MR Imaging of the Wrist and Hand

MR wrist and hand

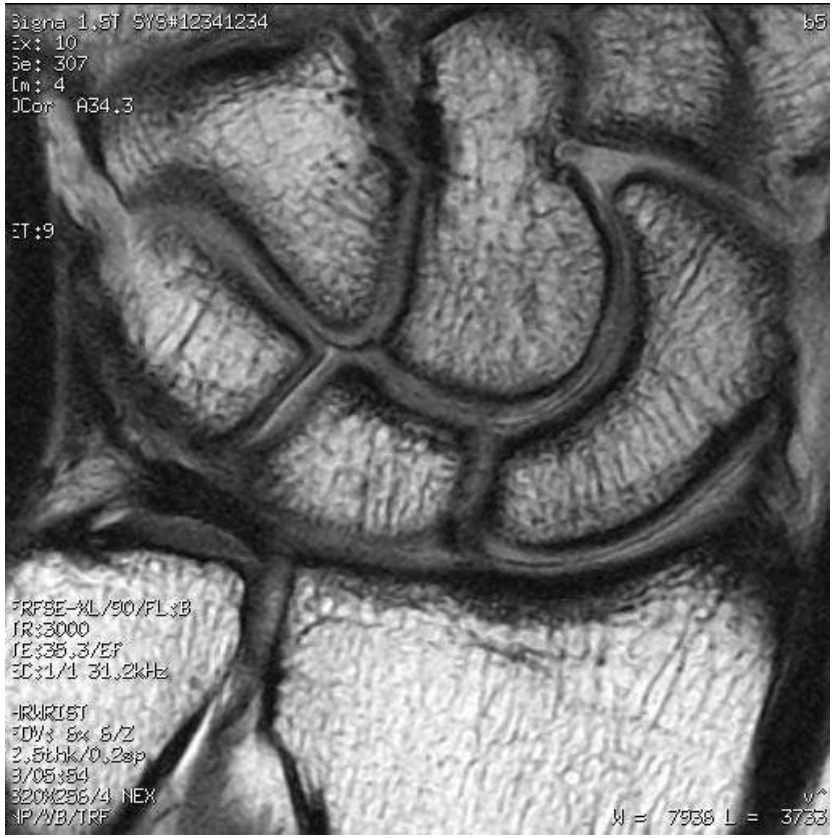
- Technical considerations
- Internal derangement of the wrist
  - TFCC
  - Ligaments
- Osseous abnormalities
- Arthritis, Tendons, and Ligaments
- Miscellaneous

Technique

- Supine, hand by side (avoid excessive pronation)
- Prone, hand above head
- Decubitus, hand in front directed cranially
- Comfortable immobilization

Protocol

- Routine protocol
- Tailored protocol for specific indications (tumor, infection)
- MR arthrography

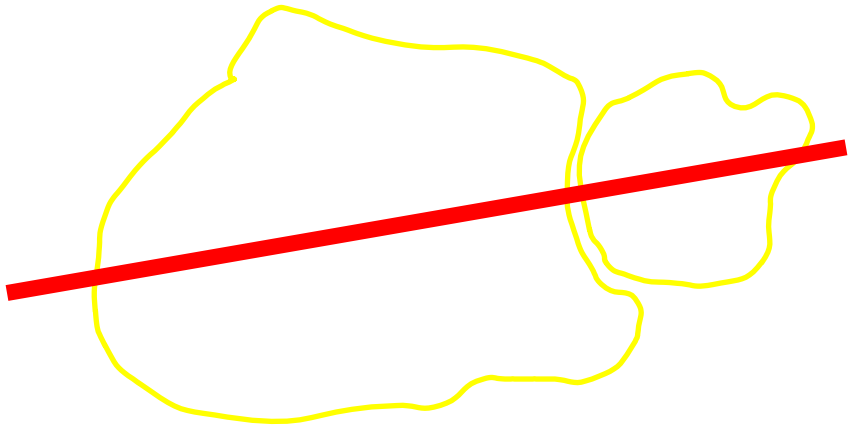


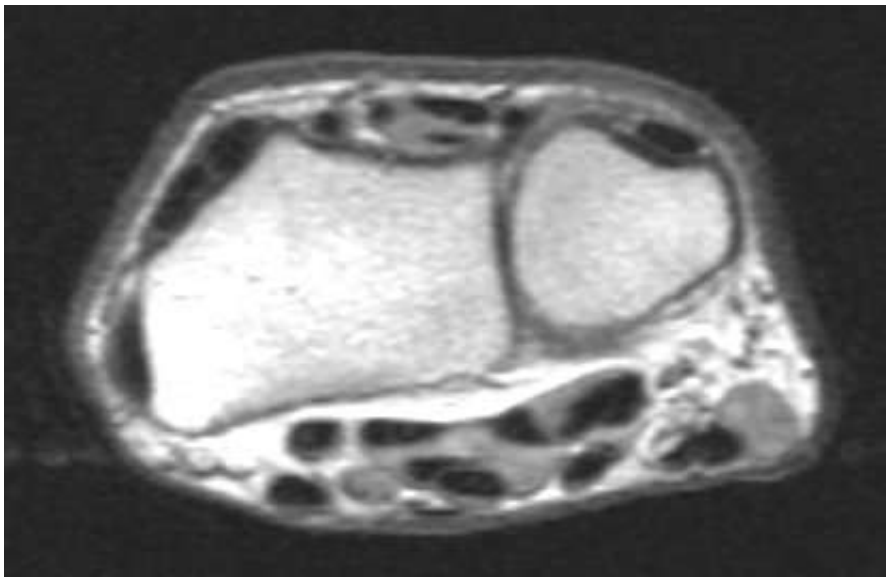
Protocol

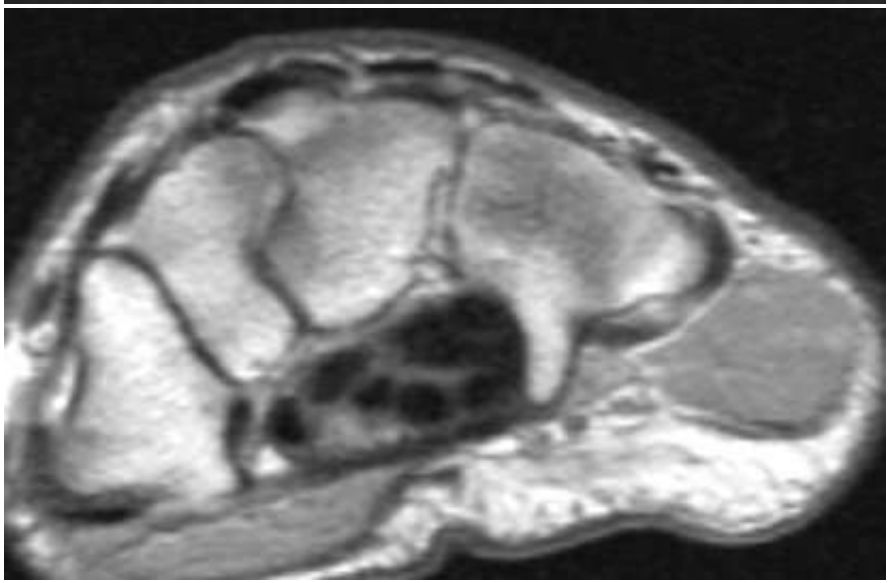
Plane	Sequence	TR/TE	FOV	Matrix	Slice/ Gap	NEX
Localizer	FMPIR	2800/30 TI 140	14	128	4/1	1
Coronal	PD FSE	2500/19	8	256	3/1	2
Coronal	T2 FSE	2500/80	8	256	3/1	2
Coronal	T2* GE	450/15 30 degree flip	8	192	.6 mm	2
Axial	PD FSE	2500/19	8	256	3/1	2
Axial	T2 FSE	2500/80	8	256	3/1	2
Sagittal	T1 SE	600/20	8	256	4/1	1

Imaging planes

- Axial sequence done first
- Radial styloid to ulnar styloid
- Parallel to volar surface of radius







Wrist Arthrography Indications

- Intercarpal ligaments
- Triangular fibrocartilage
- Scaphoid nonunion
- Soft tissue ganglia
- Wrist prosthesis

TFCC and LT ligament perforations

Wrist Arthrography Technique

- Controversy about which compartments and how many compartments need to be injected
- Most common single injection is radiocarpal

Lunotriquetral perforation

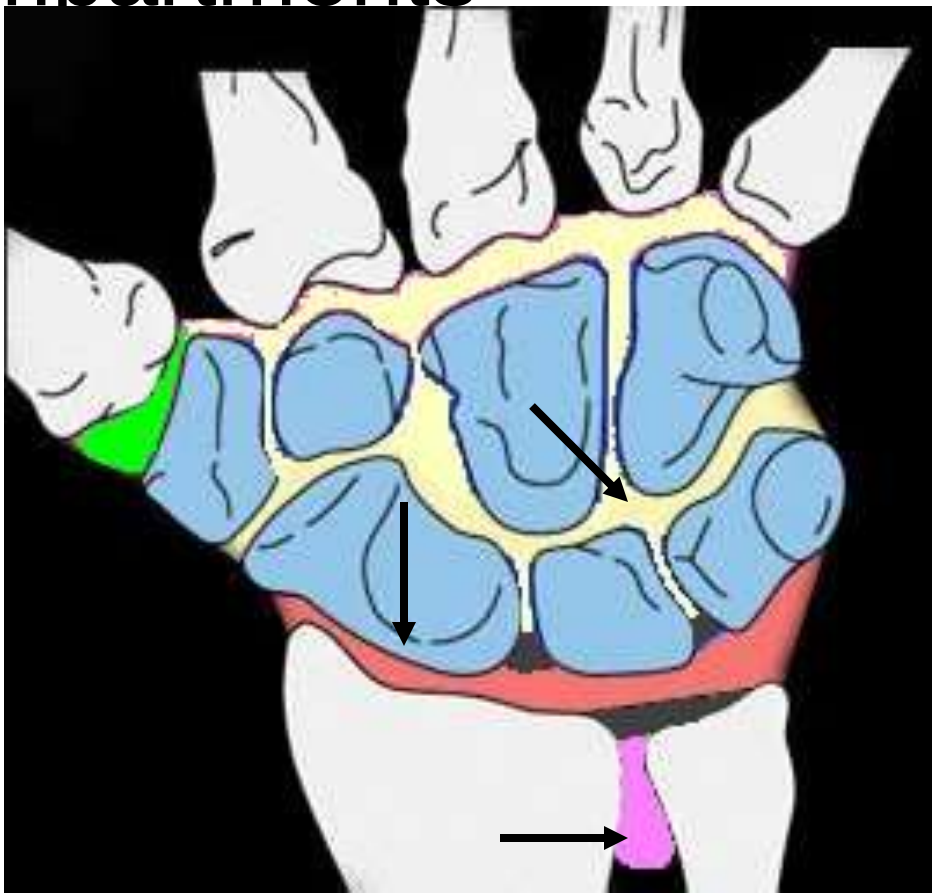
Wrist Arthrography
Arthrographic technique

