MRI of the Wrist and Hand

Anna Blask MD

Imaging Technique

- **Supine Patient, arm by the side**
- **Dorsum of hand parallel to coronal plane of the magnet**
- **Alternative position, prone patient, arm above head, elbow flexed (superman position)**
  - Less comfortable
  - May be needed for large patient

Imaging Technique-Wrist

- Dedicated wrist coil
- Small FOV; 8-12cm
- Matrix at least 256 x 512
- Slice Thickness 1.5-3mm
- Include distal radius and ulna, carpal bones, bases of metacarpal bones

Technique-Hand

- Includes the wrist, metacarpals, most or all of fingers
- Same pulse sequences and planes as for wrist
- Enlarge FOV to 14cm

Technique-Finger

- **FOV-6-8cm**

Imaging Planes

- **Combination of all three imaging planes**
- **Begin with axial scout to obtain coronal image- most important plane, obtain first**
  - Must have thin slices 1-2mm
- **Sagittal should be the last sequence in the study**
- **3mm can be used in other imaging planes and for masses, fractures**

Imaging Sequences

- **Routine / pain-T1, FSE T2FS, 3D GRE**
- **Mass or Infection-T1, STIR, FSE T2FS , T1 FS Post Gd**
- **Wrist trauma- T1, FSE T2 FS, Coronal Plane only**
- **Gamekeeper's Thumb-T1, GRE, Coronal Plane only**

Intravenous Contrast

- Mass-cystic versus solid
- Infection-abscess formation
- Wrist synovitis (ie. arthritis evaluation)
- Evaluate vascularity of scaphoid or lunate / AVN
- Indirect arthrography versus no IV contrast
- Helms / Major-Do not use contrast for routine evaluation (pain)

Indirect MR Arthrography versus Unenhanced MR Imaging

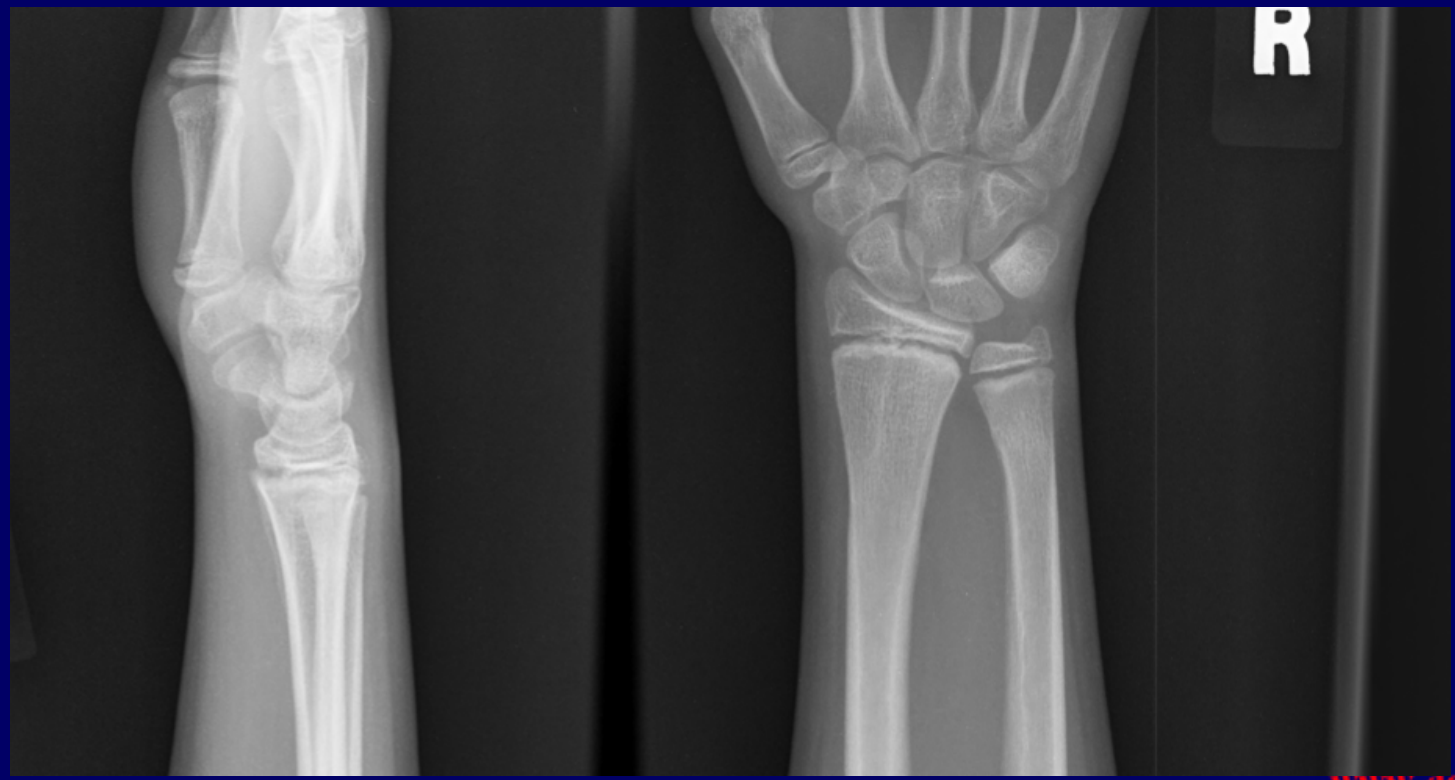
- Haims AH, Schweitzer ME; 227:701-707, Radiology 2003
- 41 wrists indirect, 45 wrists unenhanced, compared results with wrist arthroscopy
- Evaluated central disc of TFCC and scapholunate and lunotriquetral ligaments for tear
- No improvement with indirect with TFCC and lunotriquetral ligaments
- Indirect improves sensitivity for scapholunate ligament
- Do not recommend indirect arthrography for routine use

Direct MR Arthrography

- Ruegger CH, et. Al. AJR 2007, 188:187-192
- Central tears of TFC easily seen on imaging
- Peripheral tears of the ulnar attachment are frequently missed – this study looked for peripheral tears
- Compared MR arthrogram and conventional arthrogram / with arthroscopy as the gold standard
- Assessed for communicating and noncommunicating tears-injection directly into distal radioulnar joint (also second injection midcarpal row if contrast did not enter radiocarpal joint)
- 85% sensitivity-all of these patients were adults

Basic Bone Anatomy-Review

- scaphoid, lunate, triquetrum, pisiform
- trapezium, trapezoid, capitate, hamate



Wrist Anatomy-Ligaments

- **Intrinsic ligaments**
  - Connect carpal bones to one another
  - Limits their motion
- **Extrinsic ligaments**
  - Connect bones of forearm to the wrist

Intrinsic Ligaments-Wrist

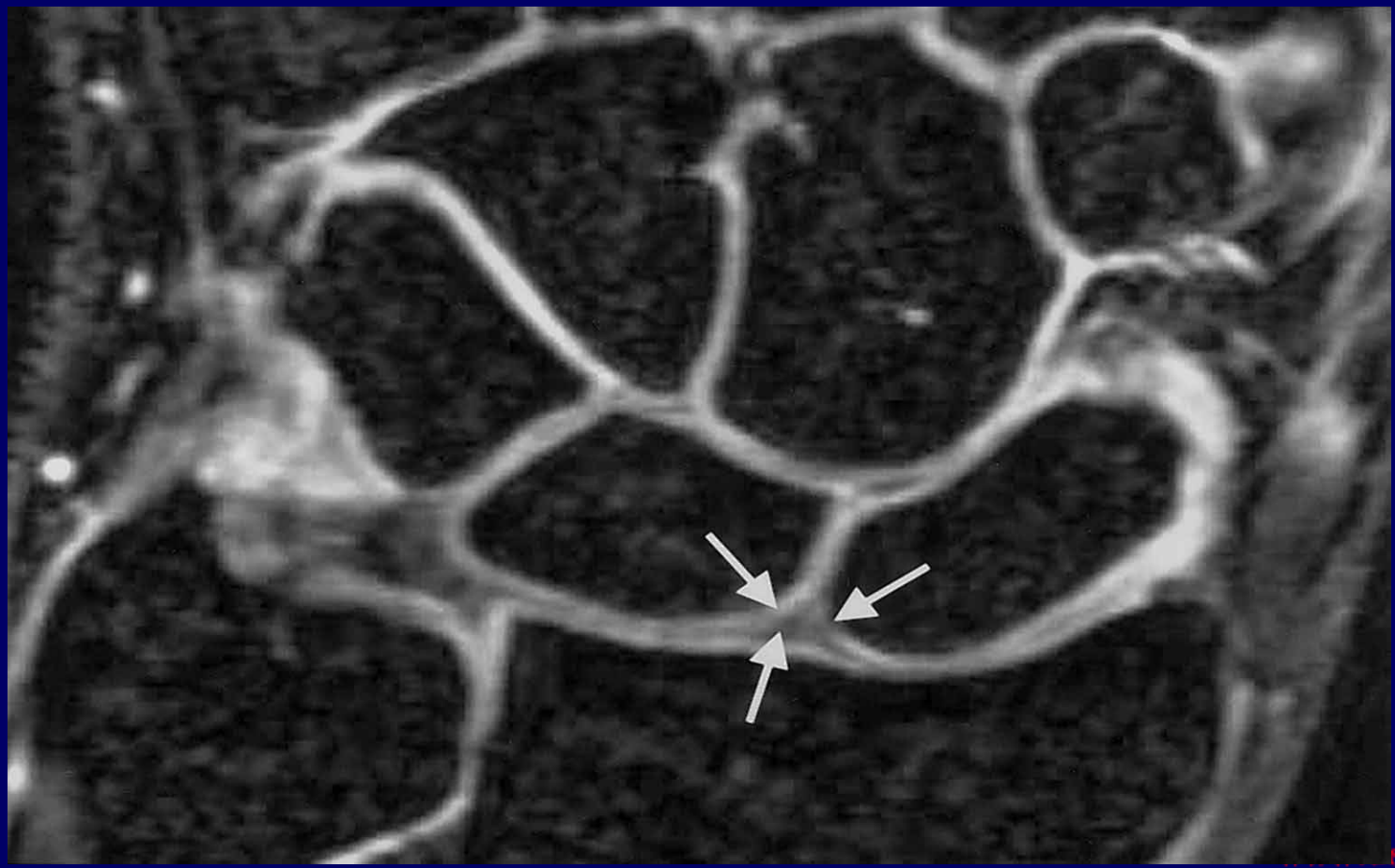
- **Two major ligaments**
  - Scapholunate ligament
  - Lunotriquetral ligament
- **Disruption may cause instability, pain**
- **Coronal, GE, thin sections**

Sensitivity of MRI Detection

- **Wide variability of reported sensitivities**
- **Haims, et. al. 3 readers /in the lower range of published series**
  - Scapholunate-38%-69% (average is 56%)
    - 41% unenhanced, 92% indirect
  - Lunotriquetral-0%-22% (average is 7%)
    - 4% unenhanced, 11% indirect

Scapholunate Ligament (3D GRE indirect arthrogram) [Normal]

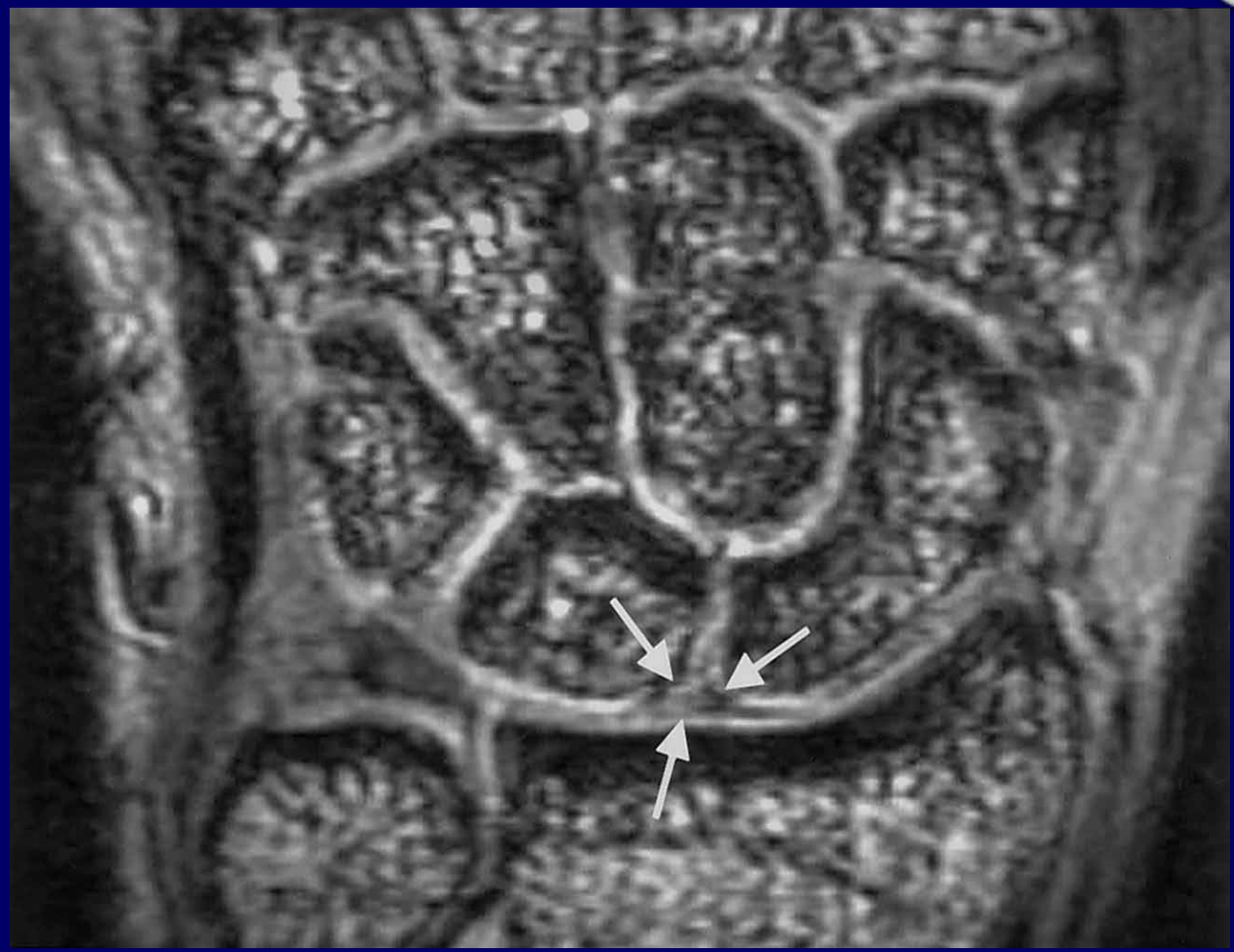
- Trapezoid, TRIANGLE or band shape



Scapholunate Ligament

- **Volar-trapezoid**
  - Intermediate signal/heterogeneous
- **Middle-triangular**
  - Slightly lower signal/heterogeneous
- **Dorsal-Band**
  - Low signal/homogeneous

Scapholunate Ligament (no Gd, 3D GRE) [normal]

