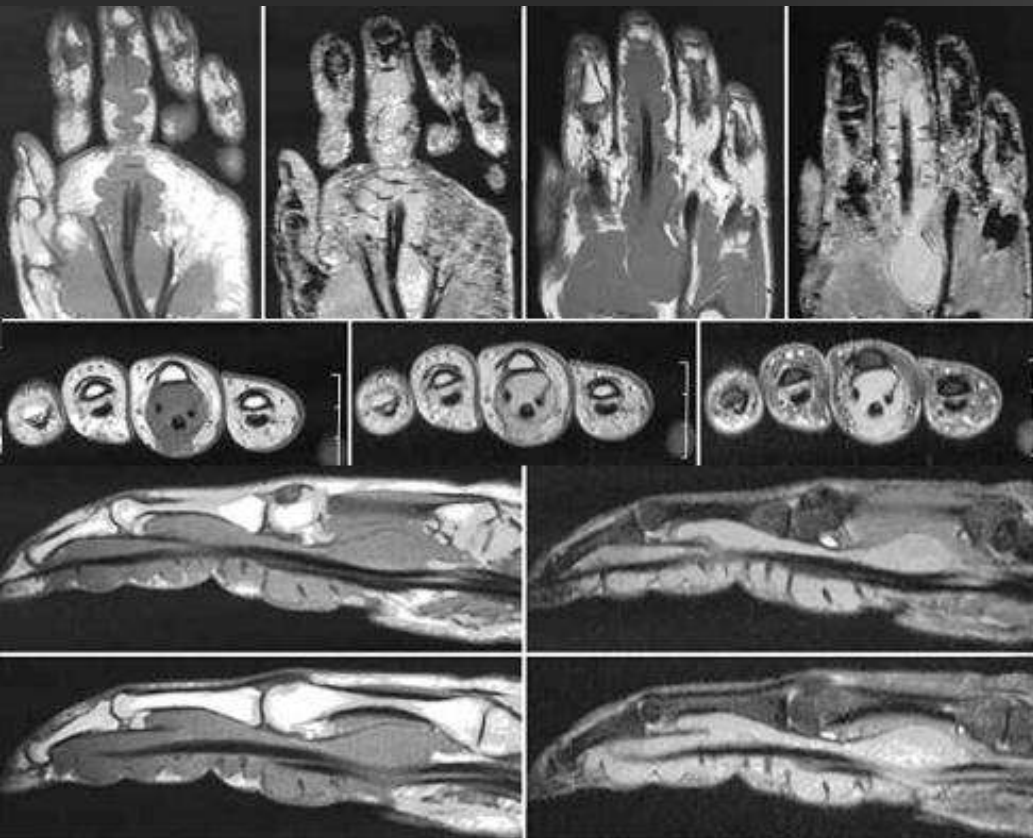
## ■ Ganglion Cyst

- Rarely communicates with the synovium of a tendon sheath or joint.

- 
- Well-circumscribed homogeneous lesions T2 hyperintensity.
  - Enhancement of a thin wall after IV gadolinium