- Radioscaphoid
- Always obtain plain film series
- DSA 1 frame/sec preferred

Lunotriquetral ligament perforation

Wrist Arthrography
Wrist compartments

- First carpometacarpal
- Midcarpal, which communicates with common carpometacarpal
- Radiocarpal
- Distal radioulnar



Target sites

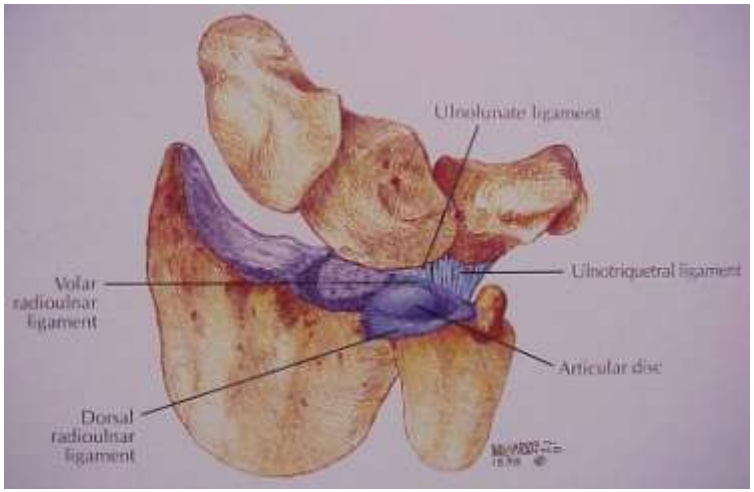
Wrist Arthrography
Which Joint ?

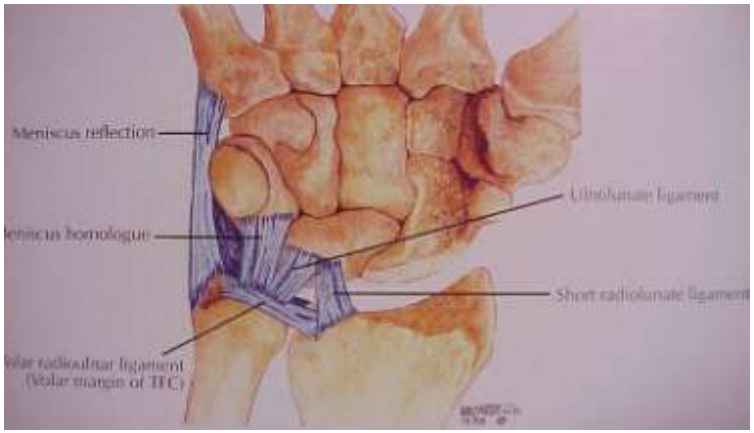
- R/O TFCC tear
  - Radiocarpal injection;
  - If negative, distal radioulnar joint
- R/O ligament tear
  - Midcarpal injection;
  - If negative, radiocarpal joint
- Second injection can be done digitally or following 2 hour delay

Normal midcarpal injection

TFCC

- Triangular fibrocartilage
  - Volar and dorsal distal radioulnar ligaments
- Ulnocarpal meniscus
  - Meniscus homologue
- Ulnocarpal ligaments
- Ulnar collateral ligament
- Sheath of ECU





TFCC - Perforation

- Conventional MR
  - Abnormal morphology
  - Defect in the TFCC
  - Fluid within the defect
  - Fluid in the inferior radioulnar joint (DRUJ)

Cor T2

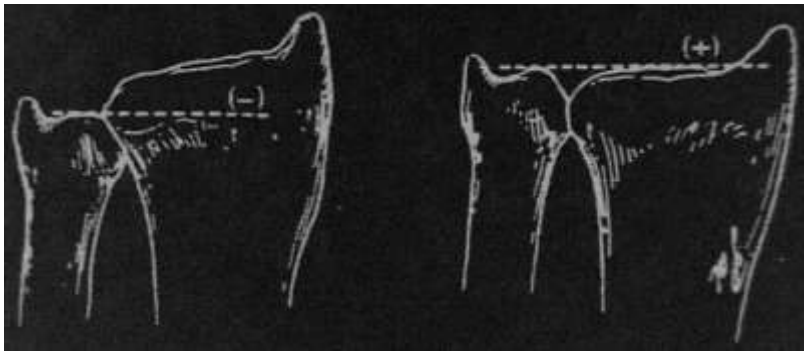
TFCC - Perforation

- Communication between the radiocarpal and the distal radioulnar joint

- MR arthrography will clearly show perforation, and help differentiate attrition from acute tear

Impaction syndromes

- Ulnar impaction (ulnar abutment)
- Ulnar styloid impaction syndrome
- Ulnar styloid nonunion
- Hamatolunate impaction
- (Ulnar impingement)



Cerezal et al, Radiographics 2002

Ulnar impaction

- Also known as ulnar abutment syndrome
- Seen with long ulna
- Cystic changes and sclerosis of distal ulna, lunate, triquetrum
- TFCC tear

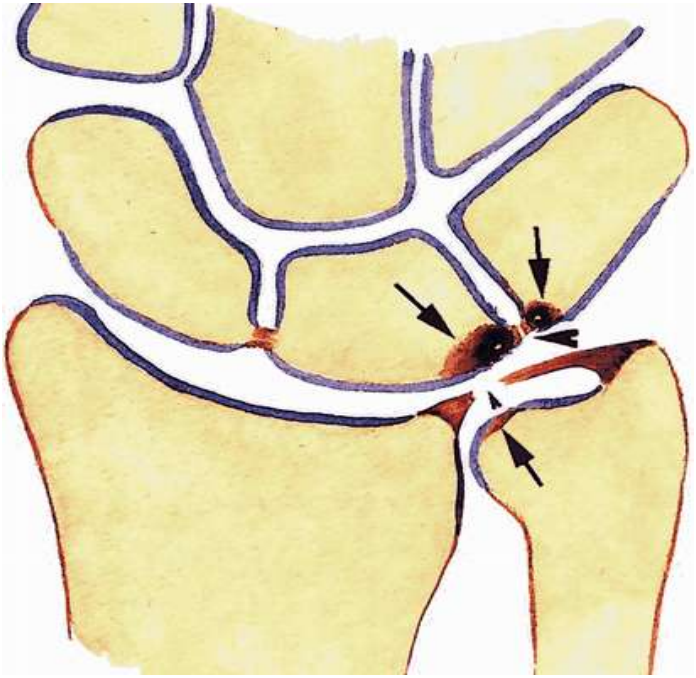
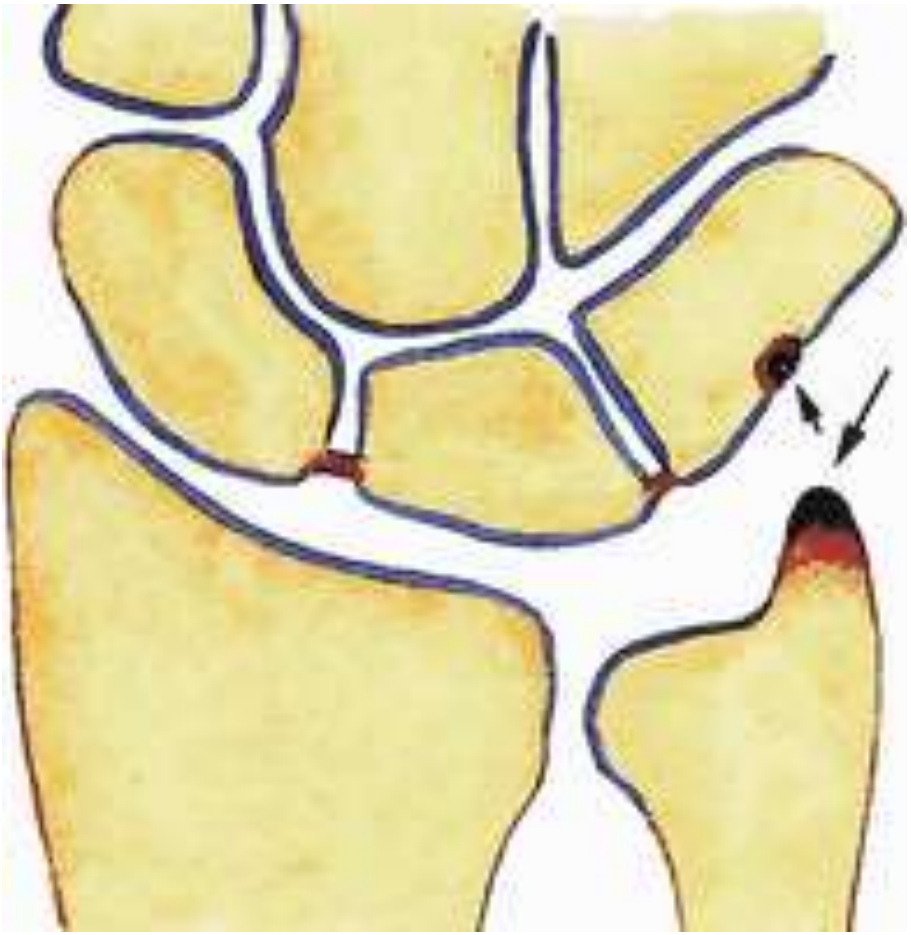


Illustration from Cerezal et al, Radiographics 2002

Ulnar Styloid Impaction Syndrome



- MR imaging may show chondromalacia of the ulnar styloid process, subchondral sclerosis of the styloid tip, and proximal triquetral bone.
- Tx: Resection of all but the most proximal 2 mm of the styloid process

Cerezal, et al. *Radiographics*.2002;22

Ulnar Styloid Impaction Syndrome

- Ulnar-sided wrist pain caused by impaction between an excessively long ulnar styloid process and the triquetrum.