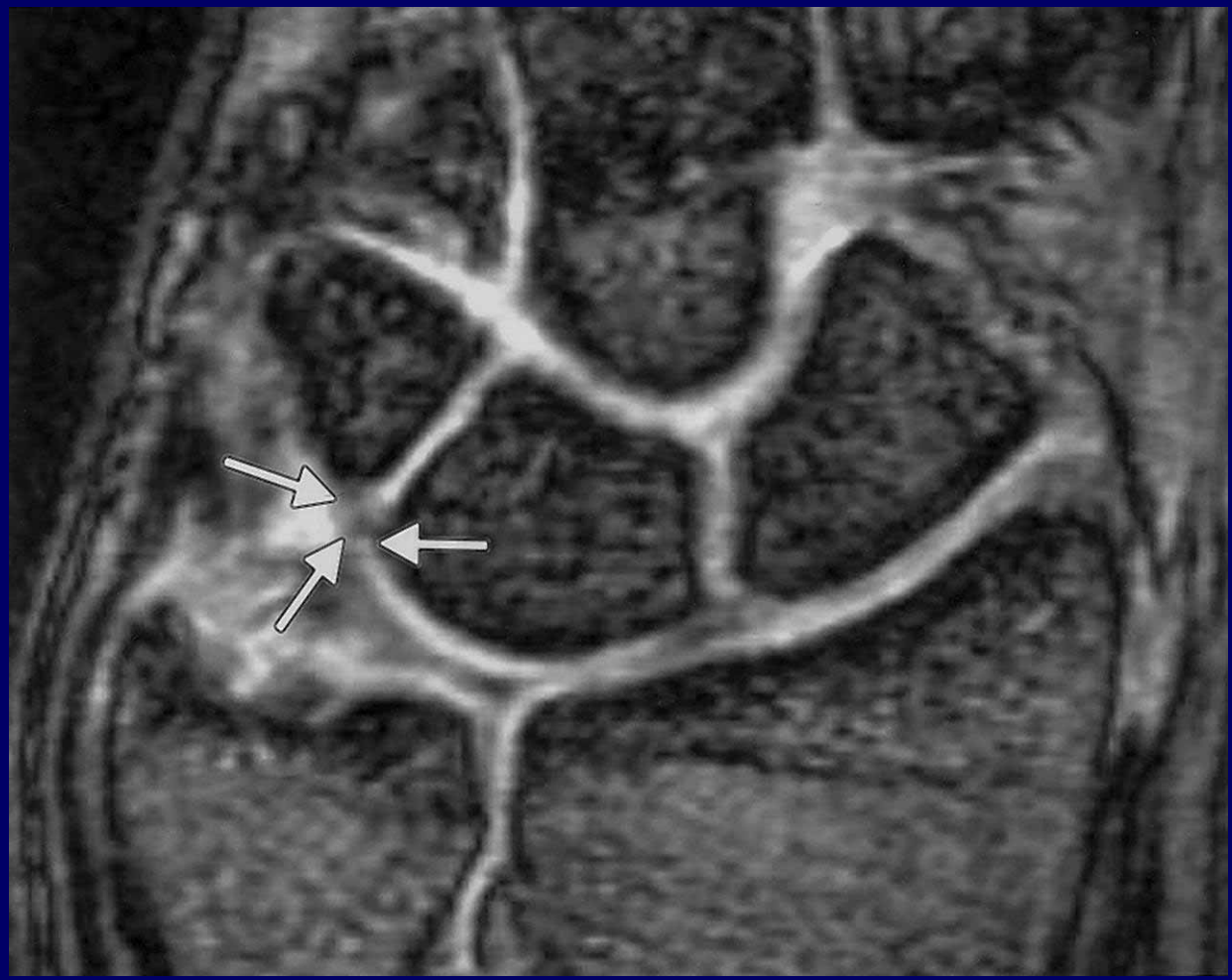


Lunotriquetral Ligament

- Slightly smaller than scapholunate
- Triangular
- Heterogeneous low signal

Lunotriquetral Ligament (3D GE indirect arthrogram) [normal]

Lunotriquetral Ligament (no Gd, 3D GRE) [normal]



Normal Signal of Intrinsic Ligaments

- Intermediate signal intensity partially or completely traversing the substance of the ligament
- Only if signal as bright as fluid on T2 sequence is it abnormal

Scapholunate Ligament Tear

- **Discontinuity**
  - With or without increased scapholunate space
- **Complete absence**
- **Distorted morphology-fraying, thinning, irregularity**
- **Elongation / stretching of intact ligament with increased intercarpal space**

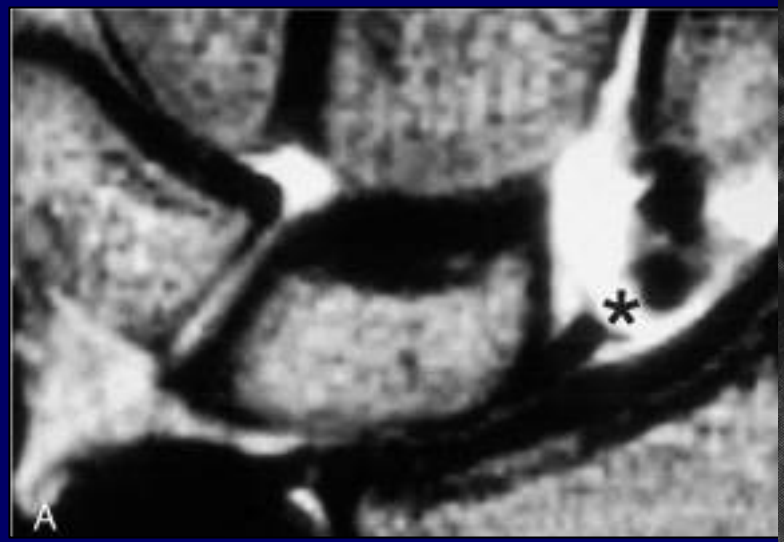
Scapholunate LigamentTear-GE, no Gd

Scapholunate Ligament Tear (indirect / T1FS)

Scapholunate CompleteTear or Stretch (DISI)

- Dorsal Intercalated Segmental Instability
- Scaphoid and lunate bones dissociate
- Lunate tilts dorsal
- Scaphoid tilts volar-rotary subluxation
- T1 sagittal image
- Can occur with unstable scaphoid fx. and intact ligament

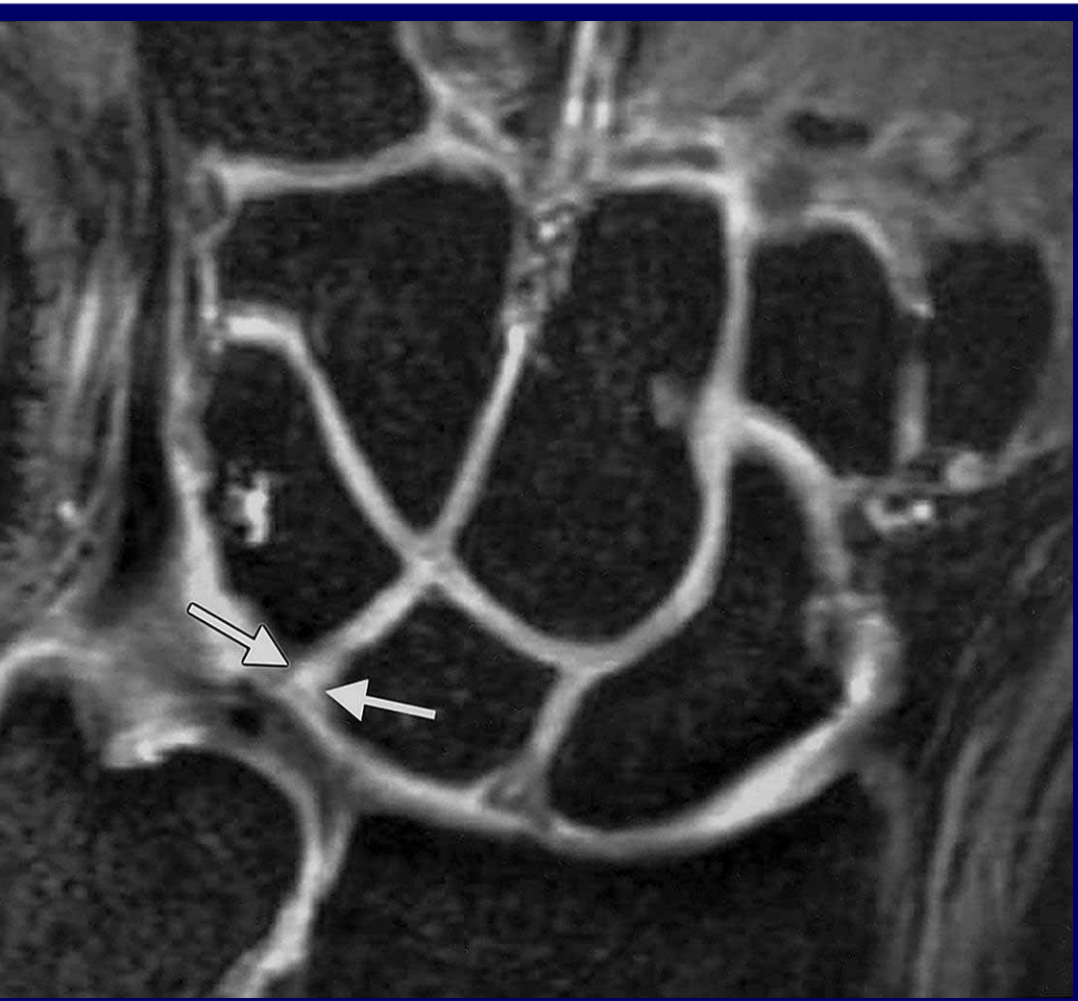
Scaphoid Lunate Separation with Ligament tear-DISI

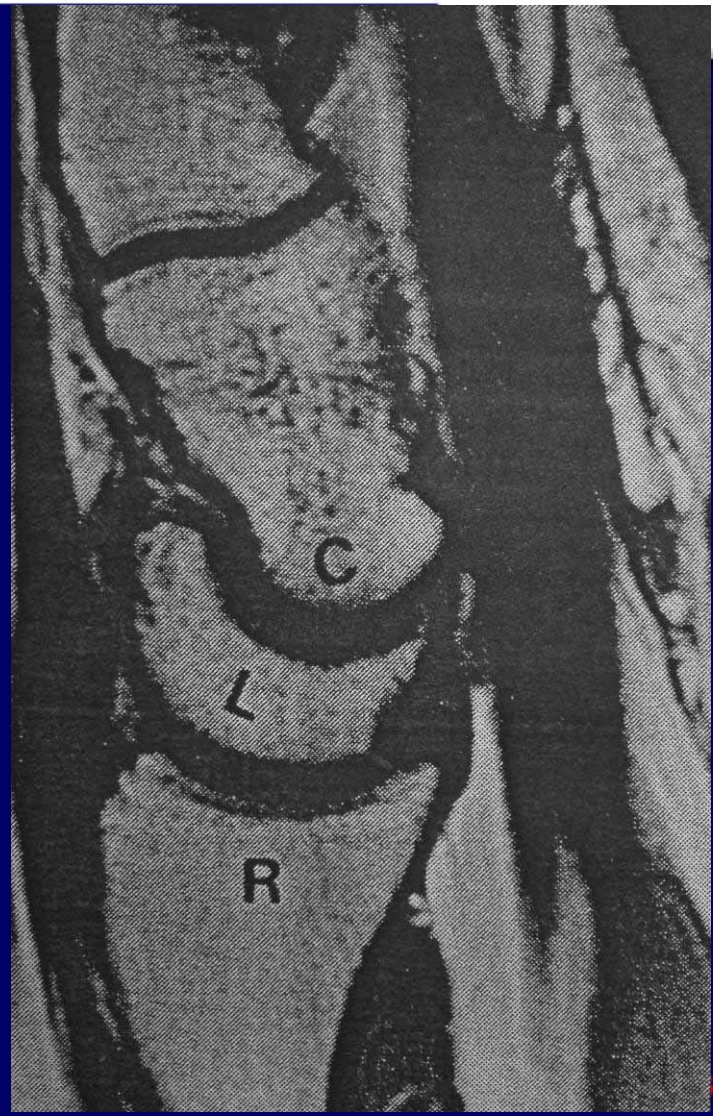


Lunotriquetral Ligament Tear

- **Harder to diagnose-smaller size**
- **Same Features**
- **Strongly associated with tears of TFC (70% of TFC tear have lunotriquetral lig. tear)**
- **VISI**
  - volar intercalated segmental instability
  - Lunate tilted volar relative to capitate and radius
  - Dorsal extrinsic ligaments are also injured

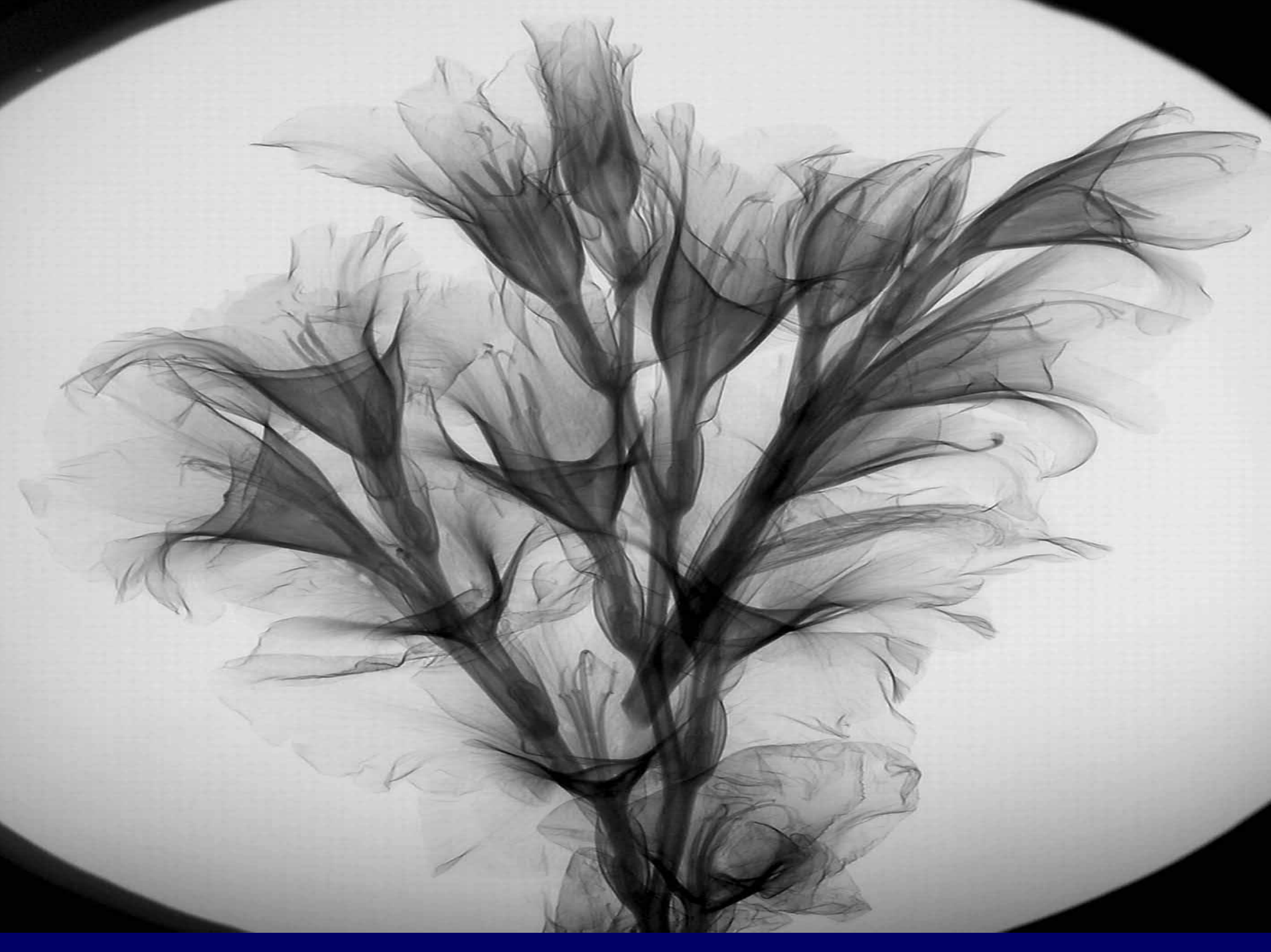
Lunotriquetral Tear (indirect arthrogram,3DGRE) VISI





CARPAL INSTABILITY

- **Malalignment of the carpal bones**
- **Three major causes**
  - Unstable fracture of the scaphoid (DISI)
  - Scapholunate dissociation (DISI)
  - Lunotriquetral dissociaton (VISI)



Extrinsic Ligaments

- Best seen on coronal GE images / seen in cross section on sagittal images
- Course between the carpal bones and the radius on both the volar and dorsal sides of the wrist
- Run obliquely-need several images to see one ligament
- Volar are stronger and thicker than dorsal ligaments