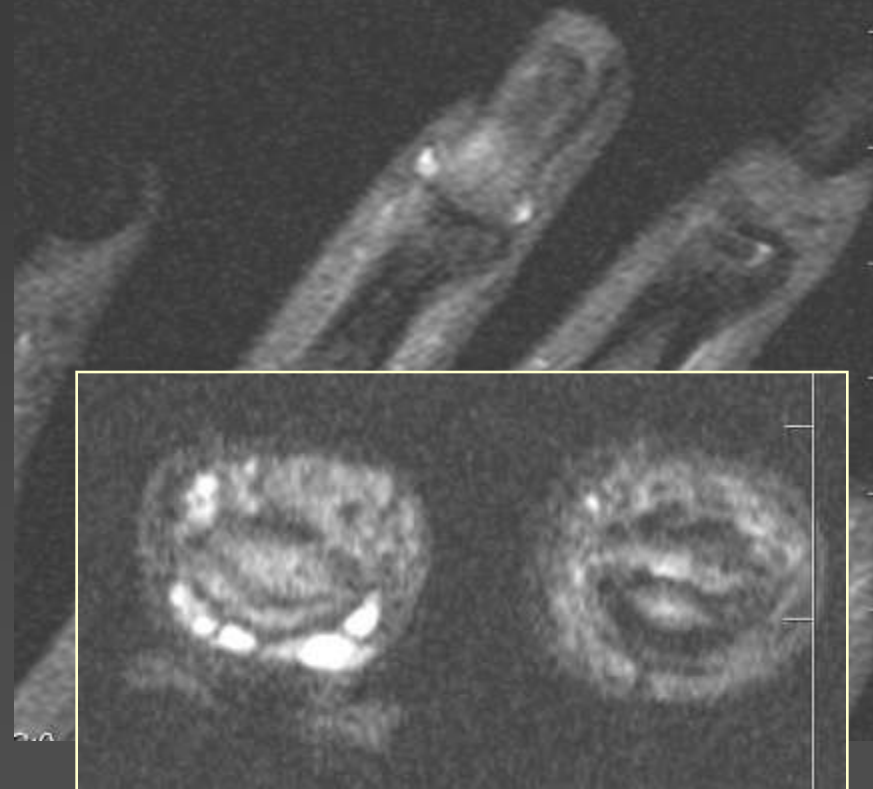
# Finger: Soft Tissue Masses & Tumors

## ■ Synovial Cyst



## ■ Ganglion Cyst

### ■ Mucoid cyst



# Finger: Soft Tissue Masses & Tumors

## Epidermoid Inclusion Cyst

- Subungual round smooth nodule
- Previous trauma
- Radiolucent lesion
  - DDX
    - Giant Cell Tumor
    - Enchondroma
    - Glomic tumor

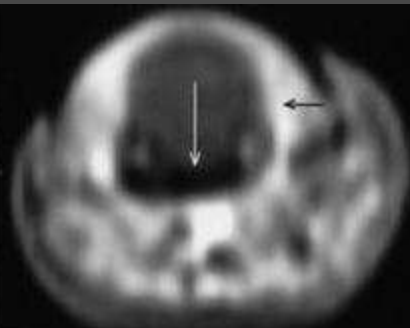


# Finger : Soft Tissue Masses & Tumors

## Epidermoid Inclusion Cyst

### ■ MR features

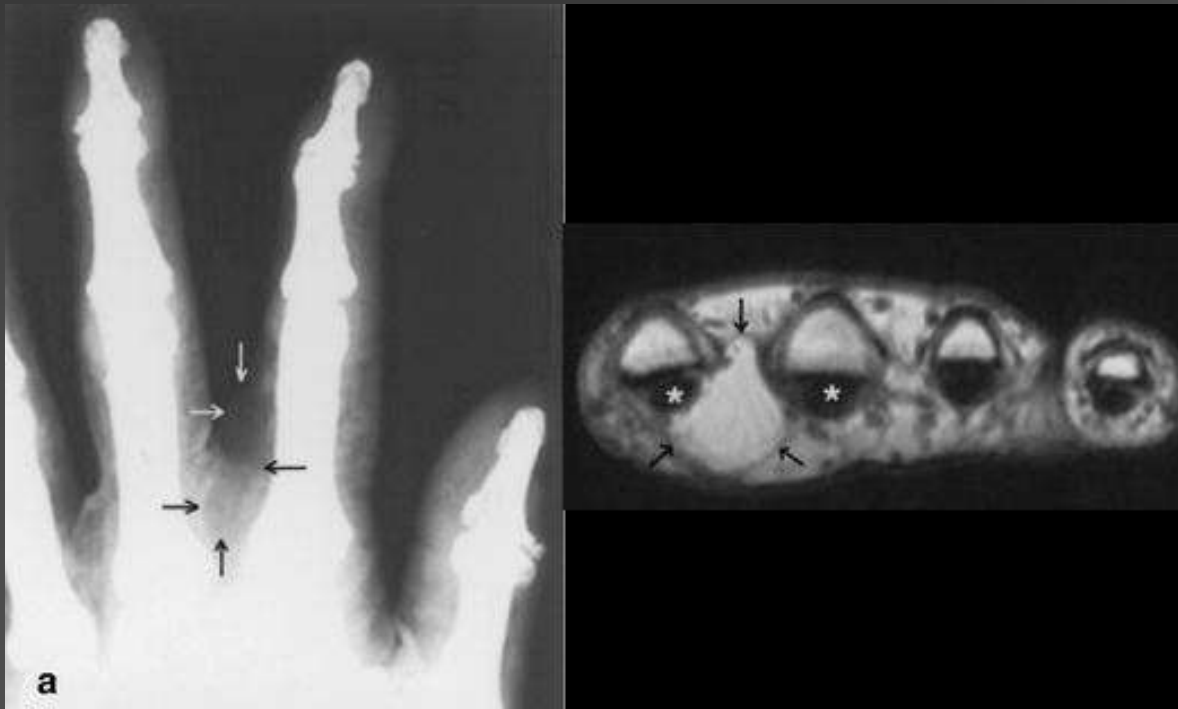
- Iso-hypo intense T1W
- Hyper-intense T2W
- Wall enhancement post IV contrast (Not seen in enchondroma, giant cell, or glomic tumor)