- Ulnar styloid process greater than 6 mm in length

- Dx can be made based on radiographic findings and provocative clinical testing

Ulnar Styloid Nonunion Impaction

- Result of nonunion of ulnar styloid fracture
- Styloid fragment abuts triquetrum
- TFCC may be abnormal, depending on level of fracture

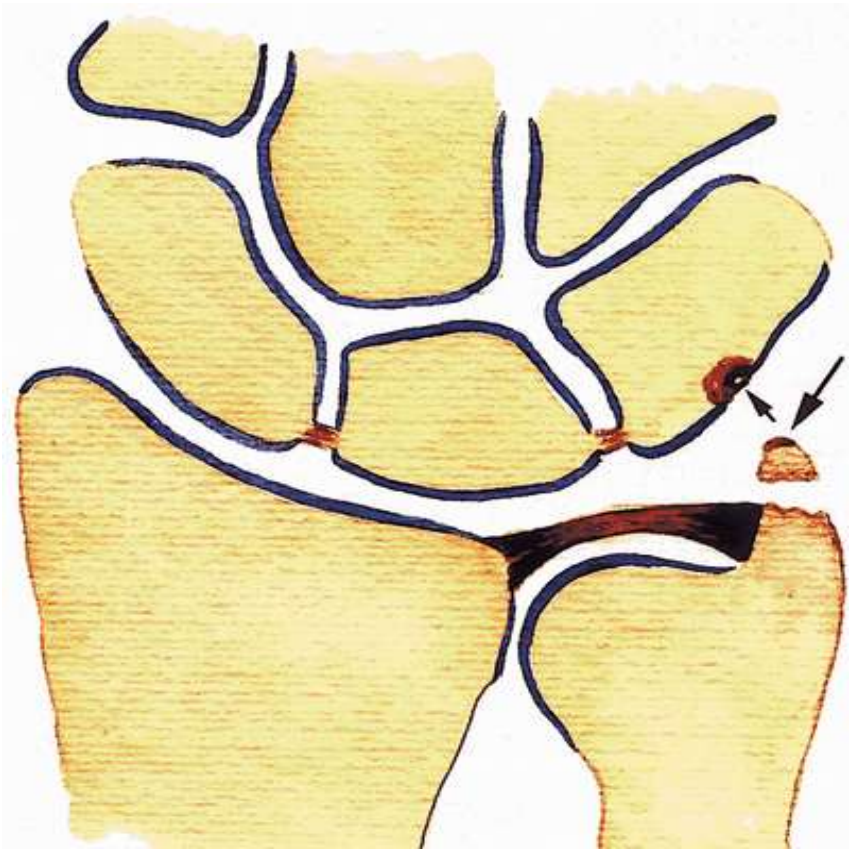
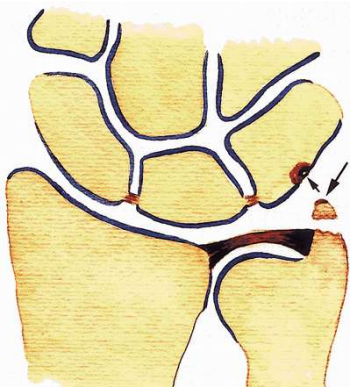


Illustration from Cerezal et al, Radiographics 2002

Hamatolunate Abutment

- Abnormal configuration of quadrilateral space



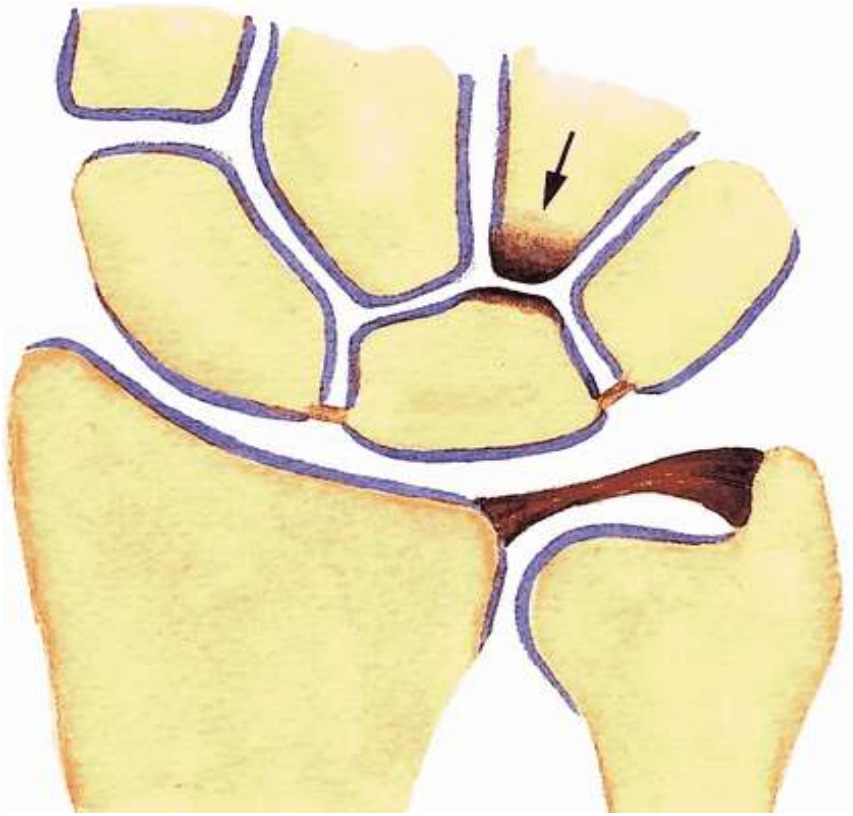


Illustration from Cerezal et al, Radiographics 2002

Hamatolunate Abutment

- 50% of lunate bones have a separate medial facet on the distal surface for articulation with the hamate bone
- Repeated impingement and abrasion in full ulnar deviation
- 25% cartilage erosion proximal pole of the hamate bone

Ulnar impingement

- Seen with short ulna
- Degenerative changes at proximal radioulnar joint

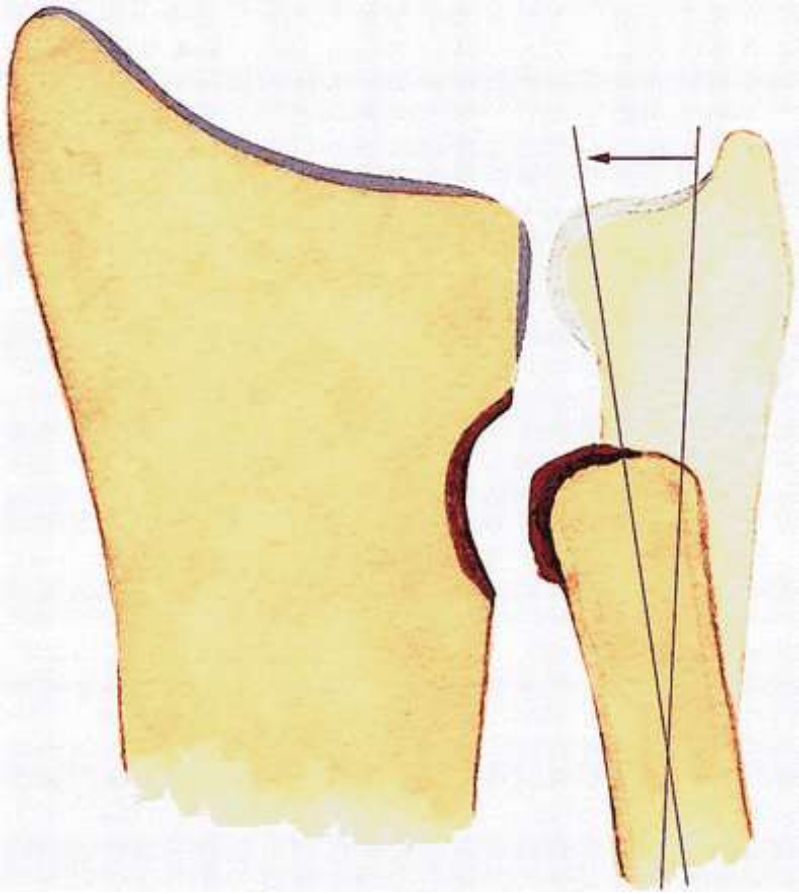


Illustration from Cerezal et al, Radiographics 2002

Extrinsic ligaments

- Dorsal
  - Radiolunatotriquetral
  - Ulnotriquetral

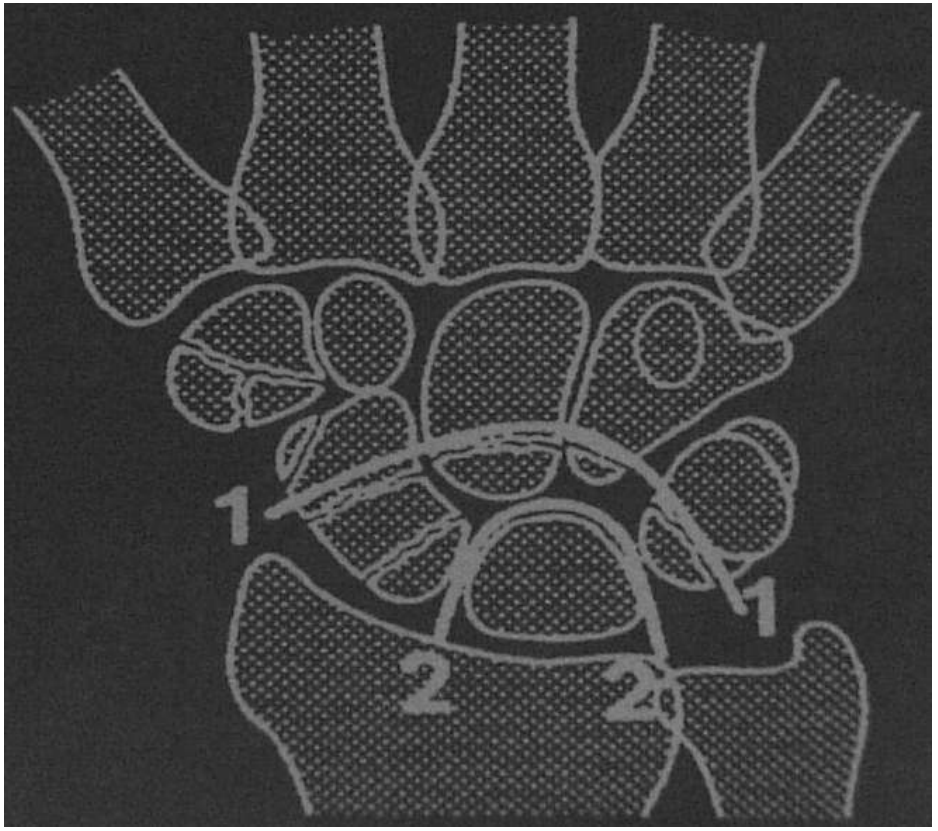
- Volar
  - Radioscaphocapitate
  - Radiolunotriquetral
  - Radioscapholunate