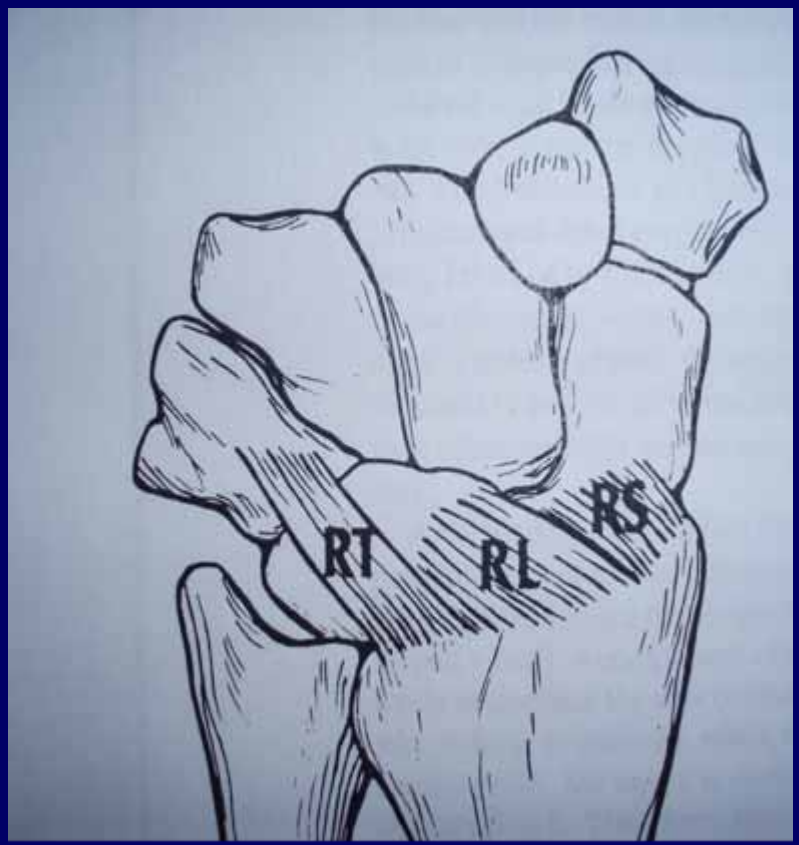
Extrinsic Ligaments

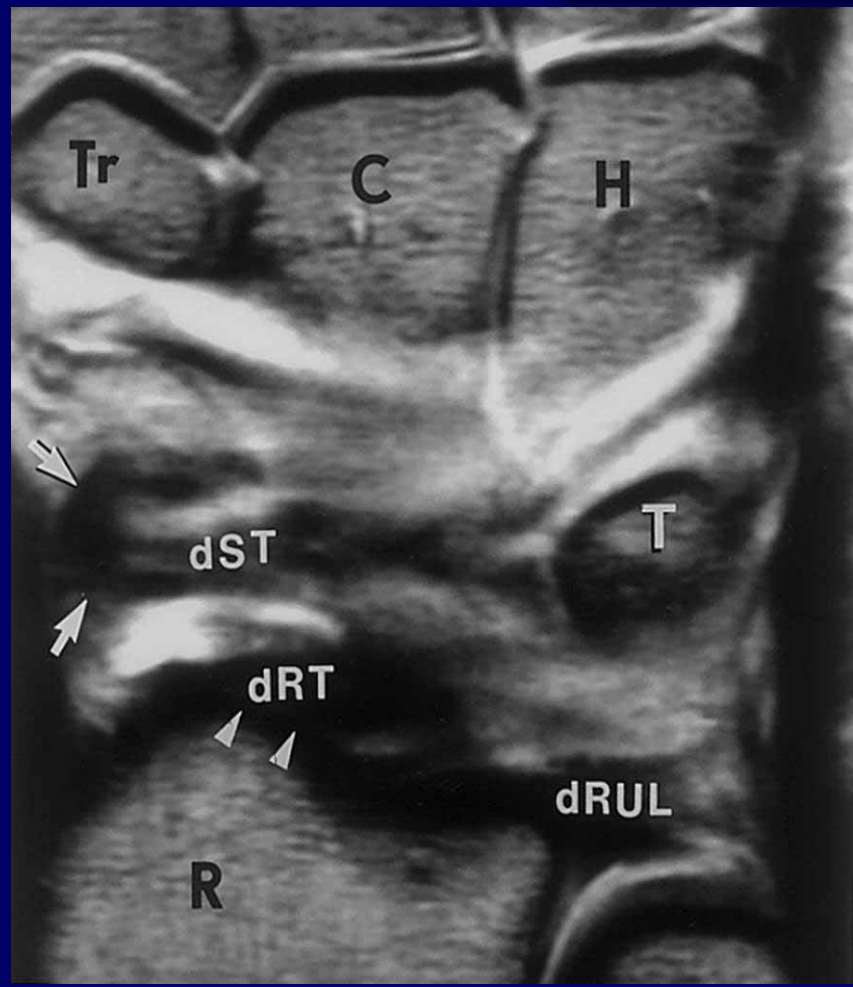
- Just outside the synovial lining of the joint but inside the capsule (extrasynovial, intracapsular)
- Striated structures with alternating bands of low and intermediate signal
- Just know there are there so they don't confuse you-do not have to analyze them

Dorsal Extrinsic Ligaments

- **Dorsal Radiocarpal Ligaments**
  - Run obliquely between the distal radius and to each of the carpal bones of the proximal carpal row
  - Radioscaphoid, radiolunate, radiotriquetral ligaments
- **Stability to wrist motion**
- **Fall on outstretched wrist-dorsal wrist sprain**
- **Better seen on MR arthrography**

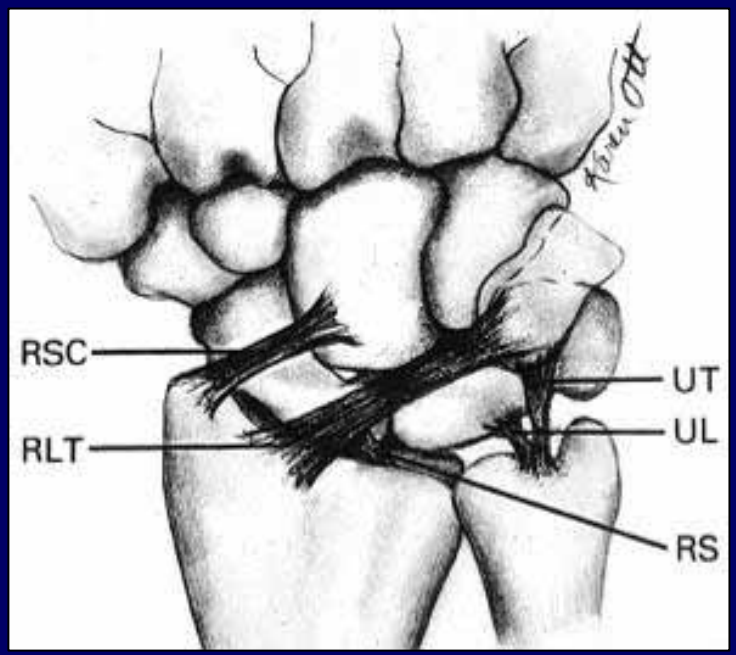
Dorsal Extrinsic Ligaments





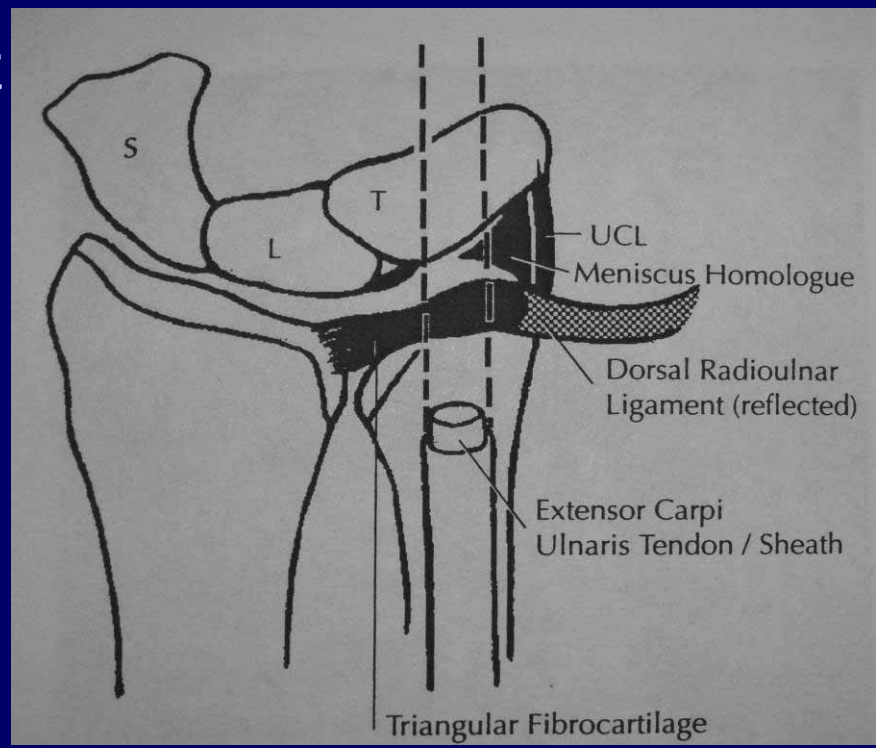
Volar Extrinsic Ligaments

- **Volar Radiocarpal Ligaments**
  - Radioscaphocapitate (RSC)-radius to the distal carpal row
  - Radiolunatetriquetral (RLT)-radius to the proximal carpal row

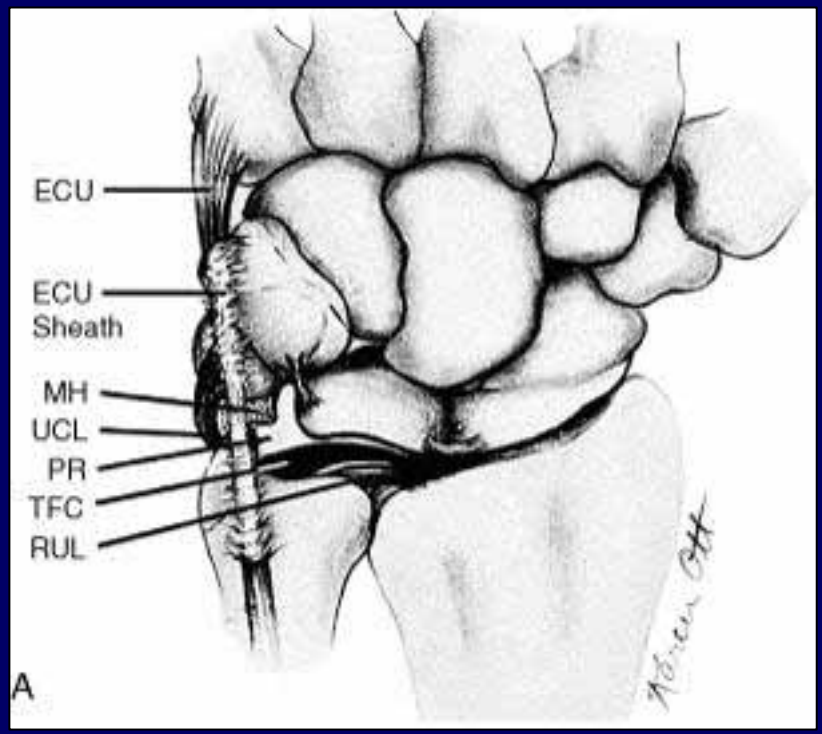


Triangular Fibrocartilage Complex (TFCC-ulnar side of wrist)

- Triangular Fibrocartilage (TFC)
- Radioulnar Ligaments (dorsal and volar)
- Extensor carpi ulnaris (ECU) tendon sheath
- Ulnar Collateral Ligament
- Meniscus Homologue

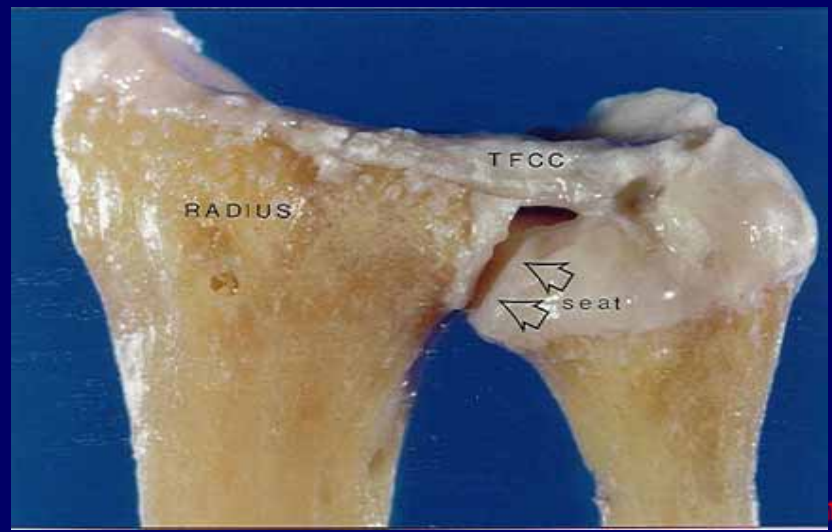


TFCC



Normal TFC

- **Biconcave disc with an asymmetric bow tie shape**
- **In ulnar carpal space**
- **Attaches to hyaline cartilage on the radius**
- **Ulnar attachment is two thin bands of tissue**
- **Diffusely low signal**
  - all sequences
- **Intermediate signal**
  - asymp. myxoid degeneration

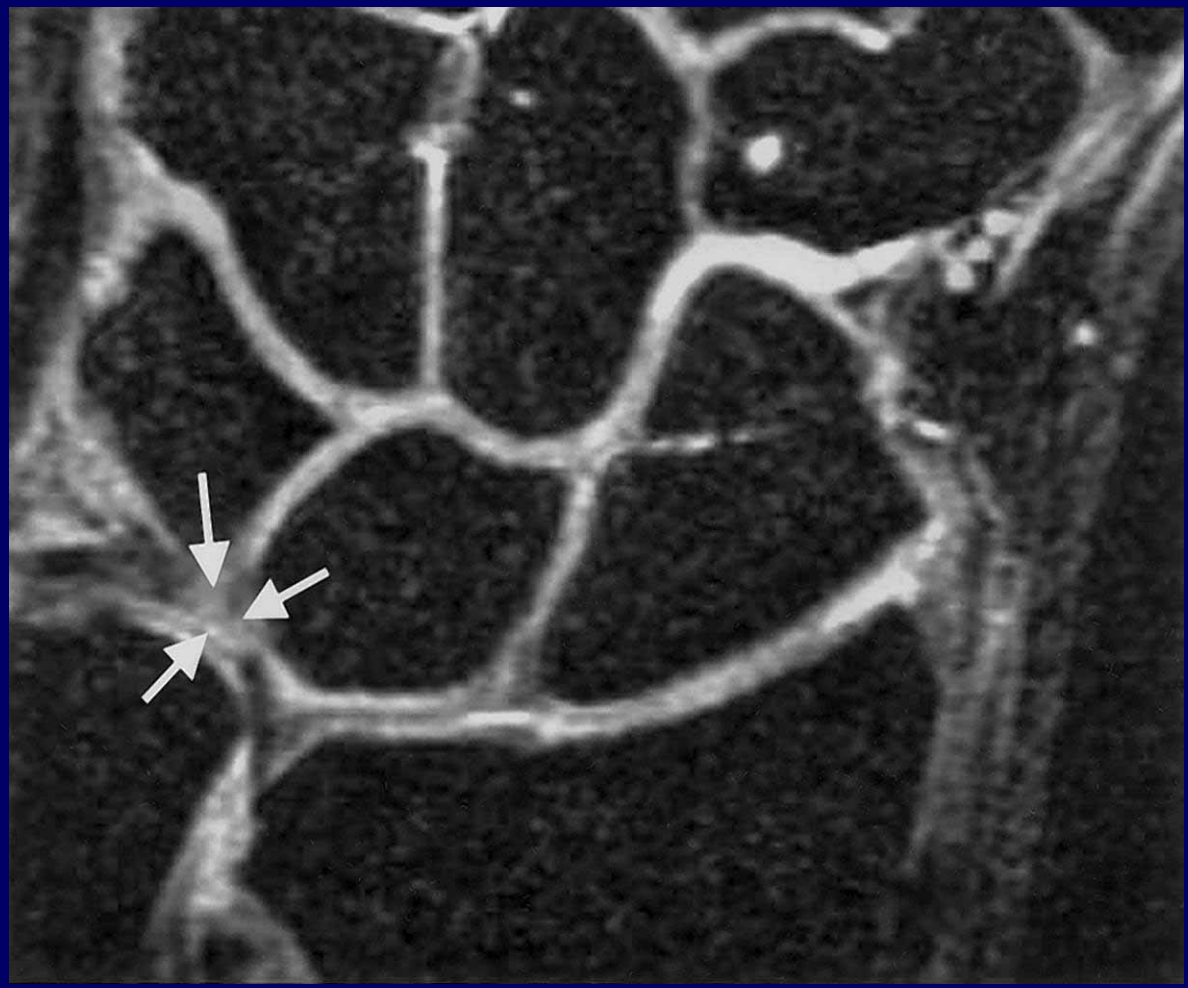


Normal TCC (nonenhanced GRE)