# Finger Soft Tissue Masses & Tumors

## ■ Lipoma

- Well-circumscribed encapsulated mass
- Iso-intense to fat



# Finger: Soft Tissue Masses & Tumors

- Hemangioma
  - Benign but non-reactive process in which there is an increase in the number of normal or abnormal vessels.
  - Heterogeneous high signal on T2
  - Flow voids
  - Serpiginous tubular hyperintense strands on T1 due to blood in dilated channels and fatty elements



# Finger: Soft Tissue Masses & Tumors

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- Malignant vascular tumors of the finger are rare and when tumoral necrosis is present the DDX may include
    - Angiosarcoma (most frequently up to 20 years old)
    - Epitheloid sarcoma
    - Kaposi's Sarcoma
-

# Finger: Soft Tissue Masses & Tumors

- Giant Cell Tumor of Tendon Sheath
  - Second most common tumors of the hand
  - Classified into the common localized type and the rare diffuse type .
  - Painless masses
  - Most commonly occur in patients aged 30-50 years, with a peak incidence in those aged 40-50 years.
  - Associated with degenerative joint disease, especially in the distal interphalangeal (DIP) joint
  - Masses occur along the volar aspect of the hand and fingers and are most commonly adjacent to the DIP joint.
  - Index and long fingers most commonly involved



# Finger: Soft Tissue Masses & Tumors

## ■ Giant Cell Tumor

- Intraoperative excision of the giant cell tumor of the tendon sheath

- Typical golden yellow color secondary to hemosiderin deposition



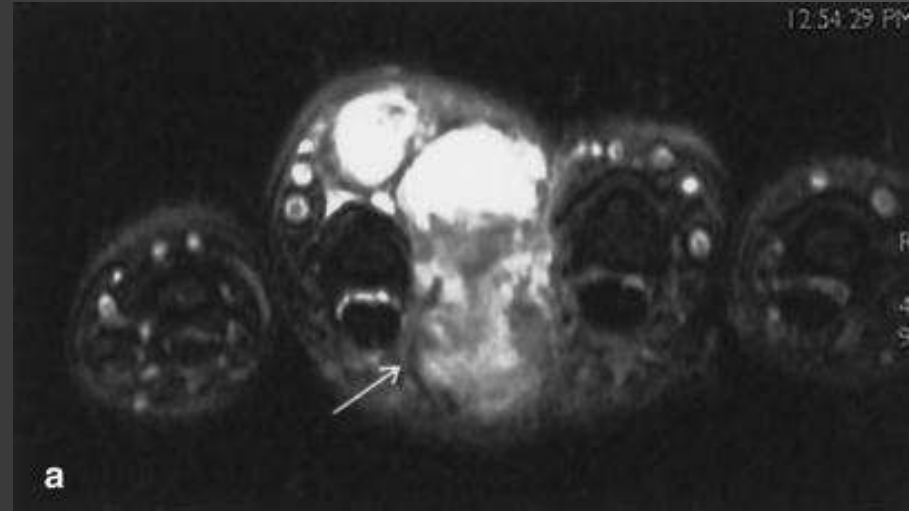
# Finger : Soft Tissue Masses & Tumors

- **Giant Cell Tumor:** T1 intermediate, T2 Hypointense, especially on Gradient Echo due to hemosiderin laden histiocytes