Intrinsic Intercarpal ligaments

- Scapholunate ligament
  - Perilunate injury
- Lunotriquetral ligament
  - Perilunate injury
  - Reverse perilunate injury
  - Ulnocarpal impaction

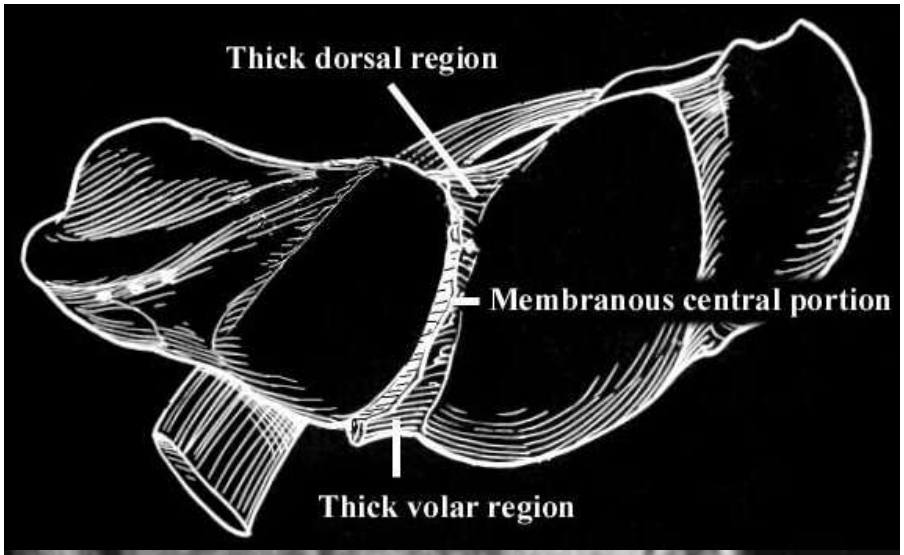
Greater and lesser arcs

- 1 Greater arc injury
- 2 Lesser arc injury
- Various combinations usually occur



Lunotriquetral ligament

- Small ligament between lunate and triquetrum
- Often difficult to visualize on MR imaging
- Accuracy of MR limited

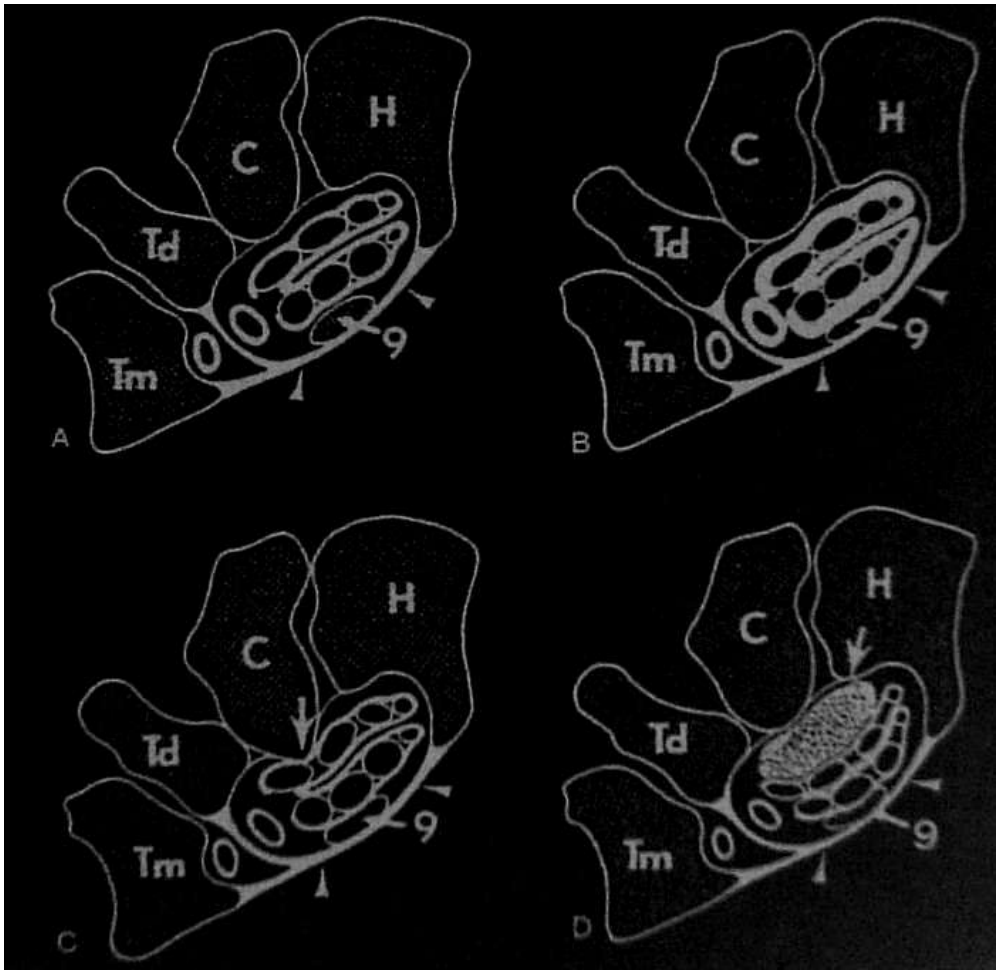


Carpal Tunnel Syndrome

- Clinical diagnosis: pain, paresthesia distribution of median nerve, Tinel's sign
- Nerve conduction abnormal
- MR findings:
  - Swelling median nerve at level of pisiform
  - Increased T2 signal in median nerve
  - Flattening median nerve at level of hamate
  - Palmar bowing flexor retinaculum
- Masses in carpal tunnel:
  - neuromas, ganglion cysts, lipomas, and hemangiomas.

Carpal Tunnel Syndrome

- Normal
- Tenosynovitis
- Osseous spur
- Mass



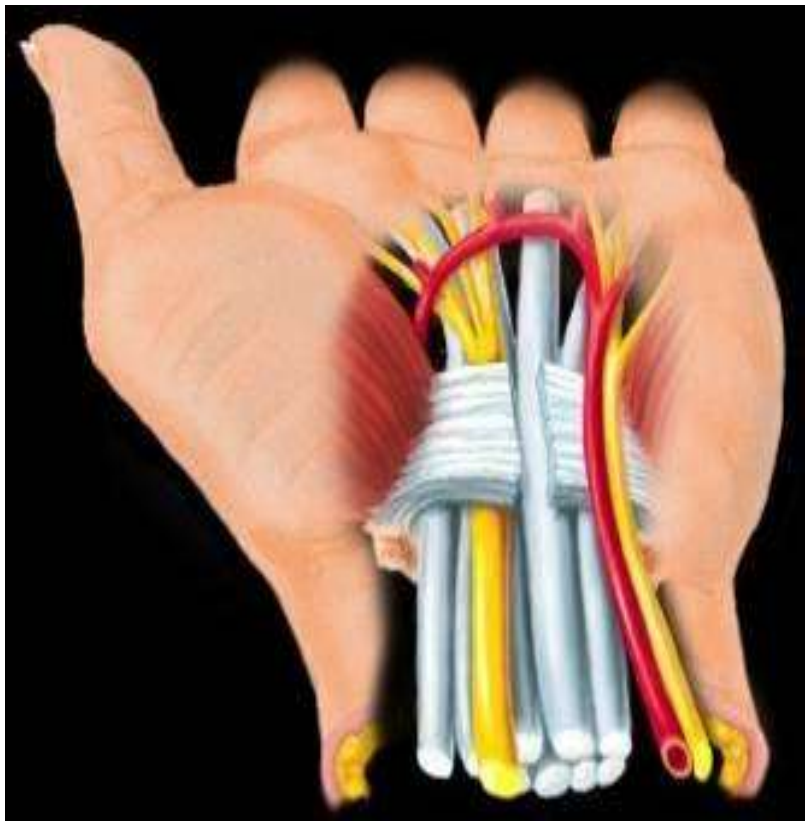
Robert Margulies

Bifid Median Nerve
Persistent Median Artery

- Anomalies of median nerve anatomy:
  - high divisions of the median nerve (bifid median nerve): incidence 2.8% in a dissection study of 246 hands
  - accessory branches proximal to the carpal tunnel
  - accessory branches in the distal carpal tunnel
  - variations in the course of the thenar branch

Carpal Tunnel Post Op MR

- Normal
  - widening of the fat stripe posterior to the flexor digitorum profundus tendons
- Failed Release
  - Incomplete release of the flexor retinaculum
  - Excessive fat within the carpal tunnel
  - Neuromas, scarring, and persistent neuritis