Abnormal TFC

- **Main component of FTTC to be abnormal**
- **Evaluate like meniscus in knee**
- **High signal within substance no significance**
- **Tear-high T2 signal extending to proximal or distal surface**
  - Partial or full thickness
- **Detachment or degeneration**

Tear Central Disc of TFC (unenhanced 3D GRE)



Sensitivity of tear of Central Disc TFCC

- **Haims A. et. al.**
- **63% sensitivity-1/3 of images of limited quality**
  - Indirect 65%
  - Unenhanced 61%
  - Other authors reporting 90% sensitivity

Radioulnar Ligaments

- Broad horizontal striated bands that pass on the volar and dorsal surfaces of the TFC and blend with it
- Flat superior and inferior margins (not biconcave like TFC)

Radioulnar Ligaments

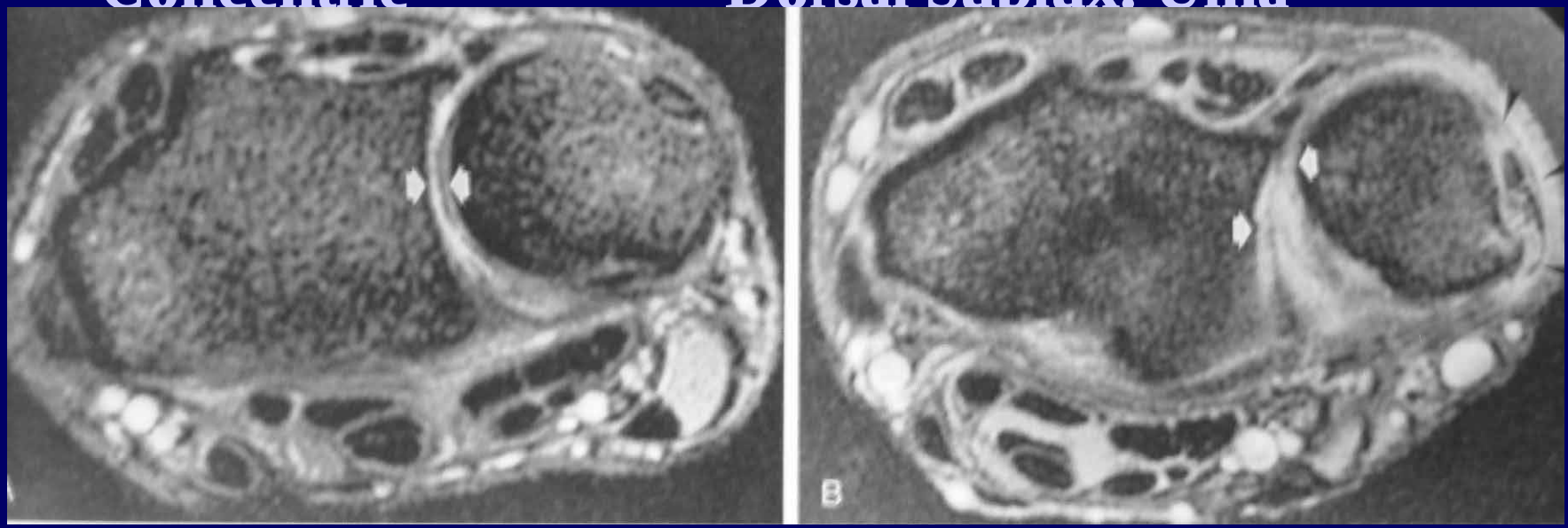
- Best seen on coronal images
- Low signal on all pulse sequences
- Are near the TFC but look different
- Have flat superior and inferior margins
- Attach directly to bone-ulnar styloid process medially and distal radius laterally

Abnormal Radioulnar Ligaments

- Associated with instability of the distal radioulnar joint (DRUJ)
- Diagnose on axial image
- Normal-concentric relationship of distal radius and ulna maintained
- Abnormal-distal ulna displaced volar or dorsal from sigmoid notch
- High signal coronal image-tear

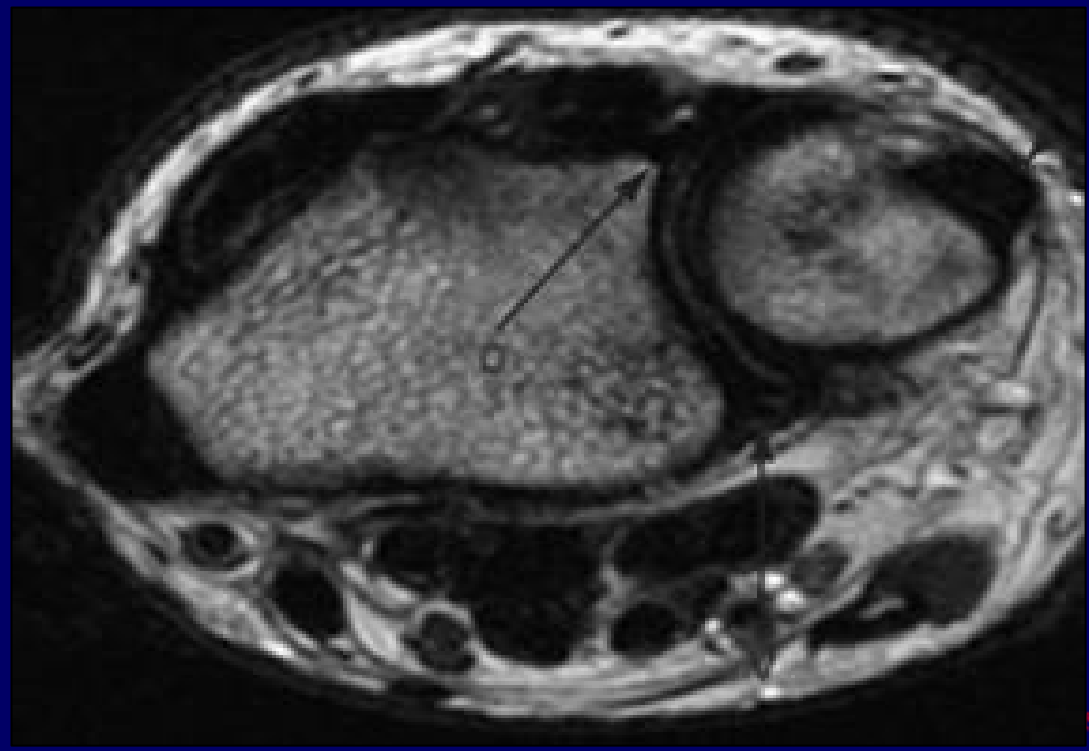
Distal Radioulnar Joint-Nl and Abnl

- Concentric Dorsal Sublux. Ulna



Extensor Carpi Ulnaris Tendon

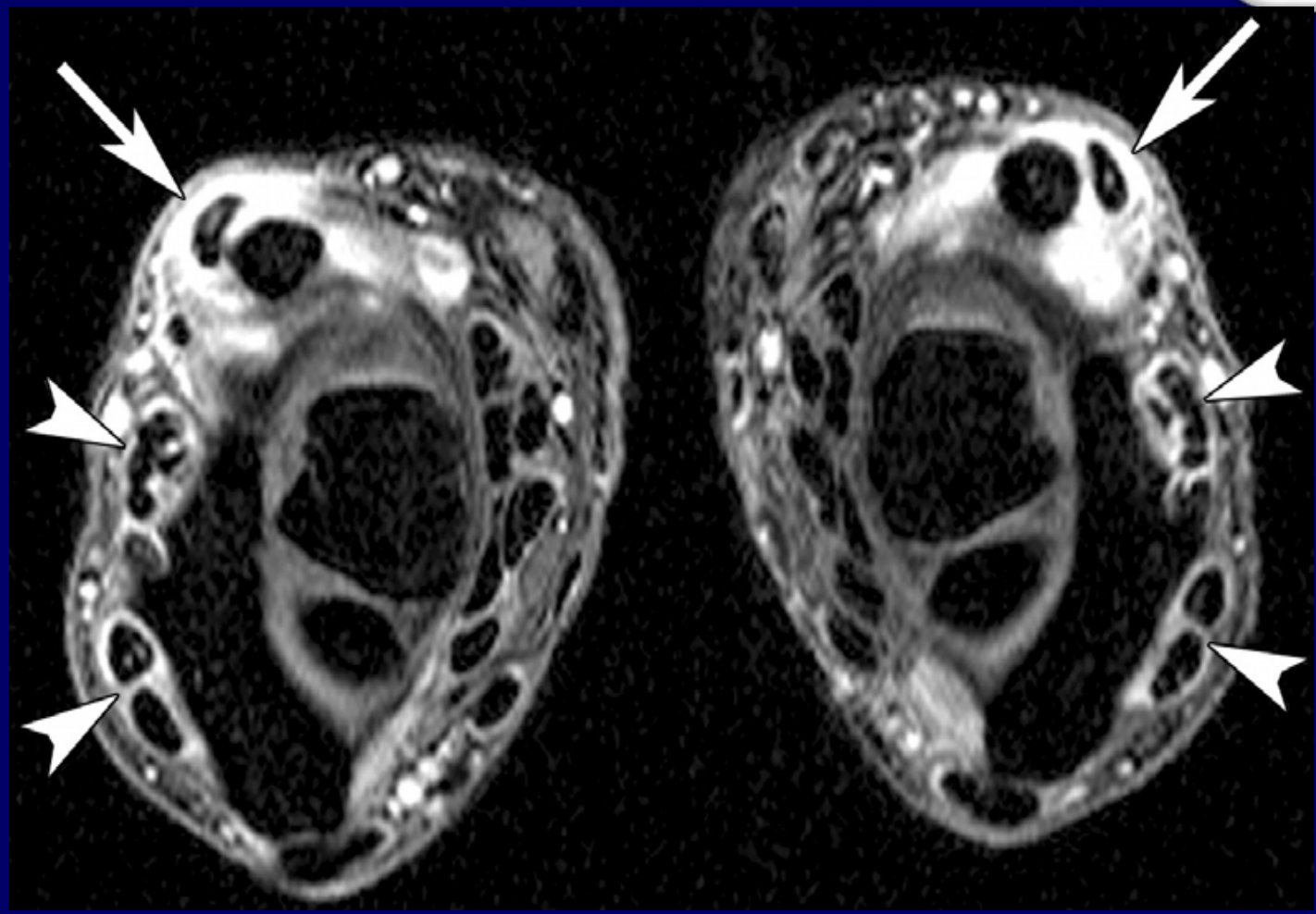
- **See on both coronal and axial plane-easier on axial plane**
- **Should be seated in the groove on the dorsum of the ulna**
  - Trauma-subluxed
  - or dislocated
  - out of groove
  - ulnar direction



Extensor Carpi Ulnaris Sheath

- Tenosynovitis is common
- High signal surrounds tendon on axial T2
- Tendon Sheath Not Evident Unless fluid it

Extensor Carpi Ulnaris Tenosynovitis
T1 contrast enhanced



Meniscus Homologue

- Thickening of ulnar side of joint capsule
- Not always present
- Just distal to prestyloid recess (normally contains fluid)
- Attaches to triquetrum
- Low signal triangular shape

Meniscus Homologue

Ulnar Collateral Ligament

- Support structure of TFCC
- A thickening of wrist capsule
- Extends from ulnar styloid process to triquetrum

Radial Collateral Ligament

- Similar structure on opposite side
- From Radial styloid process to the scaphoid

Carpal Tunnel

- Fibro-osseous space
- Formed by volar aspects of carpal bones and by volar flexor retinaculum
- Contains flexor tendons and median nerve
- Very little or no fat in tunnel-only present dorsally

Normal Carpal Tunnel-3 standard locations, axial images

- Level of distal radioulnar joint just before the median nerve enters the tunnel
- Level of pisiform in proximal tunnel
- Level of hook of hamate in distal tunnel

Normal Anatomy-Carpal Tunnel

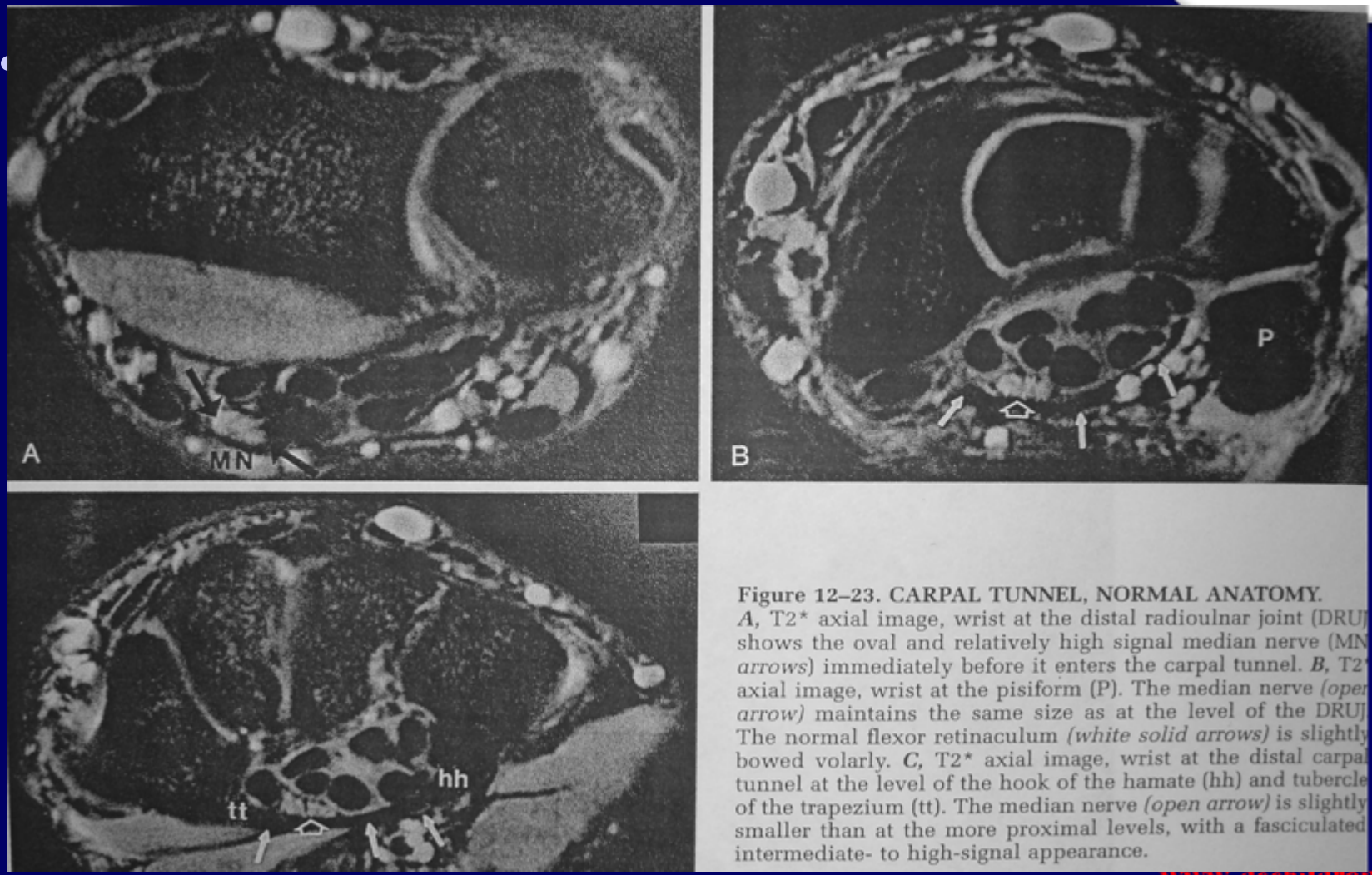
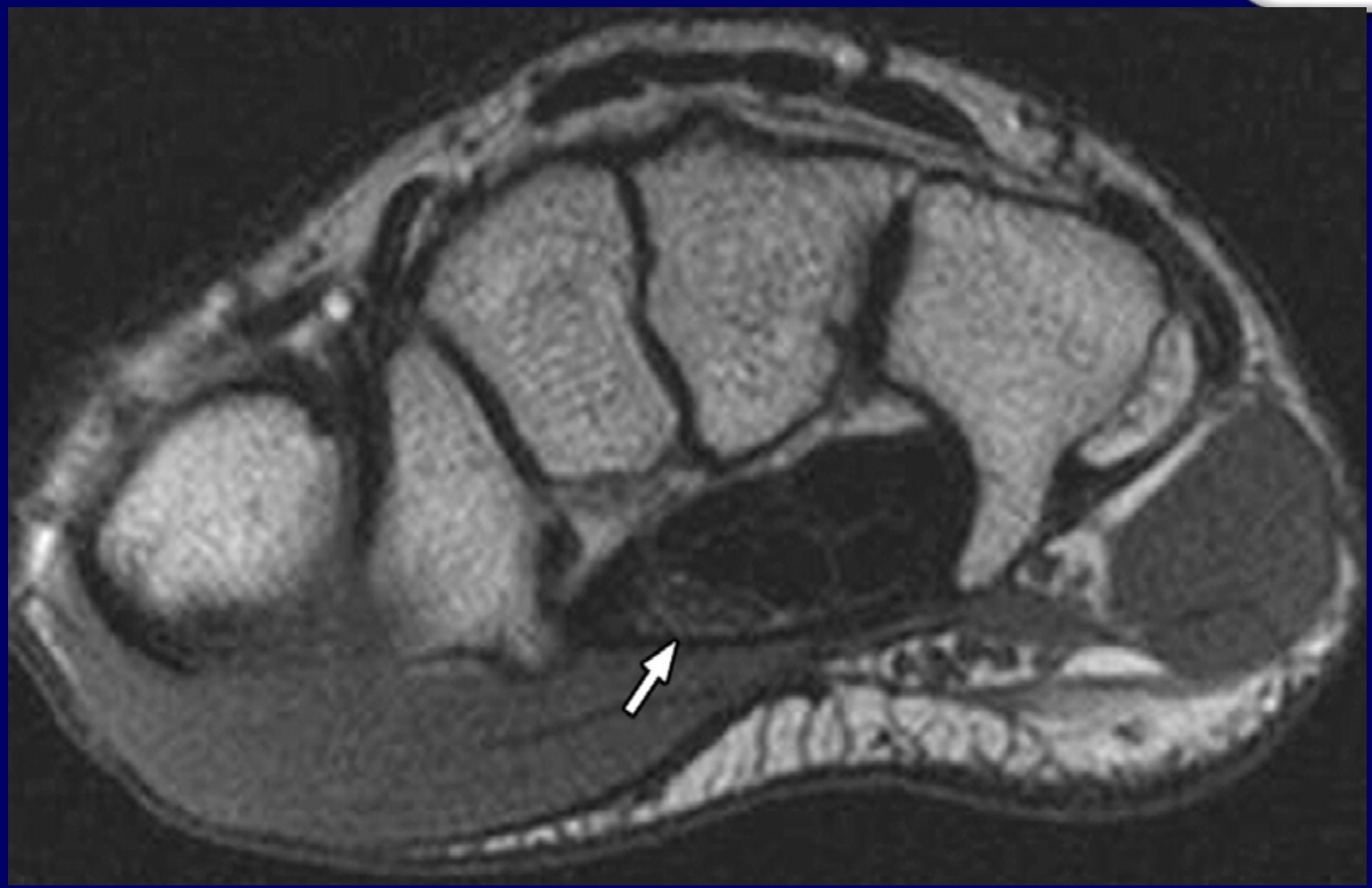