# Finger: Soft Tissue Masses & Tumors

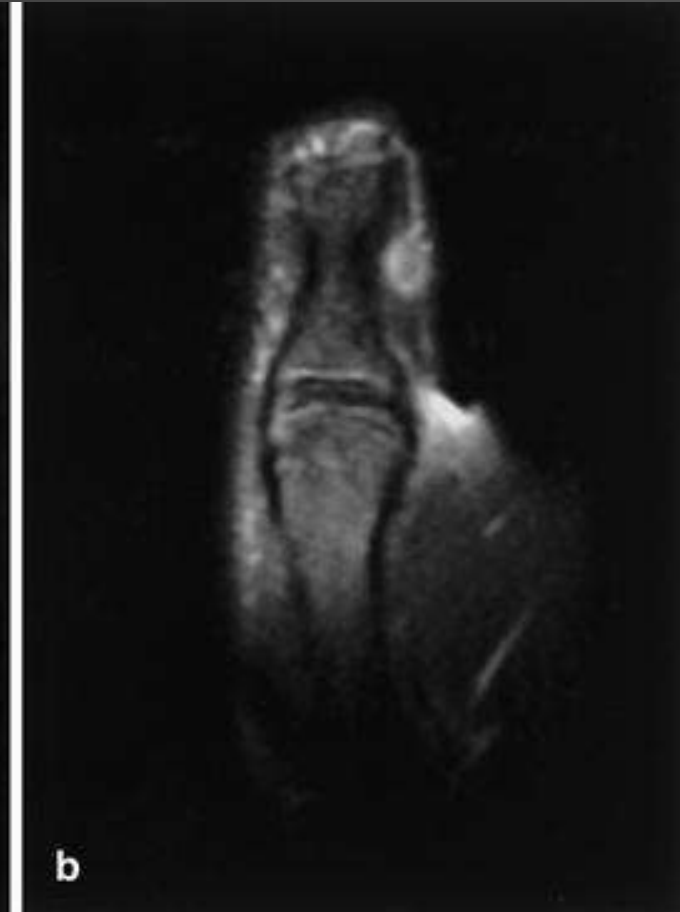
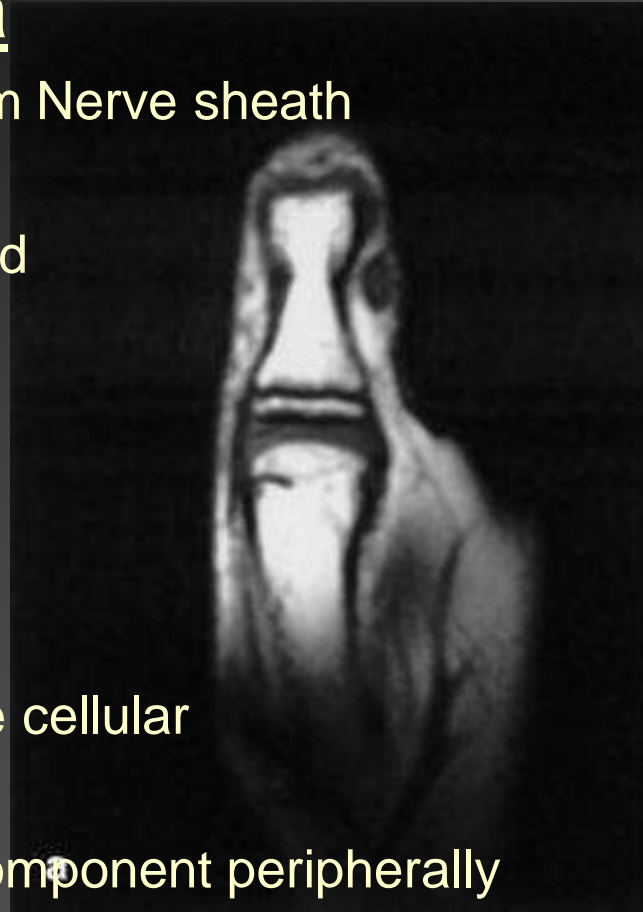
- Fibroma of the Tendon Sheath
  - Rare, benign tumor
  - > Males
  - Well-circumscribed mass attached to tendon sheath
  - Low T1 & T2 Signal with variable enhancement after IV gadolinium
  - Main DDx based on frequency is Giant Cell tumor of tendon sheath.