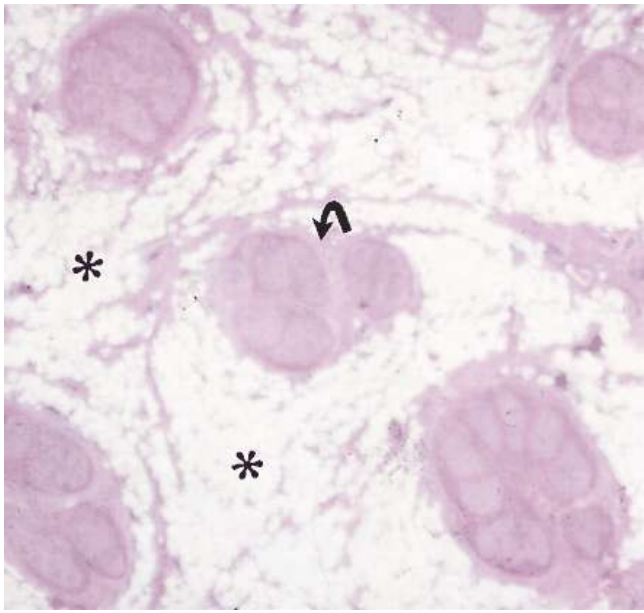
Fibrolipomatous Hamartoma

- Present as child or young adult
- Slowly enlarging palmar mass, CTS
- M=F
- UE 90%
- Median nerve 85%
- 50% macrodactyly
  - Macrodystrophia lipomatosa

Murphey MD, et al. "Imaging of Musculoskeletal Neurogenic Tumors: Radiologic-Pathologic Correlation." Radiographics 1999;19:1253-1280

Macrodystrophia lipomatosa

- 2^{nd}+3^{rd} digits hand or foot
- Diffuse increase in fibroadipose
- Osseous and ST overgrowth
- Growth ceases at puberty

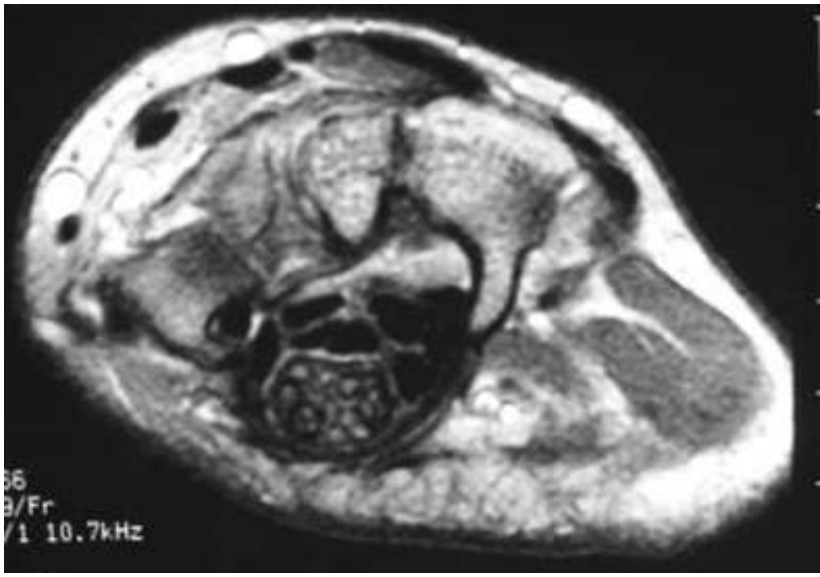


Murphey MD, et al. "Imaging of Musculoskeletal Neurogenic Tumors: Radiologic-Pathologic Correlation." Radiographics 1999;19:1253-1280

Fibrolipomatous Hamartoma

- Ultrasound
  - Cable like appearance

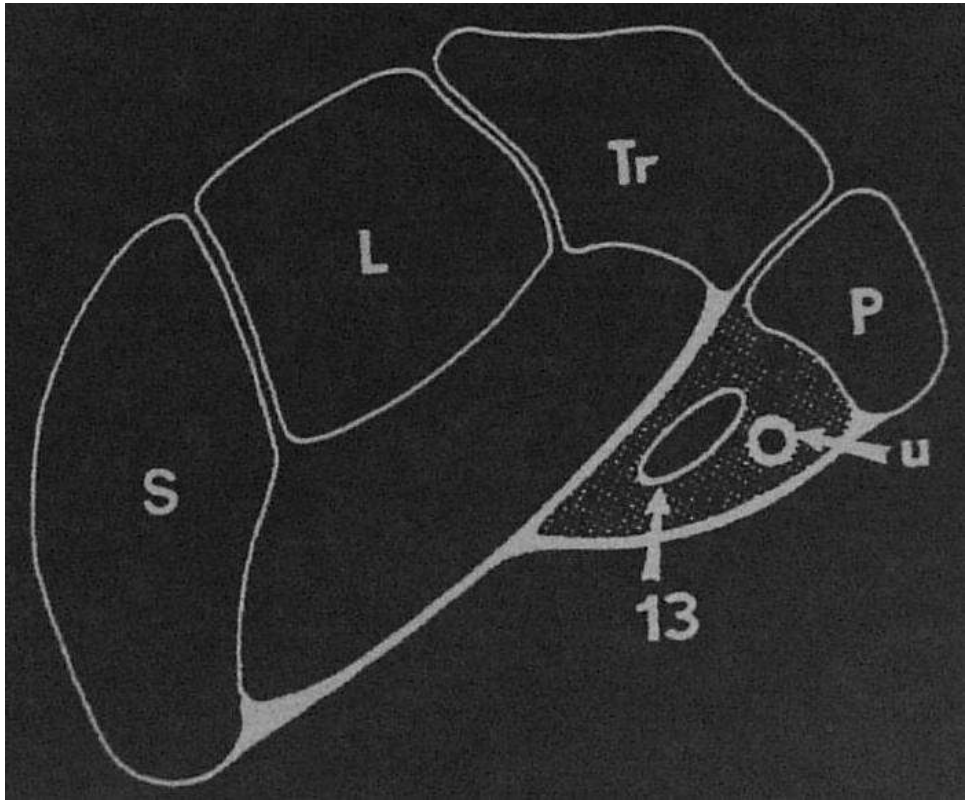
- MRI
  - Enlarged nerve
  - Low signal fascicles
  - Surrounding fat



Murphey MD, et al. "Imaging of Musculoskeletal Neurogenic Tumors: Radiologic-Pathologic Correlation." Radiographics 1999;19:1253-1280

Ulnar tunnel syndrome

- Occurs in Guyon's canal
- Masses
- Fractures
- Accessory muscle



Osseous lesions

- Occult fracture
- Known fracture
  - Healing
  - Complications
- Osteonecrosis

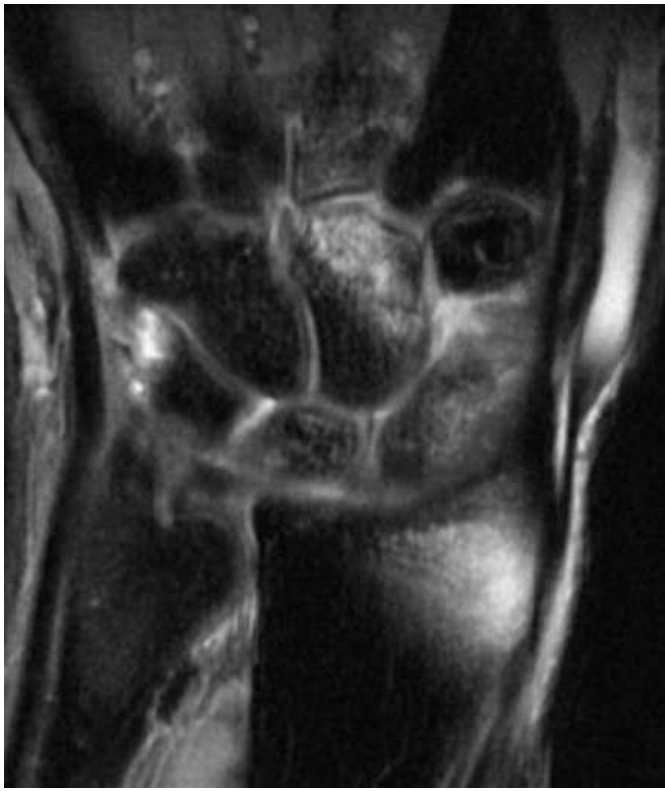
Occult distal radius Fx. Cor T2FS

Scaphoid nonunion

- Simple nonunion: undisplaced, no instability or osteoarthritis
- Unstable nonunion: displacement 1 mm or more
- Scaphoid nonunion advanced collapse (SNAC): radioscaphoid and midcarpal OA

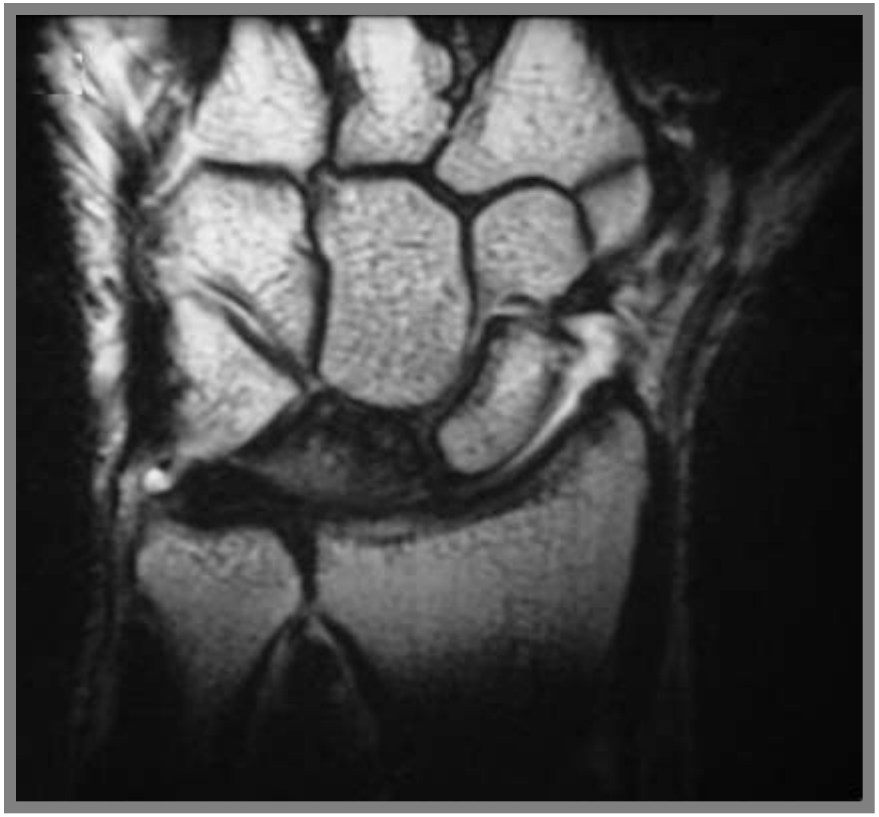
Isolated capitate fracture

- 0.3% of all carpal injuries
- Usually caused by hyperextension
- Usually associated with other carpal injuries such as a scaphoid fracture
- Isolated non-displaced waist fractures usually missed on plain films
- Can lead to posttraumatic arthritis, AVN or non-union