Figure 12–23. CARPAL TUNNEL, NORMAL ANATOMY.
A, T2* axial image, wrist at the distal radioulnar joint (DRUJ) shows the oval and relatively high signal median nerve (MN *arrows*) immediately before it enters the carpal tunnel. *B,* T2* axial image, wrist at the pisiform (P). The median nerve *(open arrow)* maintains the same size as at the level of the DRUJ. The normal flexor retinaculum *(white solid arrows)* is slightly bowed volarly. *C,* T2* axial image, wrist at the distal carpal tunnel at the level of the hook of the hamate (hh) and tubercle of the trapezium (tt). The median nerve *(open arrow)* is slightly smaller than at the more proximal levels, with a fasciculated intermediate- to high-signal appearance.

Median Nerve

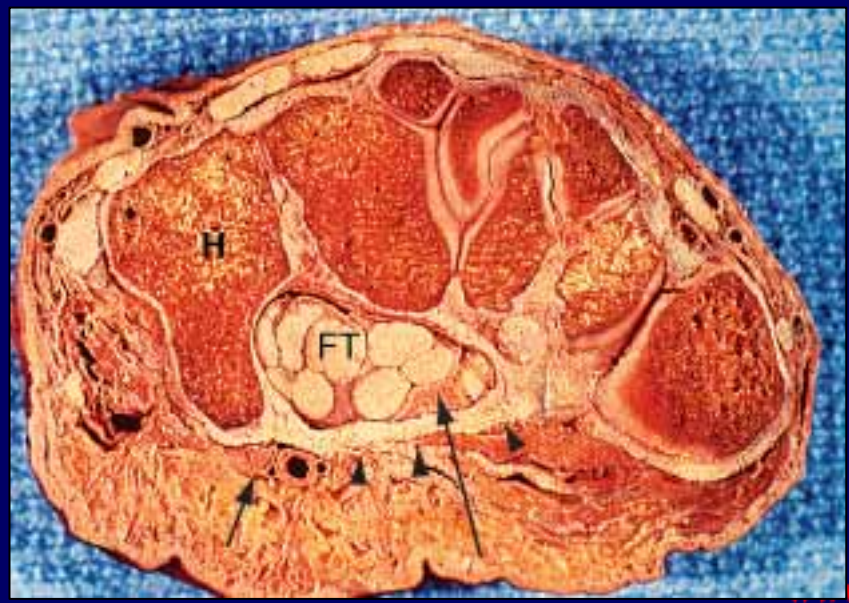
- Volar/radial aspect of the tunnel
- Just deep to the retinaculum
- Higher signal/more oval than flexor tendons
- Size is maintained or slightly decreases from proximal to distal (tunnel gets smaller p to d)
- Mildly flat distal tunnel/HH

Normal Carpal Tunnel-hook hamate level (T1/3T)



Flexor Retinaculum

- Dense, fibrous band (low signal)
- Attachments
- Scaphoid and tubercle of trapezium radial side
- Hook of hamate ulnar side



Carpal Tunnel Syndrome

- Entrapment Neuropathy (nerve compression syndrome)
- Alteration of nerve function caused by mechanical compression

Technique for dx. Peripheral Neuropathy

- Axial plane-nerves run longitudinally
- T1 SE or FSE sequence
- Post Gd to see relationship to an adjacent mass

Appearance of normal nerve

- **T1**
  - Smooth round or ovoid
  - Isointense to muscle
  - May have rim of hyperintense signal
- **FSE T2 or stir**
  - Isointense to mildly intense to muscle
- **Post Gd-normal nerve does not enhance**

Causes of Carpal Tunnel Syndrome

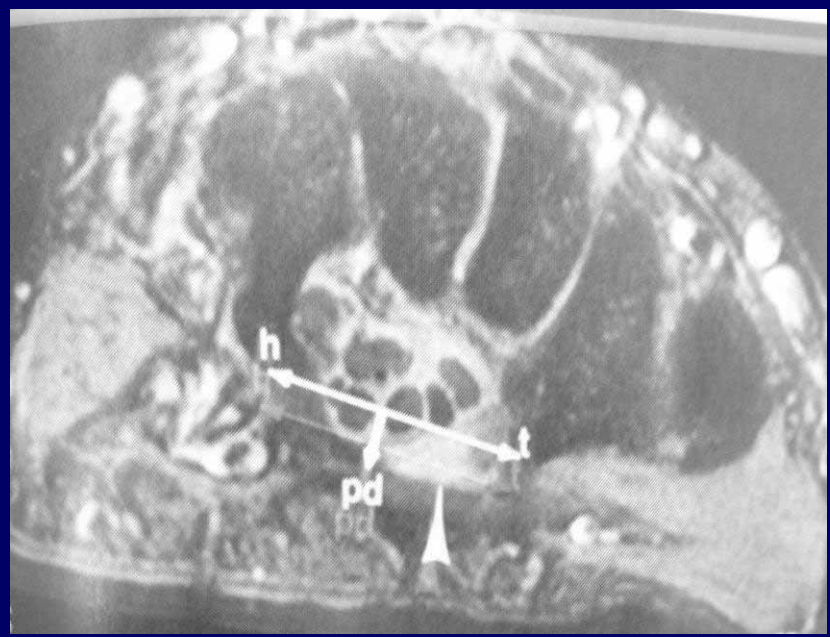
- **Tenosynovitis of the flexor digitorum tendons in the carpal tunnel**
- **Anything that compresses the nerve**
  - Congenital, inflammatory, infectious, idiopathic, diabetes, pregnancy, hypothyroidism
  - Trauma
  - Masses-ganglion,lipoma,neurofibroma,fibromatous hamartoma

Carpal Tunnel Syndrome

- **Repetitive use / trauma**
- **RADIOLOGISTS!!! Per Dr. Lynn Reuss our prior fellow, Radiology**

Bowing ratio

- Draw a line from hook of hamate to tubercle of trapezium (th)-measure line
- Measure distance of palmar displacement of the flexor retinaculum (pd)
- Divide pd/th



Carpal Tunnel Syndrome

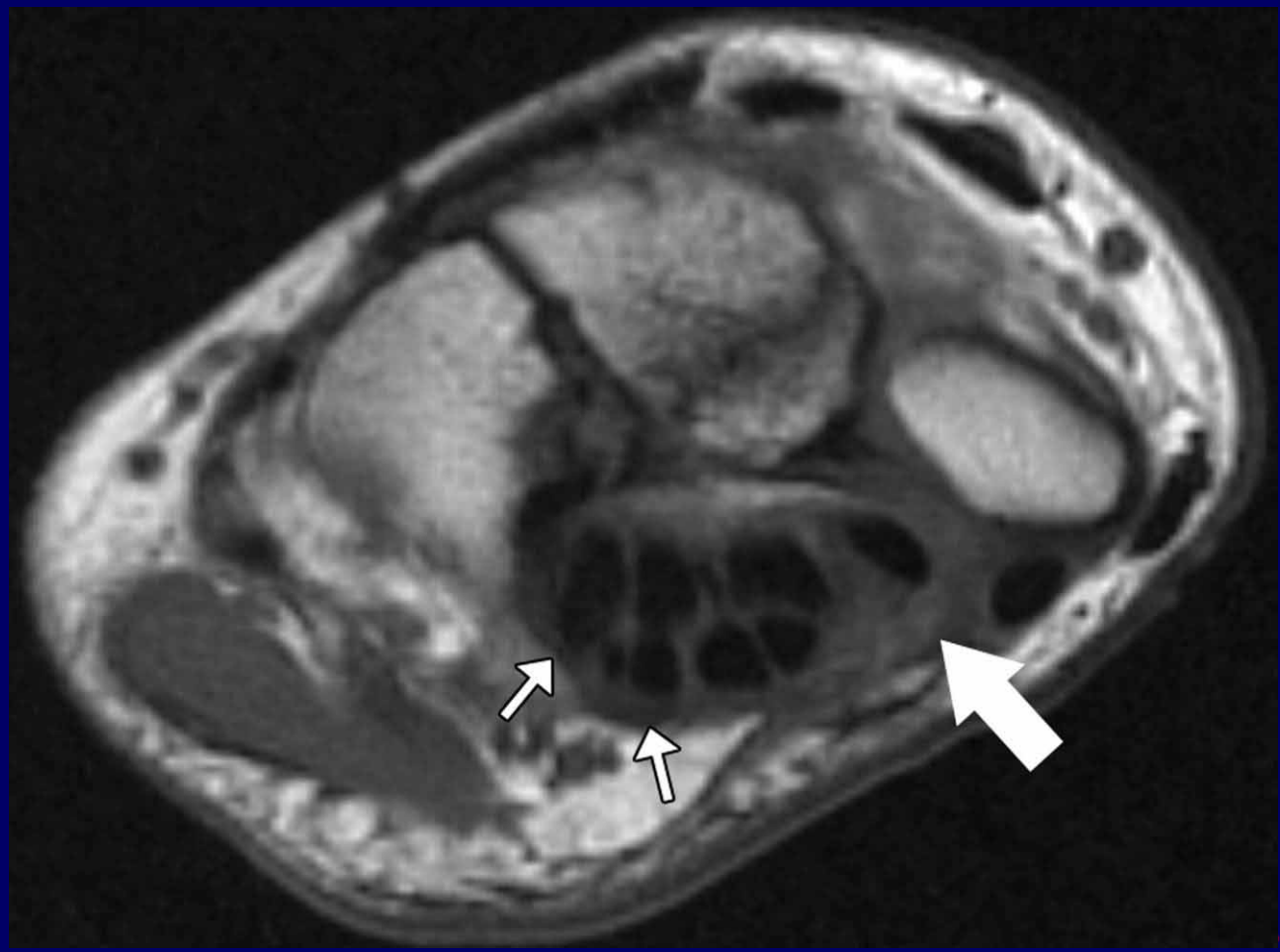
- **Focal or segmental swelling of median nerve**
  - larger at pisiform than distal radioulnar joint
  - Should stay same size or get smaller distally
- **Flattened median nerve (at hook of hamate)**
- **Outward bowing of flexor retinaculum (bowing ratio >15%)**
- **Increased T2/IR signal of median nerve (beware false increase in signal)**

Carpal Tunnel Syndrome (A-radioulnar level)

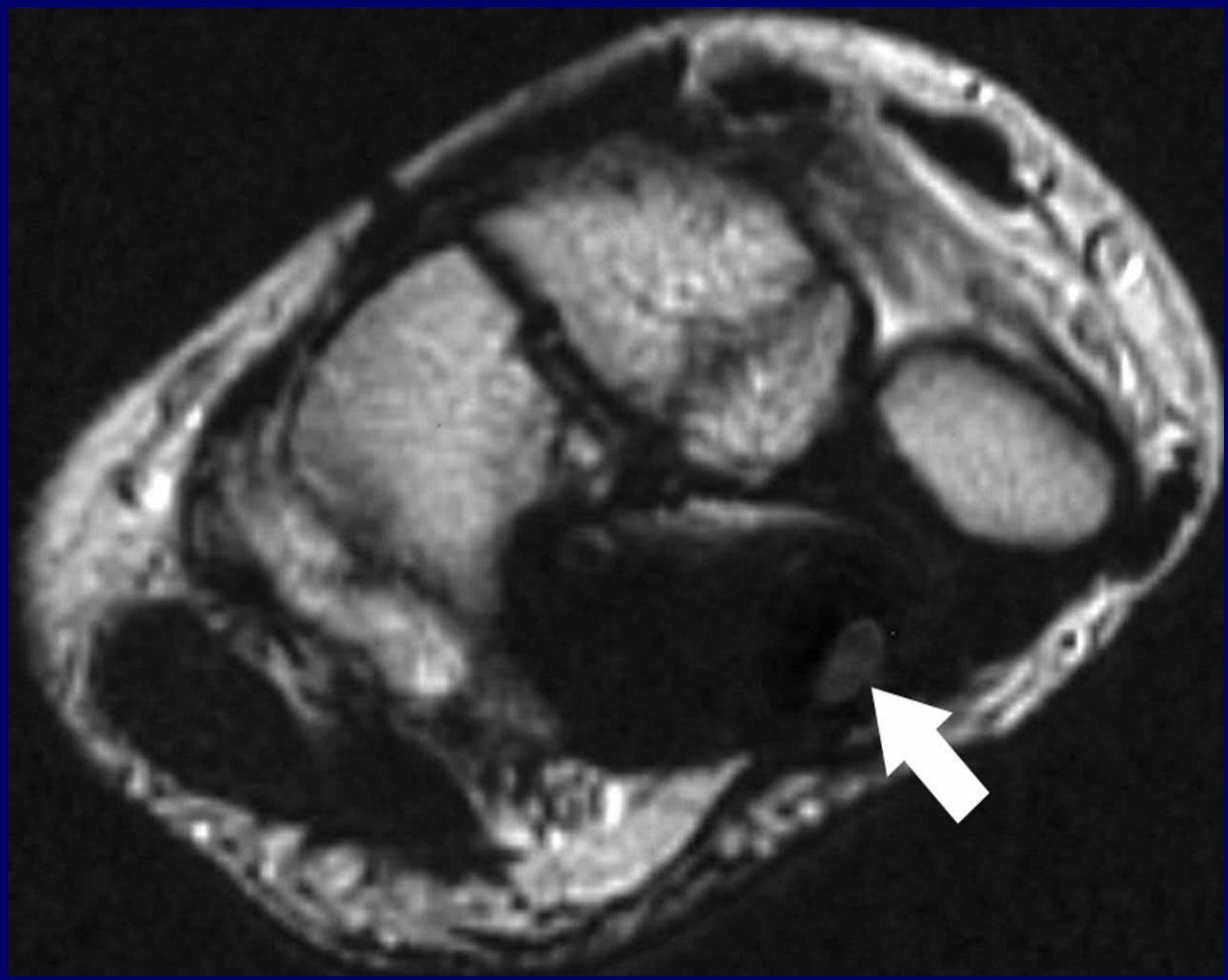
Carpal Tunnel Syndrome from Tenosynovitis (B-pisiform level)