# Finger: Soft Tissue Masses & Tumors

## Neurofibroma

- Tumor arising from Nerve sheath
- Benign
- Well-circumscribed
- Age 20-30 years
- MR Features
  - High T1
  - T2 Target sign:
    - Low T2 Central zone cellular component
    - Higher T2 cellular component peripherally



# Finger: Soft Tissue Masses & Tumors

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## Chondroma

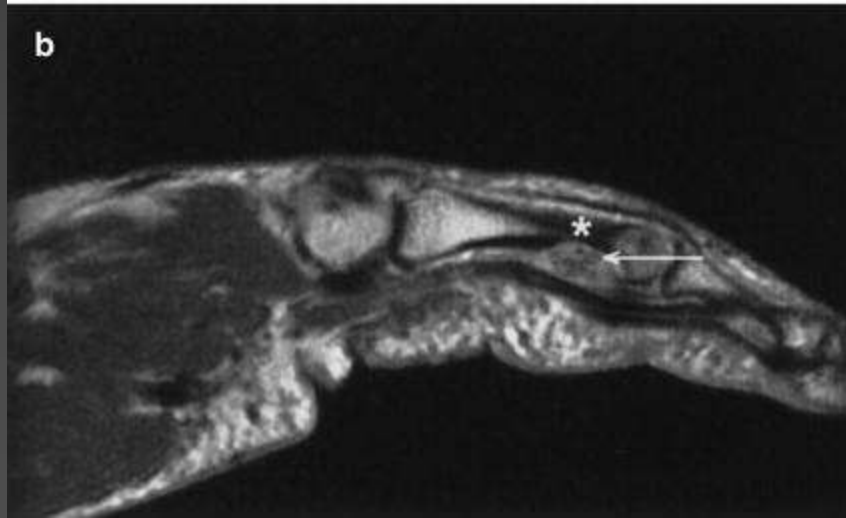
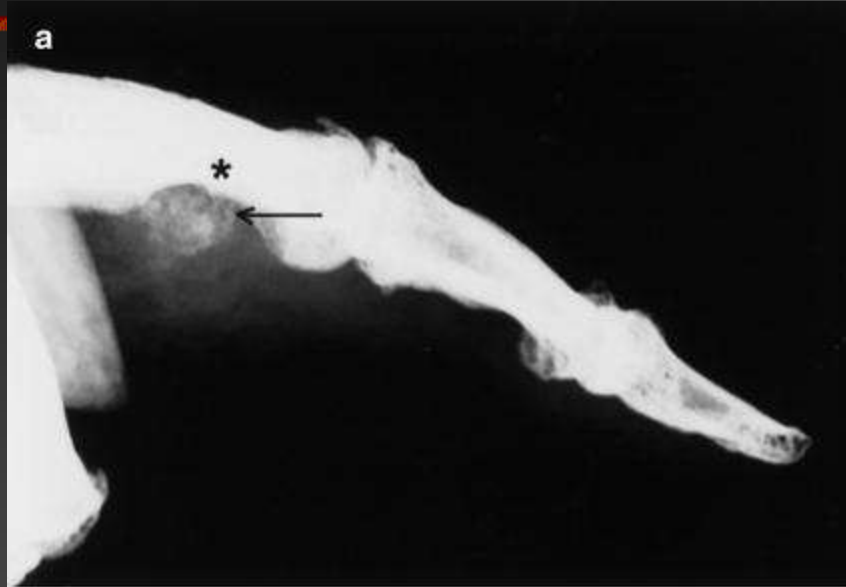
- Well defined nodule of cartilage unattached to bone.
  - Age 10-70 years old
  - Slow growing masses causing pain or tenderness
  - Small (<3cm), firm and often mobile
  - Calcification 33-70%
  - Extrinsic bone erosion may be seen.
-

# Finger: Soft Tissue Masses & Tumors

MR Features:  
T1 isointense  
to muscle

T2  
hyperintense

Central  
Stippled  
calcifications  
may present  
as dark  
central foci  
on T1 & T2



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