Osteonecrosis

- Lunate
  - Kienböck's
- Scaphoid
  - Proximal pole
- Hamate
  - Hook after Fx
- Capitate



Kienböck's disease

- Osteonecrosis of lunate
- Ages 20-40
- Fixed position and vulnerable blood supply of lunate
- May have history of trauma
- Ulna minus present in 75%

Kienböck's disease

- Diffuse or focal low on T1, variable on T2
- Specific when entire lunate abnormal, adjacent bones not affected, and ulna minus
- Joint effusion and adjacent synovial inflammation may be present
- Fragmentation in advanced disease

Carpal Boss/Carpe Bossu

- bony protuberance at dorsal wrist
- base of the second and third metacarpals
- adjacent to capitate and trapezoid
- osteophyte or an accessory ossicle (os styloideum)

Extensor digitorum brevis manus (EDBM)

- Located on dorsum of wrist, ulnar to the extensor indicis proprius
- The proximal belly of the EDBM lies distal to the extensor retinaculum and extends to the middle 2nd and 3rd metacarpals
- Muscle forms a fusiform mass on the dorsal wrist

Extensor digitorum brevis manus

- Incidence reported between 1% and 9%
- Pain caused by synovitis due to recurrent constriction of the hypertrophic belly by firm distal edge of flexor retinaculum
- Various classifications based on insertion of EDBM and relation to extensor indices propius

Inflammatory arthritis

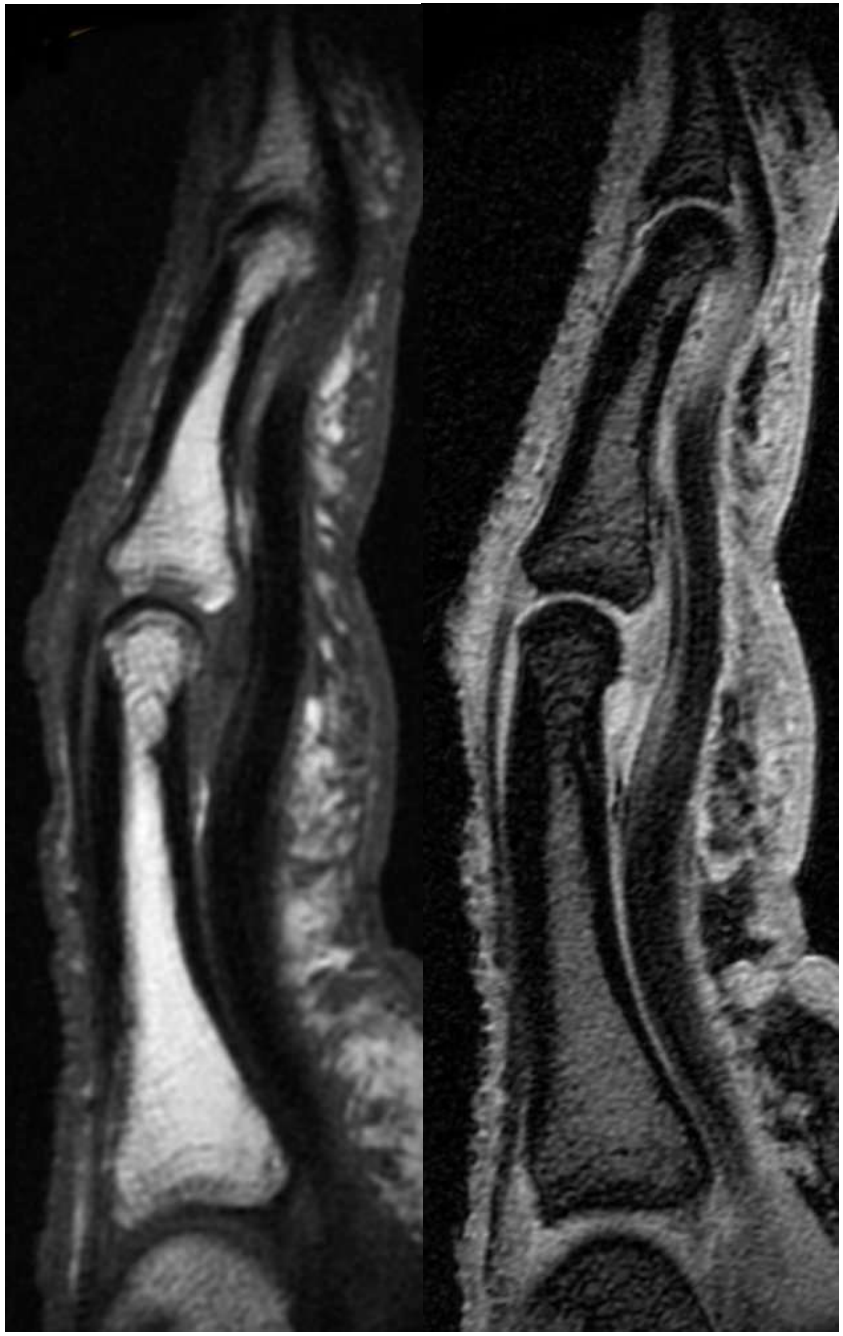
- Rheumatoid arthritis
- Seronegative spondyloarthropathy
- Crystal induced arthritis
- Inflammatory osteoarthritis
- Nonspecific synovitis

Gout

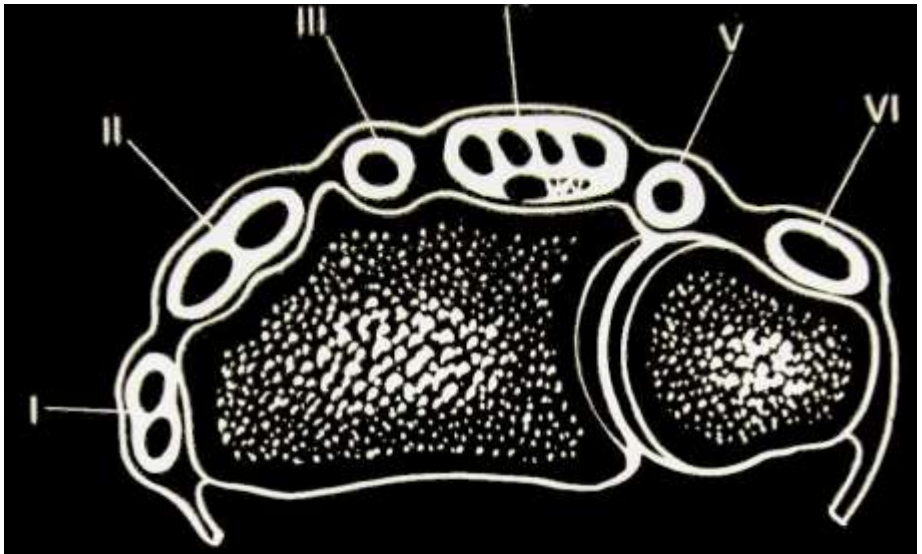
- It is recommended that MRI studies be done with gadolinium to evaluate any tendon sheath involvement and to evaluate for osteomyelitis in the differential.

Tendons

- Anatomy
- Tenosynovitis
- Degenerative disease
- Tendon injury
- “Trigger” finger



Extensor Tendon Compartments



I-Abductor pollicis longus
and extensor pollicis brevis

II-Extensor carpi radialis
longus and brevis

III-Extensor pollicis longus

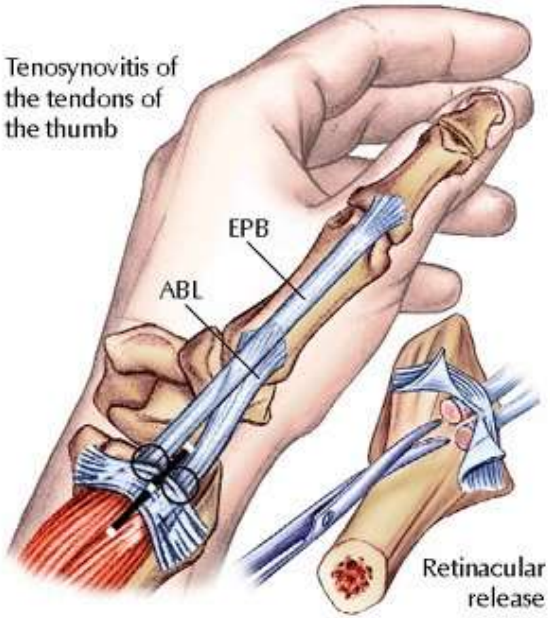
IV-Extensor digitorum communis
and extensor indicis