Carpal Tunnel Syndrome-14 year old with fx. Capitate bone

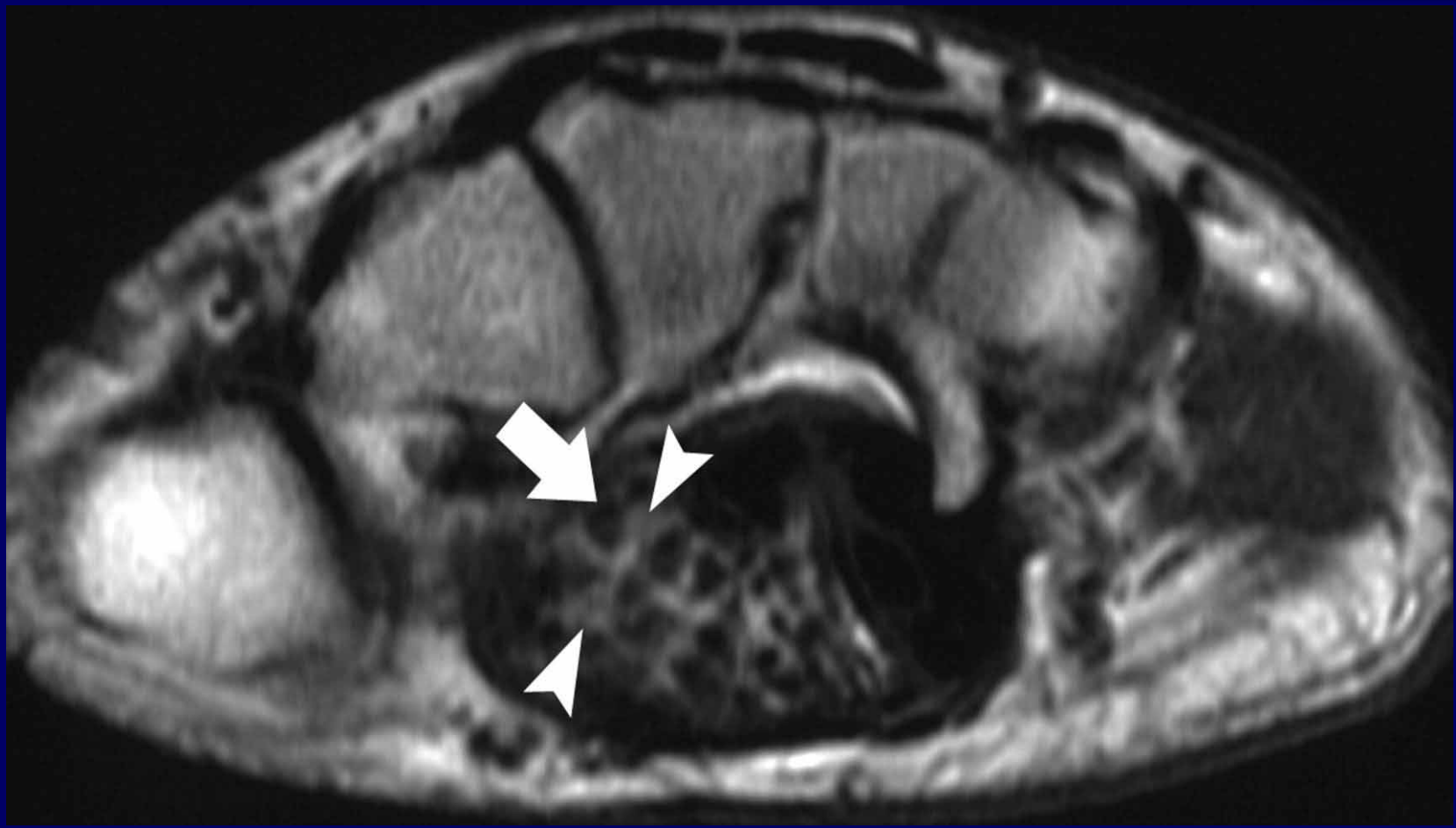
Carpal Tunnel-14 year old Complete Conduction Block of Median Nerve T1 SE



Carpal Tunnel Syndrome-T2



Carpal Tunnel Syndrome- Fibrolipomatous Hamartoma of Median Nerve (Coaxial cable sign)



Fibrolipomatous Hamartoma of a Nerve

- Benign Lesion of young adulthood
- Arises in and causes marked enlargement of a nerve
- Asymptomatic or nerve compression/pain,paresthesia
- Infiltration by fibrous and fatty tissue
- Occurs in 2/3 of patients with macrodactyly (macrodystrophia lipomatosa/a congenital form of localized gigantism)

Ulnar Nerve-Guyon's Canal

- **Ulnar side of the wrist**
- **Contains ulnar nerve, artery and vein**
- **Boundaries**
  - Dorsal-flexor retinaculum, hook of hamate
  - Ulnar-hypothenar musculature
  - Volar-layer of fascia

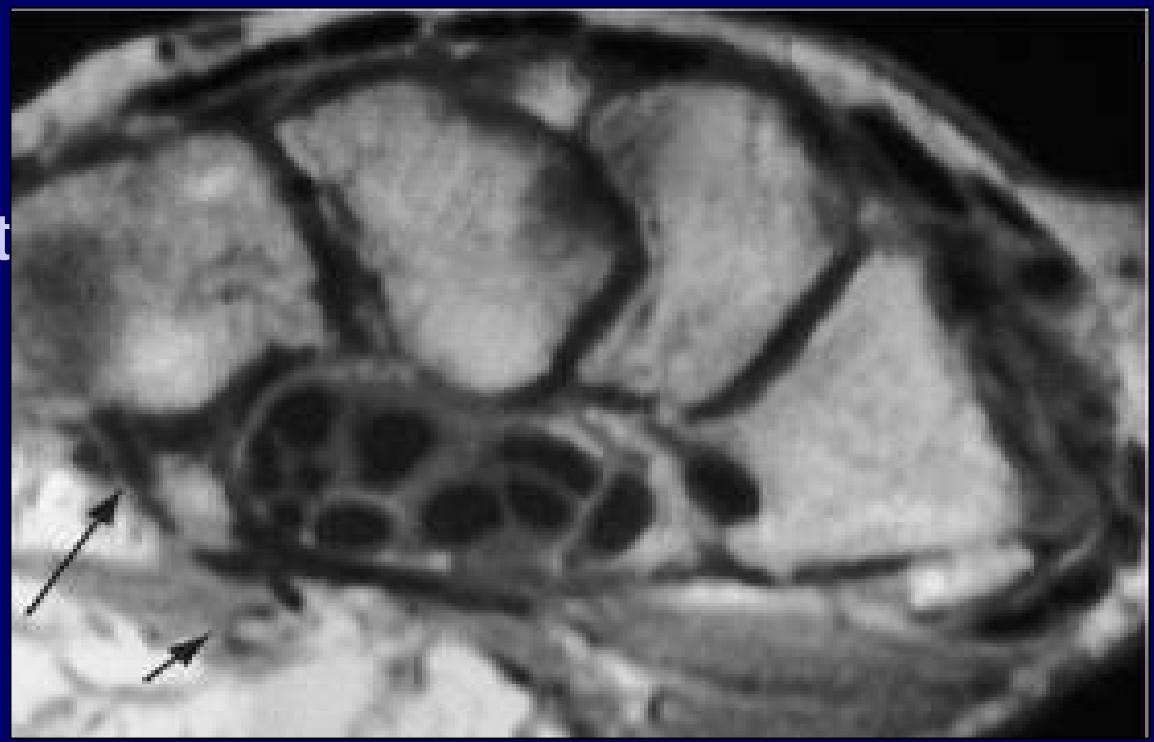
Ulnar Tunnel Syndrome

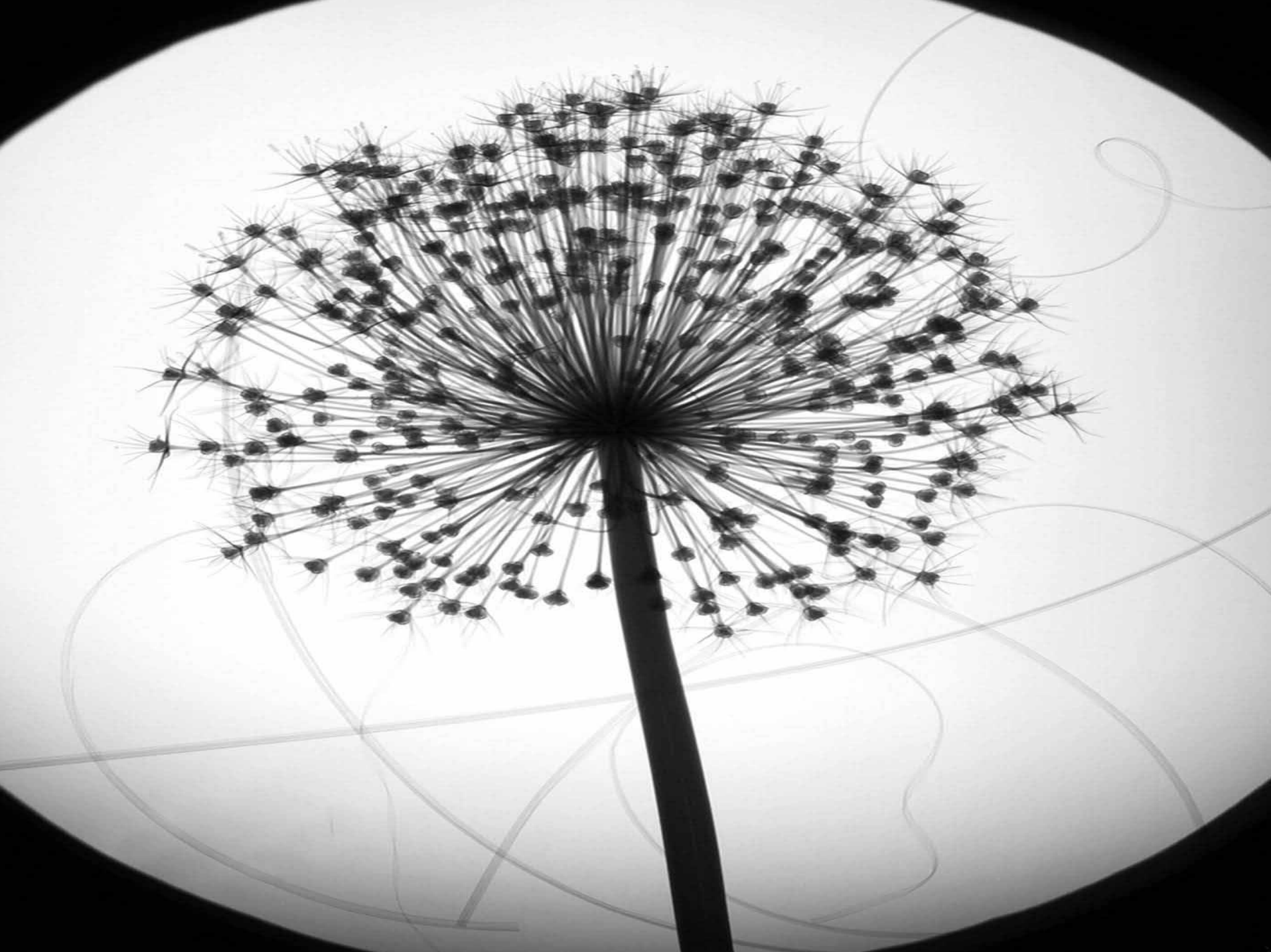
- Compression of ulnar nerve in Guyon's Canal
- Mass, ganglion cyst, fracture of hamate, repetitive trauma

Enlargement

Flattening

High Sig.

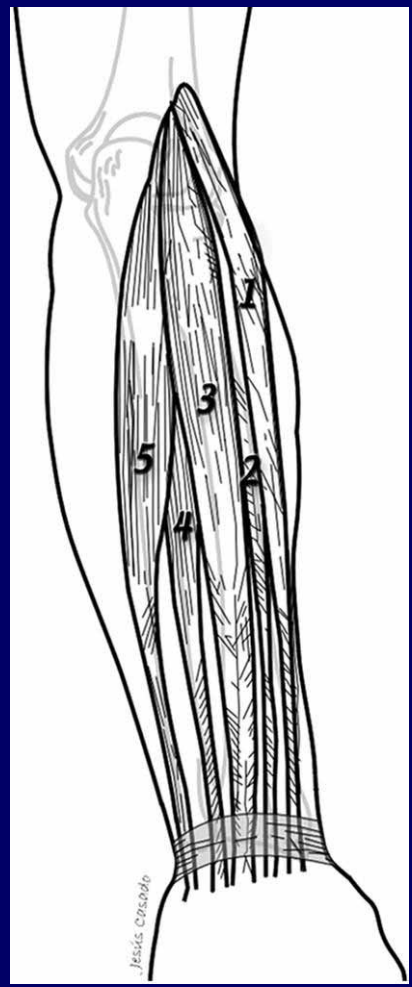




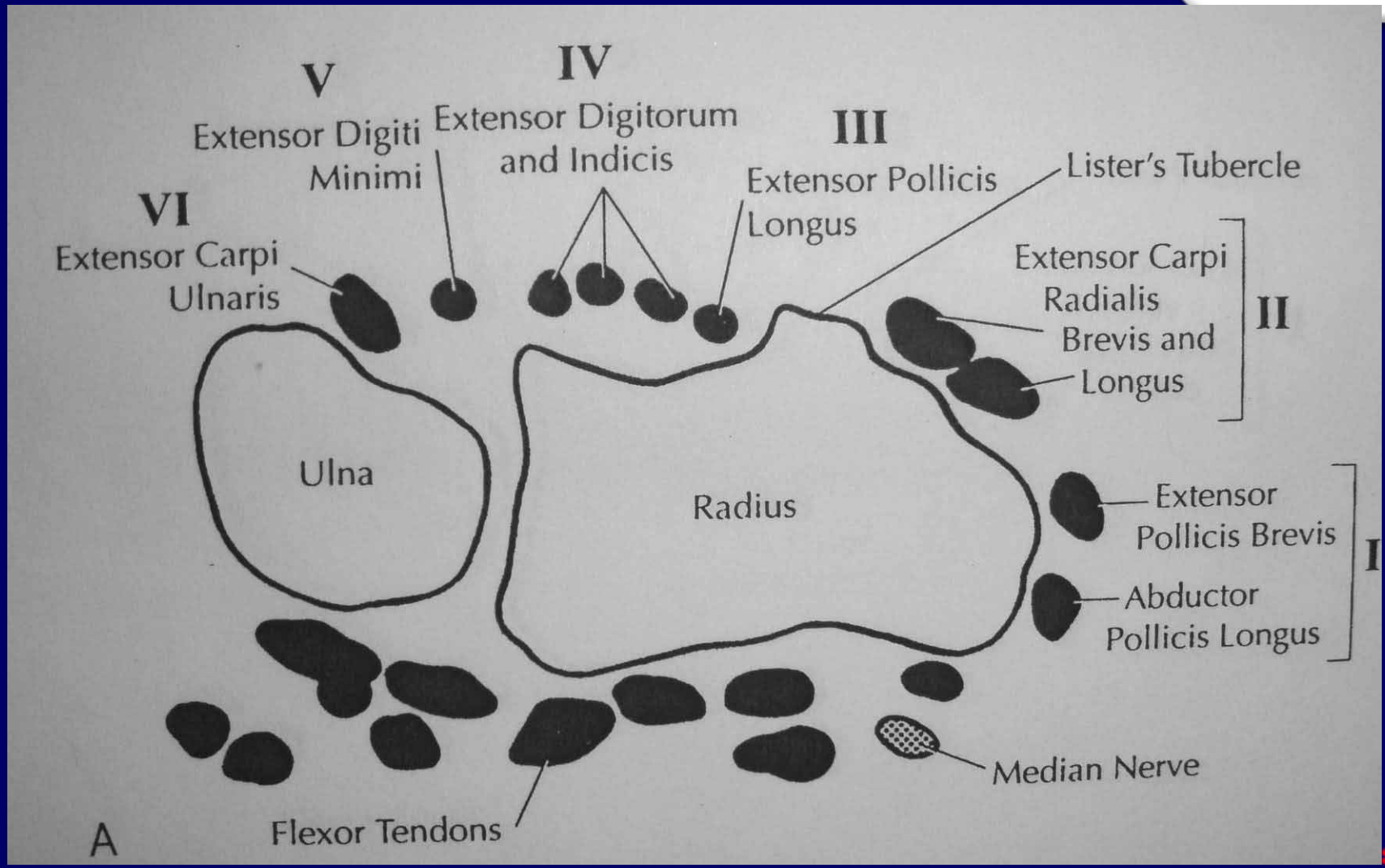
Tendons of the Wrist

- Best seen in axial plane
- Great news! Do not need to know the names of the nine flexor tendons that pass through the volar carpal tunnel
- Do need to know the extensor tendons on the dorsum of the wrist
- Are stabilized by an extensor retinaculum with fascial septations forming 6 compartments