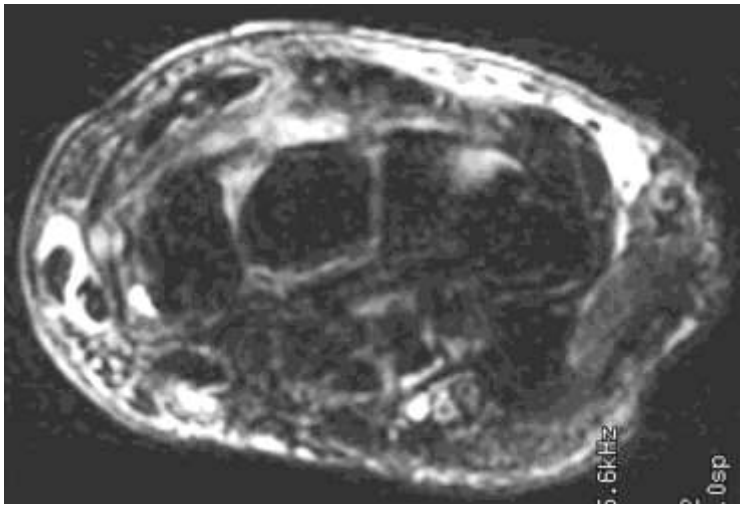
V-Extensor digiti minimi

VI-Extensor carpi ulnaris

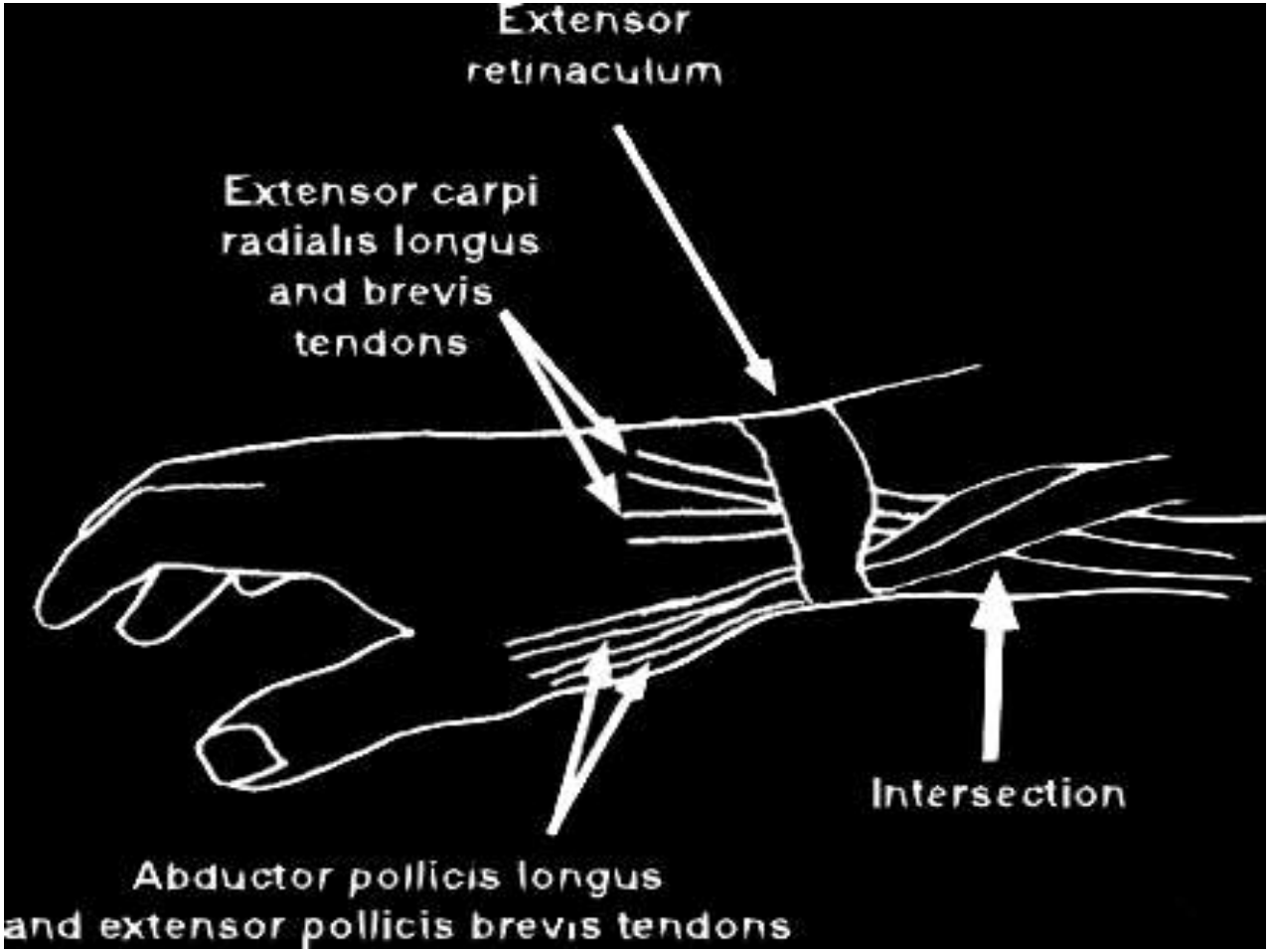
de Quervain’s tenosynovitis

- Tenosynovitis of first dorsal compartment (APL, EPB)
- Pain and swelling
- Finkelstein's test (pain when thumb is held and wrist deviated ulnarly)





Intersection Syndrome



Flexor tendon injuries

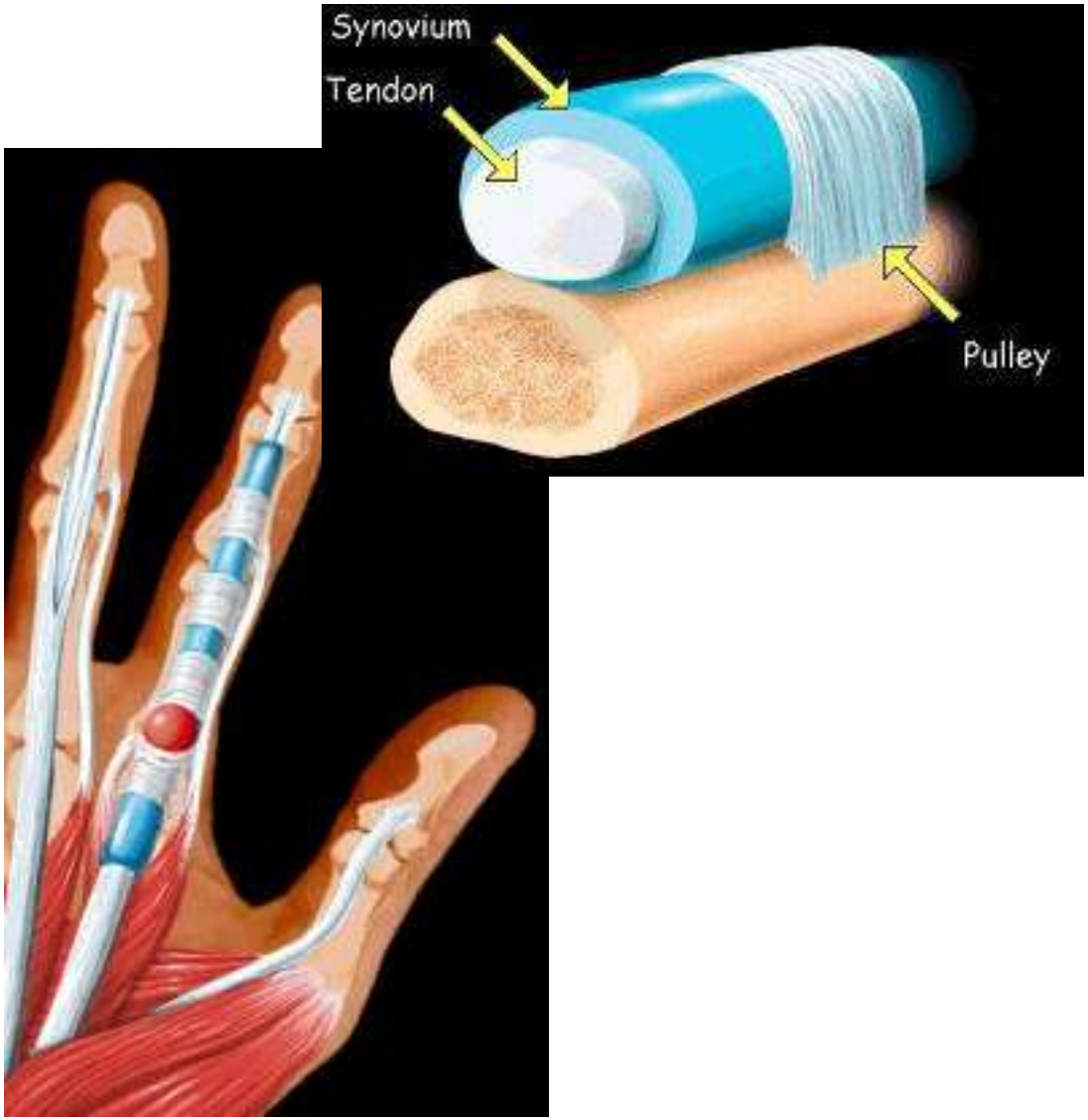
- Less common than extensor tendon injuries
- Closed vs open (more common)
- Closed: Sudden hyperextension during active flexion (aka “jersey finger”)

- Types:
  - I: Retraction of tendon into palm
  - II: Retraction of tendon to PIP
  - III: Bony avulsion
  - IV: III + avulsion of tendon from fracture fragment

- Rx: Primary repair for most

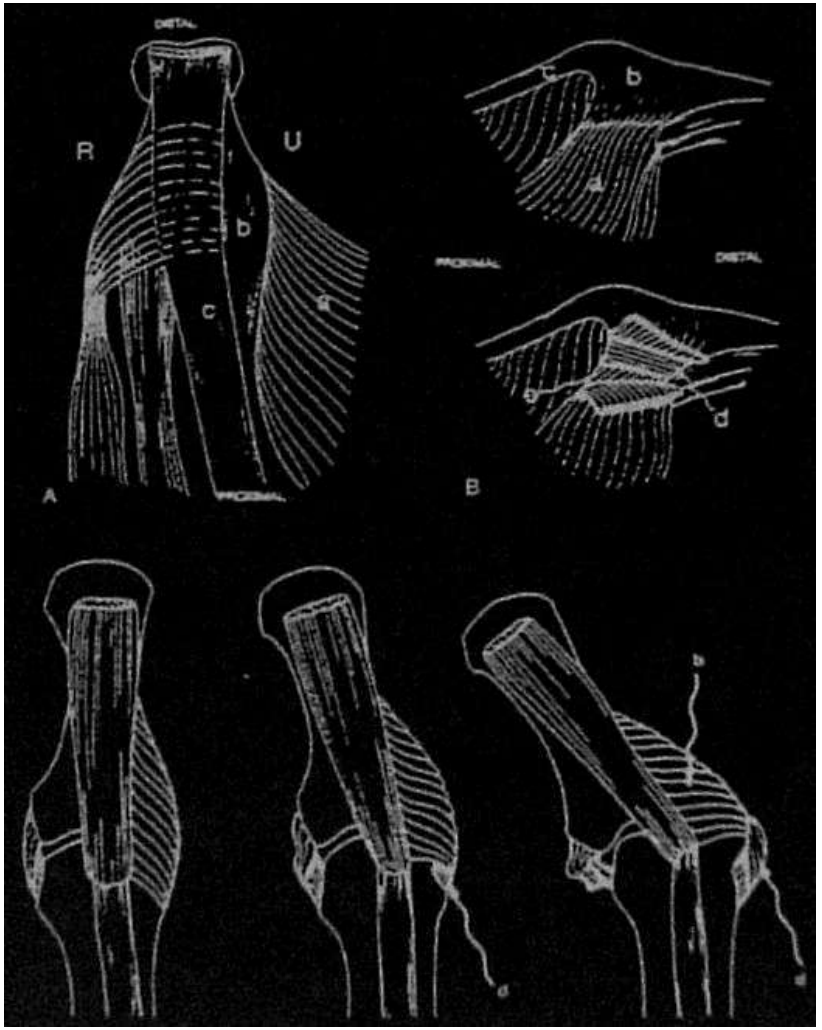
Trigger finger

- Nodule develops on flexor tendon
- Nodule becomes entrapped on the pulleys holding tendon in place
- Catching, followed by abrupt release