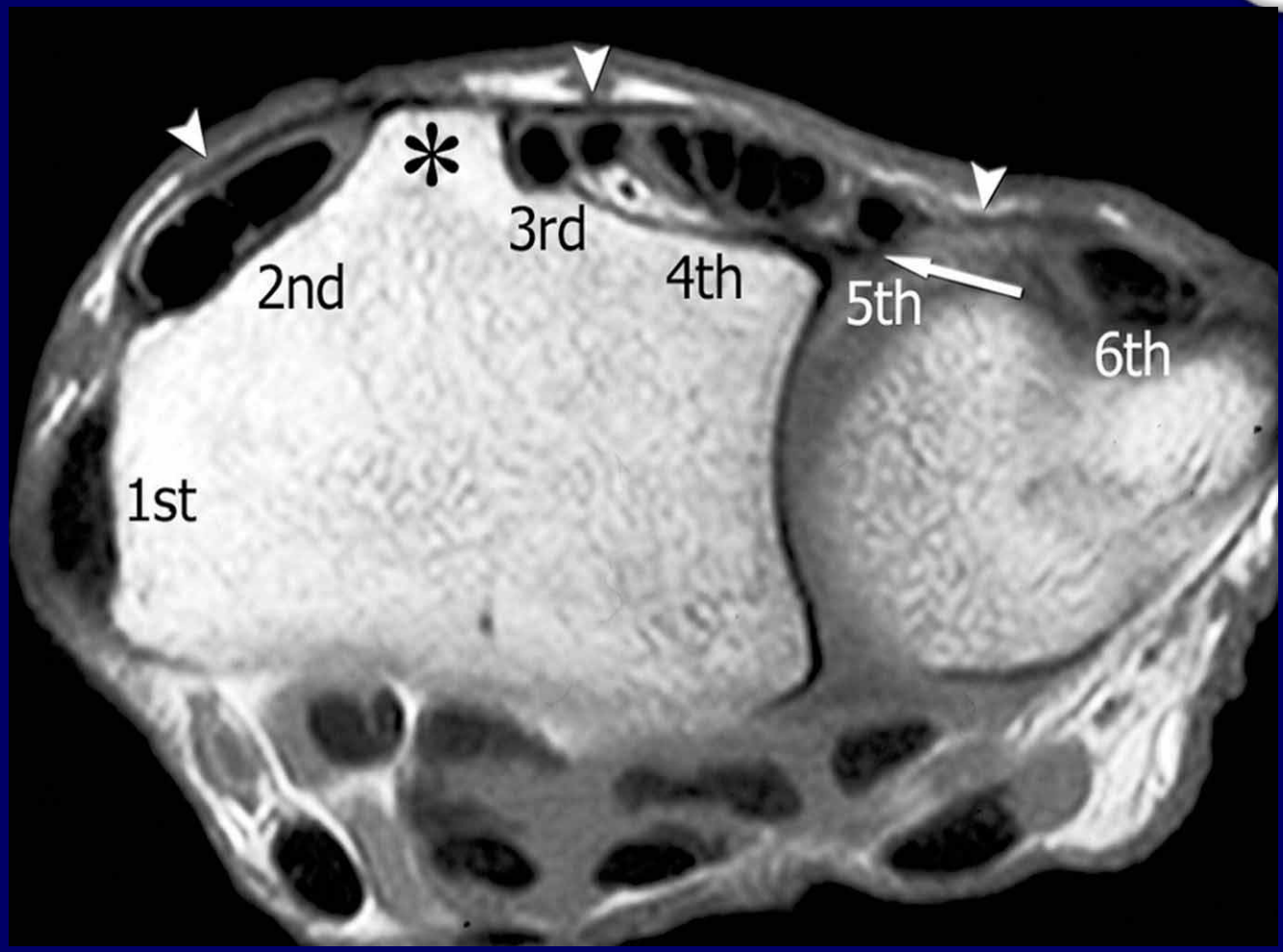
Extensor muscles become tendons at the wrist



Normal Tendons of the Wrist



Normal Tendons of the Wrist



Helpful Hints

- Tendon on ulnar aspect of Lister's tubercle is the extensor pollicis longus and it has a longus way to get to the thumb
- As travel radially, tendons alternate longus and brevis

Tendons

- Round to oval, low signal structures
- ECU tendon may have high signal in it
- Small amounts of fluid in tendon sheaths are normal
- Only call tenosynovitis if has fluid completely surrounding the tendons
- Look for abnormally enlarged or thinned tendons

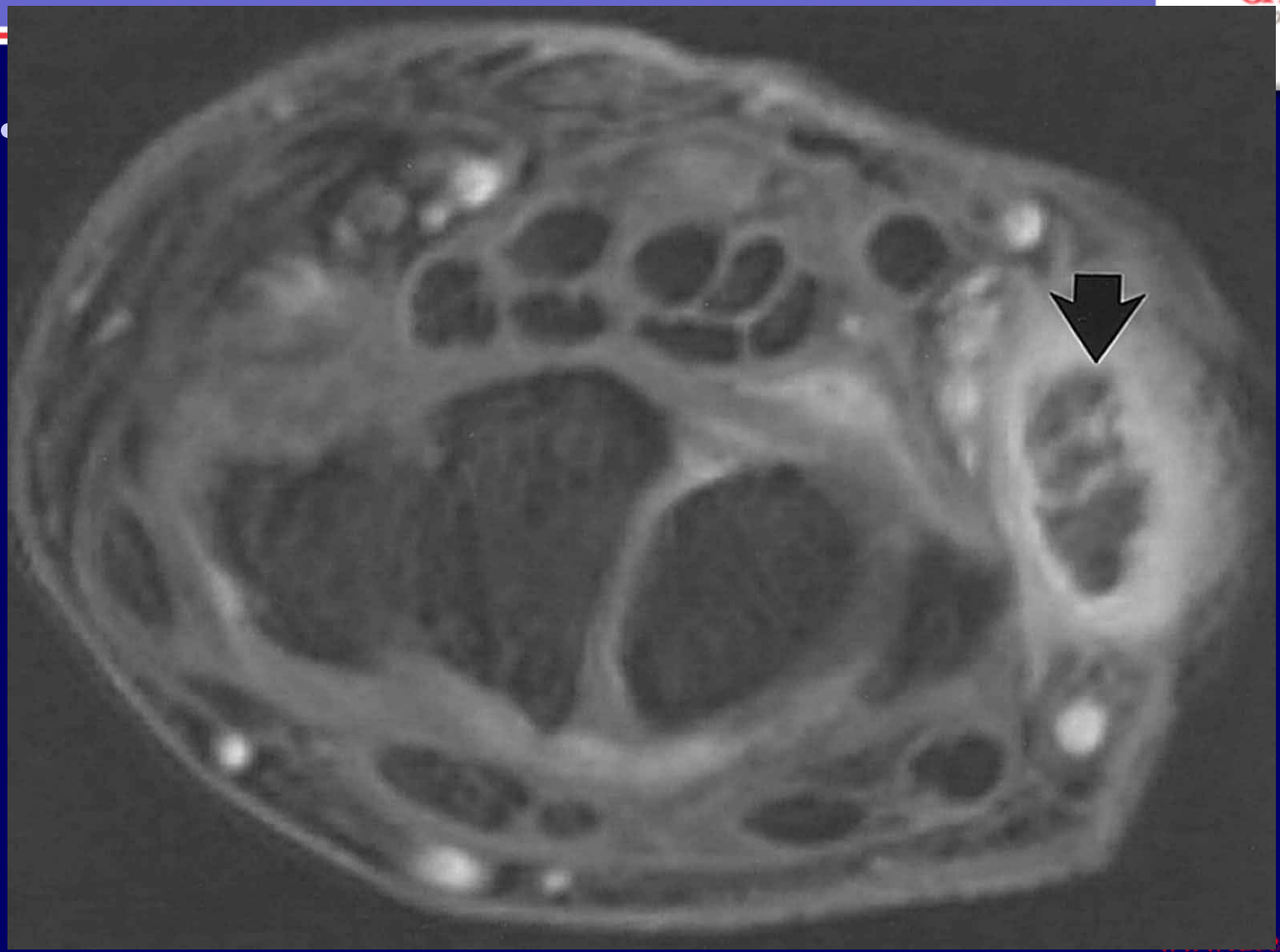
Tendons Injuries in wrist and hand

- **Tenosynovitis, tears, degeneration**
- **Repetitive trauma from overuse**
- **Inflammatory Arthritis**
- **De Quervain Syndrome**
  - Entrapment and tenosynovitis of the abductor pollicis longus and extensor pollicis brevis in the first dorsal compartment

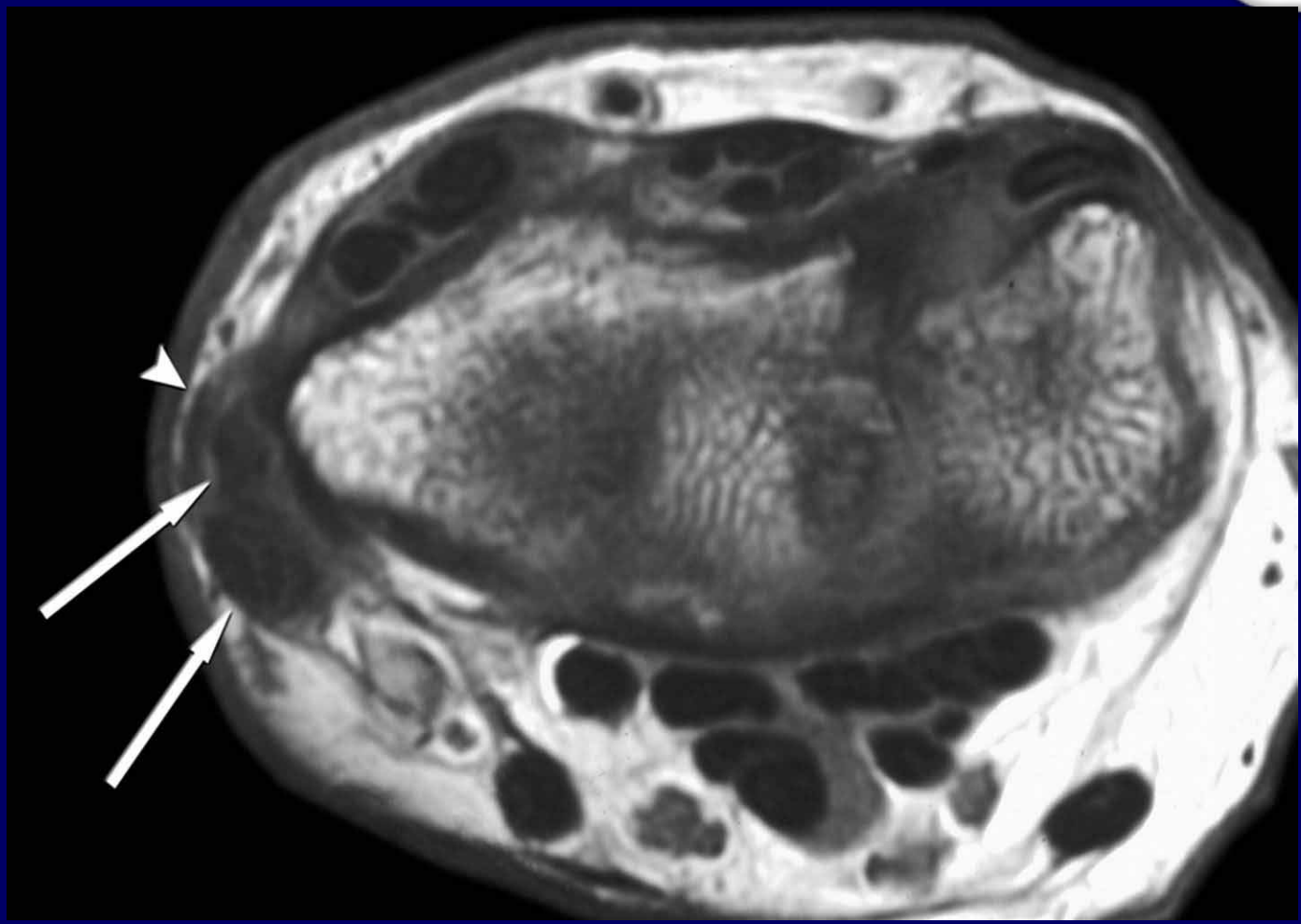
DeQuevain tenosynovitis

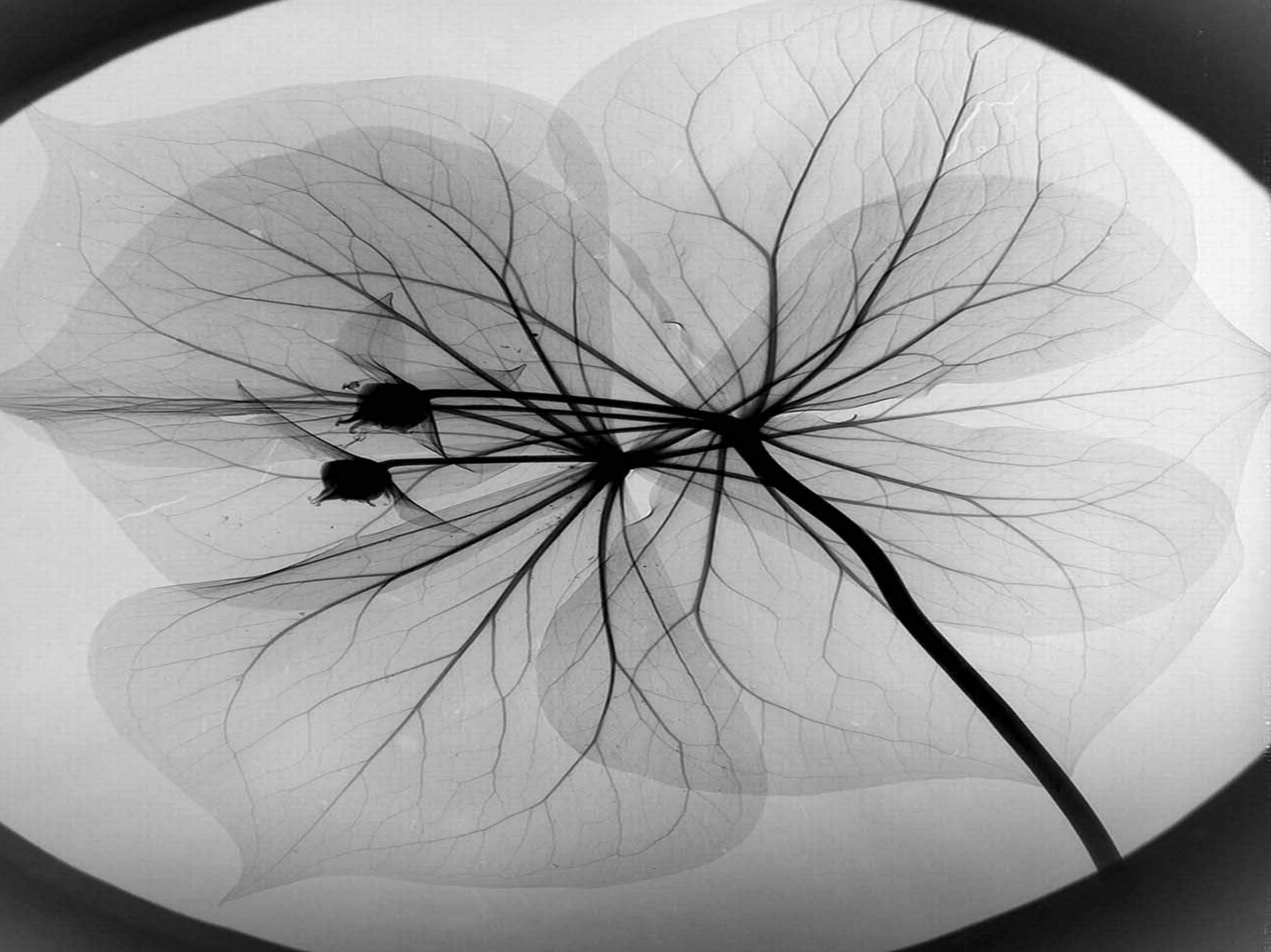
- Pregnancy/repetitive trauma
- Loss of overlying subcut. Fat/fibrosis
- Tendons are not discrete low signal structures
- Increased size and signal of tendons and contrast enhancement around the tendons from tenosynovitis

De Quervain Tenosynovitis (Indirect)



DeQuervain Tenosynovitis





Scaphoid Fracture

- Most common wrist injury in children
- Recent increase in frequency-competitive youth sports
- Waist fractures most common
- Major issues-detection of fx and amount of displacement

Scaphoid fracture

- **65% are radiographically occult after injury**
- **Memarsadeghi M, et. Al. Radiology 2006 (adult group of patients)**
  - MR detected all 11 fractures (but only 2/8 cortical fractures) (29 clinically suspected)
  - Multidetector CT showed all 8 cortical fractures but did not detect trabecular fractures
  - No false positive dx for CT or MR

Summary-Occult Scaphoid Fx.