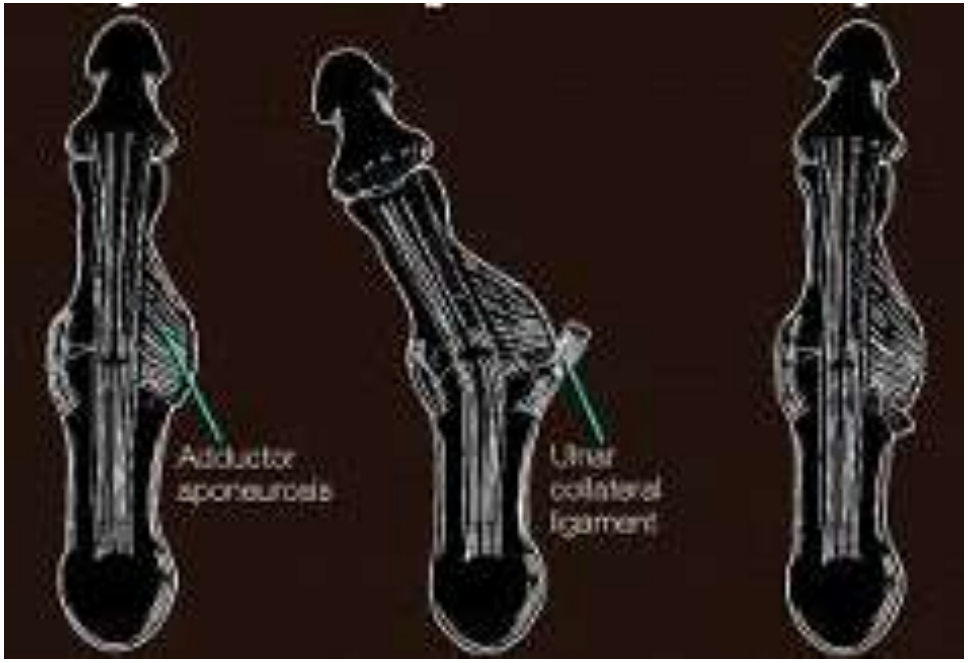
UCL and Stener's

- Bony avulsion or ligamentous injury
- Torn end superficial to adductor aponeurosis = Stener



Stener lesion

- Entrapment of adductor aponeurosis



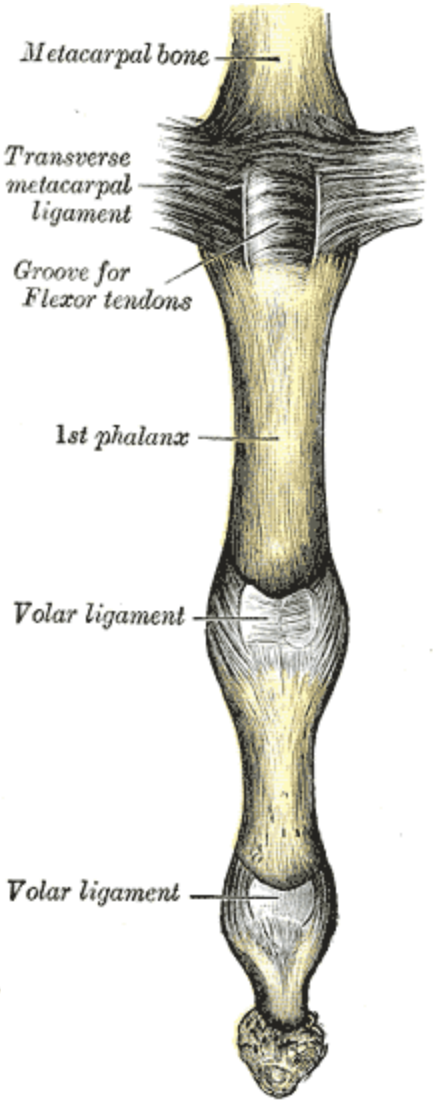
Gamekeeper's thumb

- Sudden valgus stress applied to the MCP joint of the thumb.
- Initially described as an occupational hazard in English game wardens.
- Now recognized in skiers…led to change in design of ski poles and also to the recommendation for skiers to discard their ski poles during a fall.
- Attenuation or disruption of the ligamentous apparatus of the thumb.
- Possible associated pain, swelling, tenderness, edema and pinch instability.

Diagnosis of Bone and Joint Disorders, 4th Ed. p2850

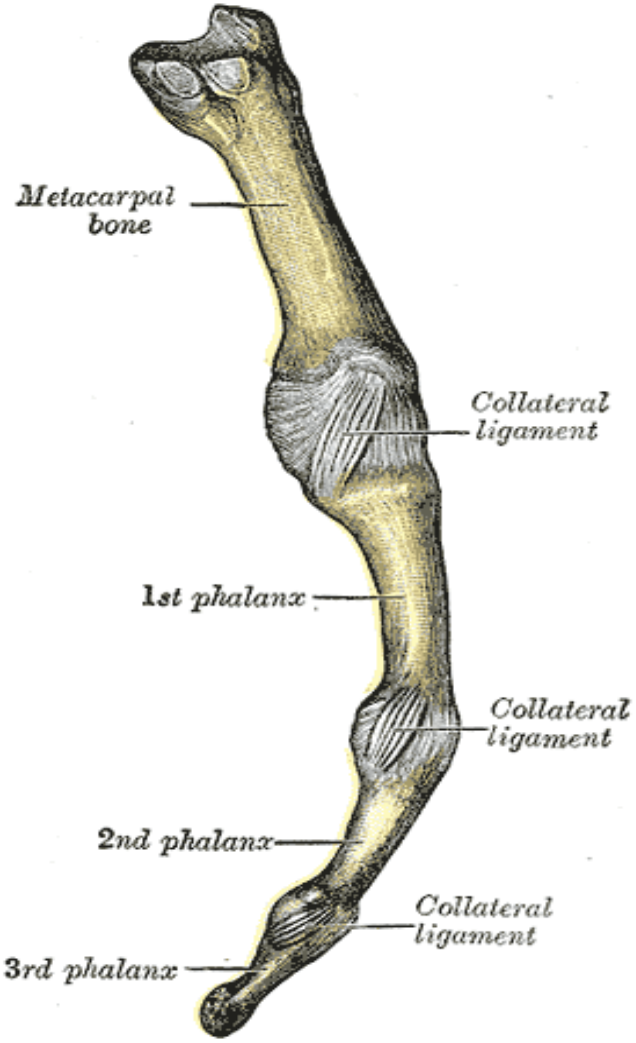
Volar Ligaments

- Thick fibrocartilaginous structures
- Placed between the collateral ligaments, to which they are connected
- Loosely united to the metacarpal bones BUT
- Very firmly attached to the bases proximal phalanges
- -volar surfaces blended with the transverse metacarpal ligament
- -grooves for the passage of the Flexor tendons
- -deep surfaces form parts of the articular facets for the heads of the metacarpal bones, and are lined by synovium



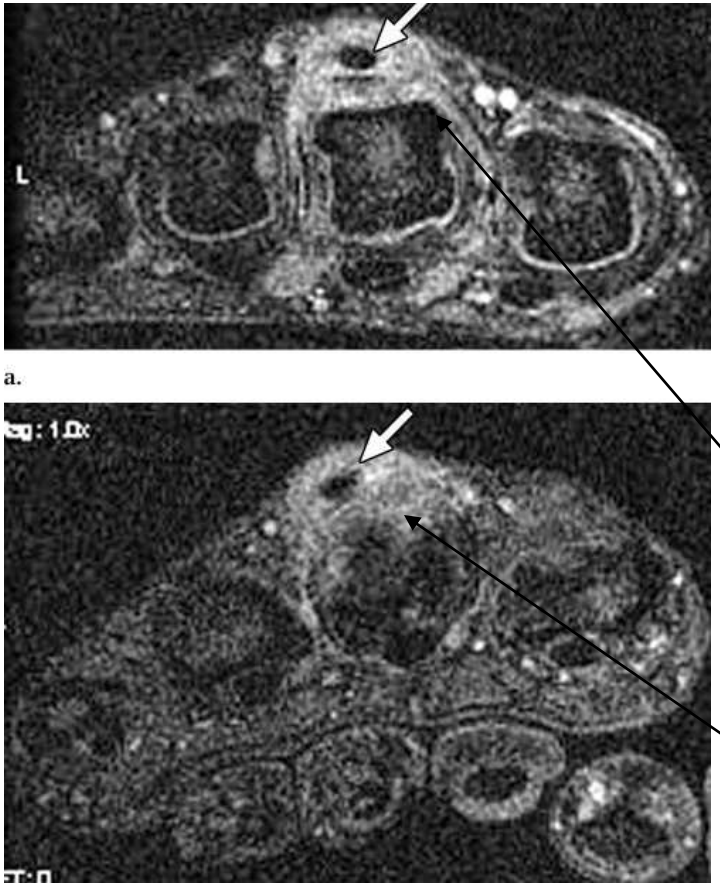
Collateral Ligaments

- - rounded cords, placed on the sides of the joints
- - attachments:
- posterior tubercle and adjacent depression on the side of the head of the metacarpal bone
- phalanx.



49 yo male 3rd right finger pain

Boxer's Knuckle



Damage to the sagittal bands of the extensor hood which help stabilize the extensor tendon during joint motion.

Sxs: pain, swelling, loss of full range of motion, subluxation of the extensor tendon

T2 Fat Sat with fingers extended

Subluxation of extensor tendon after clenching fist