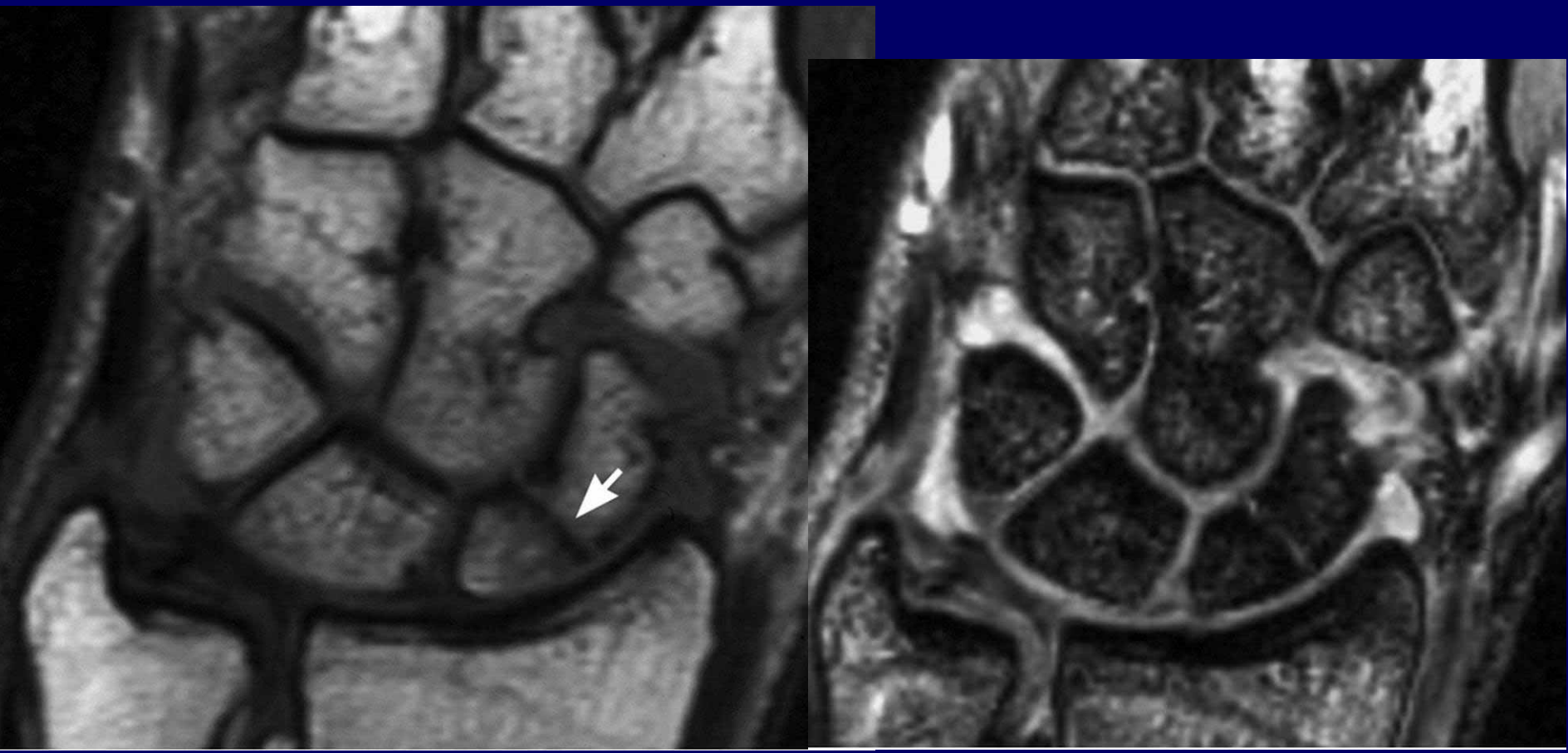
- MR is better than MDCT for detection of all scaphoid fxs.
- MDCT is better than MR for detection of cortical involvement of occult scaphoid fx.

Scaphoid Fx. Children

- Displacement beyond 1-2mm associated with malunion or nonunion (unstable)
- CT scans indicated to be certain of 3D anatomic alignment
- Osteonecrosis occurs-with displaced proximal waist or proximal pole fx.
- DISI malalignment associated with instability

Occult Navicular Fracture-STIR

Complete Scaphoid fx. –neg. XR



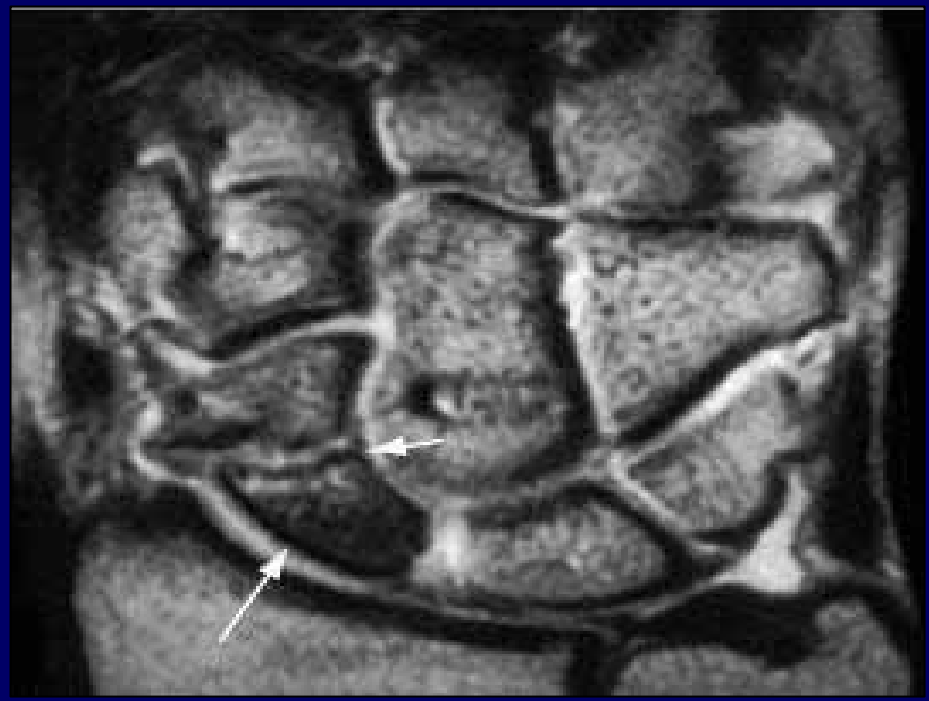
Osteonecrosis of the Navicular Bone

- Risk of nonunion and osteonecrosis even with nondisplaced waist fxs
- More common with a displaced proximal waist or proximal pole fx.

Osteonecrosis Prox. Pole Scaphoid

- **Viable when normal fatty marrow signal**
  - T1 high signal, T2 intermediate
- **AVN**
  - Low T1, Low T2
- **Less clear**
  - Low T1, High T2
  - Marrow edema, healing, ischemic changes

Avascular Necrosis of Scaphoid



Osteonecrosis of the Lunate

- Keinbock Disease
- Repetitive trauma, fx., Ulna Minus variant

Masses of the Hand and Wrist- Benign

- Ganglion
- Giant Cell Tumor of the Tendon Sheath
- Fibromatosis
- Dupuytren's contraction
- Deep Musculoaponeurotic Fibromatosis
- Fibroma of Tendon Sheath
- Lipoma
- Fibrolipomatous Hamartoma
- Hemangioma/Vascular Malformations

Benign Masses

- Glomus Tumor
- Soft Tissue Condroma

Soft Tissue Masses-Ganglion

- **Ganglion is most common cause of a palpable mass in wrist and hand**
- **Ganglion**
  - Thin connective tissue capsule, no true synovial lining
  - Contain mucinous material
- **Synovial cyst**
  - Synovial lining
  - Thick mucoid material
- **Identical on imaging-ganglion=synovial cyst**

Ganglion Cysts

- May represent synovial herniation or coalescence of small degenerative cysts arising from tendon sheath, joint capsule or bursa
- May have small pedicle attachment
- Synovial cyst-rheumatoid arthritis
- May be small and occult
- May be associated with pain

Ganglia-Location

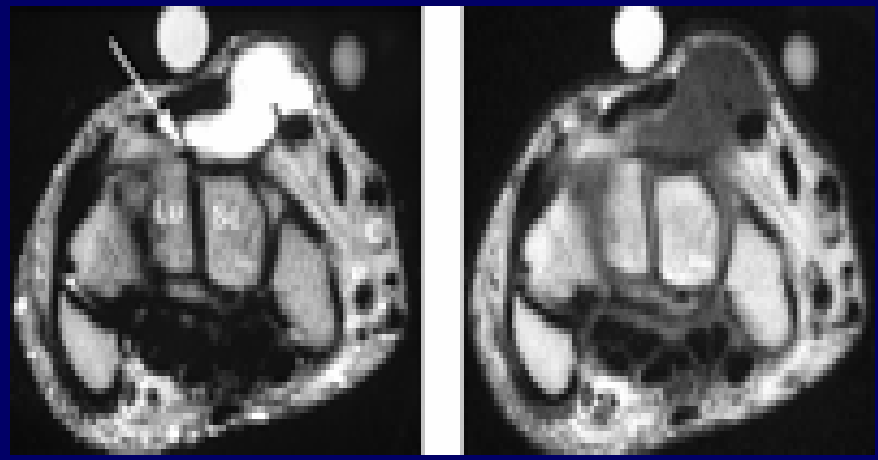
- **Dorsum of the wrist-60%**
  - Scapholunate joint or ligament
- **Volar wrist-20%**
- **Pisotriquetral joint**
- **Flexor tendon sheath-10%**
  - Metacarpo-phalangeal joint
- **DIP joint dorsum-10%**
  - Osteoarthritis

Ganglia-MRI appearance

- T1-low signal
- T2-diffusely high signal
- Occasionally T1 isointense or hyperintense from proteinaceous content or hemorrhage
- Unilocular or Multilocular
- Round or Lobular
- Adjacent to a joint or tendon sheath-nonpalpable are deep to the tendons
- Mild enhancement of capsule or septae post Gd

Ganglion-T2 indirect

Ganglion



Giant Cell Tumor of the Tendon Sheath (GCTTS)

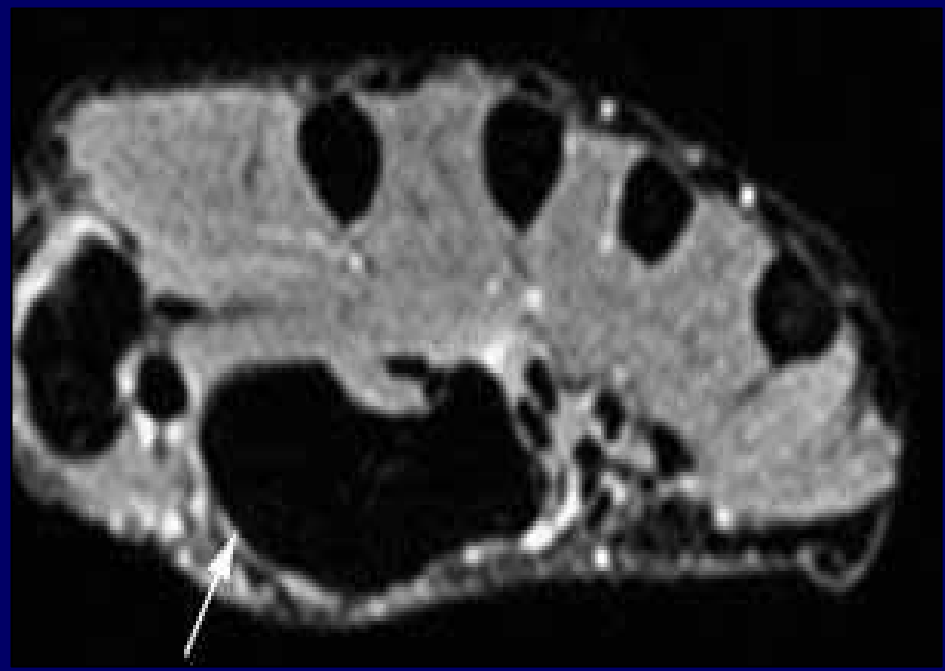
- Second most common mass hand/wrist
- Focal pigmented villonodular synovitis (PVNS)
- Hyperplastic synovial process of unknown cause
- Volar aspect of first three digits/wrist less often

GCTTS-MRI

- **Well defined mass**
- **Adjacent to or enveloping a tendon**
- **Low signal on T1 and T2**
- **T2 low signal from chronic hemorrhage with hemosiderin or low and high from hem and fluid**
  - GE blooming artifact
- **Uniform enhancement post GD**

GCTTS-T1/ GE T2*

Lipoma



Vascular Malformation-AV mal.

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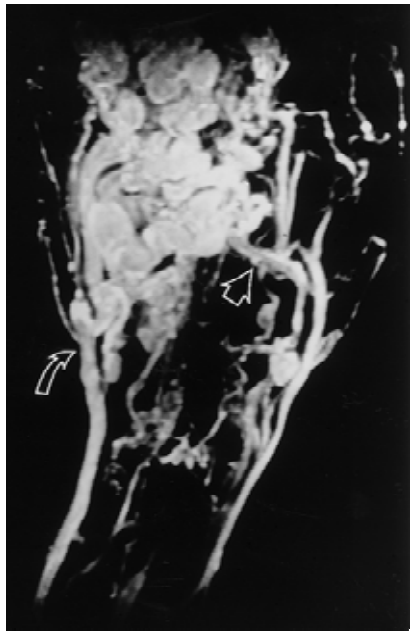
Figure 8b. Arteriovenous malformation in a 28-year-old man with vascular deformity of the hand



Connell, D. A. et al. Radiographics 2002;22:583-599

RadioGraphics

Malignant Masses

- Uncommon
- Malignant FH, synovial sarcoma, rhabdomyosarcoma, malignant nerve sheath tumors, liposarcomas, extraskeletal chondrosarcoma
- Consider if mass not clearly benign MRI features
- Large lesion, poorly defined margins, inhomogeneity T2, irregular enhancement, necrosis

Juvenile Rheumatoid Arthritis

- **Under the age of 16, symptoms at least 6 wks.**
- **Rheumatoid factor negative**
  - Oligoarticular (4 joints or less)
  - Polyarticular (more than 4 joints)
  - Systemic=Still's disease (polyarticular with hepatosplenomegaly and fevers)
- **Rheumatoid factor positive**
  - Polyarticular, females

What is the Role of MRI in JRA?

- Dx. is usually well known prior to MRI, especially if polyarticular
- May make the dx. with pauciarticular JRA when MRI for unexplained joint pain or swelling
- With single joint involvement, septic arthritis must be ruled out
- Determine disease activity before and after changes in treatment

Plain Findings of JRA

- **Diffuse STS**
- **Osteopenia-juxtaarticular or diffuse**
- **Periosteal reaction (unique to children)**
- **Joint space narrowing, marginal erosions**
  - Late finding / thick articular and epiphyseal cart.
- **Joint malalignment**
- **Location-distal RUJ, Ulnar prestyloid recess, carpal bones, MCP, PIP**

MRI features / Therapy / Progression

- **Synovial hypertrophy and enhancement**
  - Mild enhancement may be nl
  - May predict future no. of erosions
- **Subchondral bone edema / increased T2**
  - May predict future site of erosions / articular D.
- **Subchondral bone enhancement**

Erosions

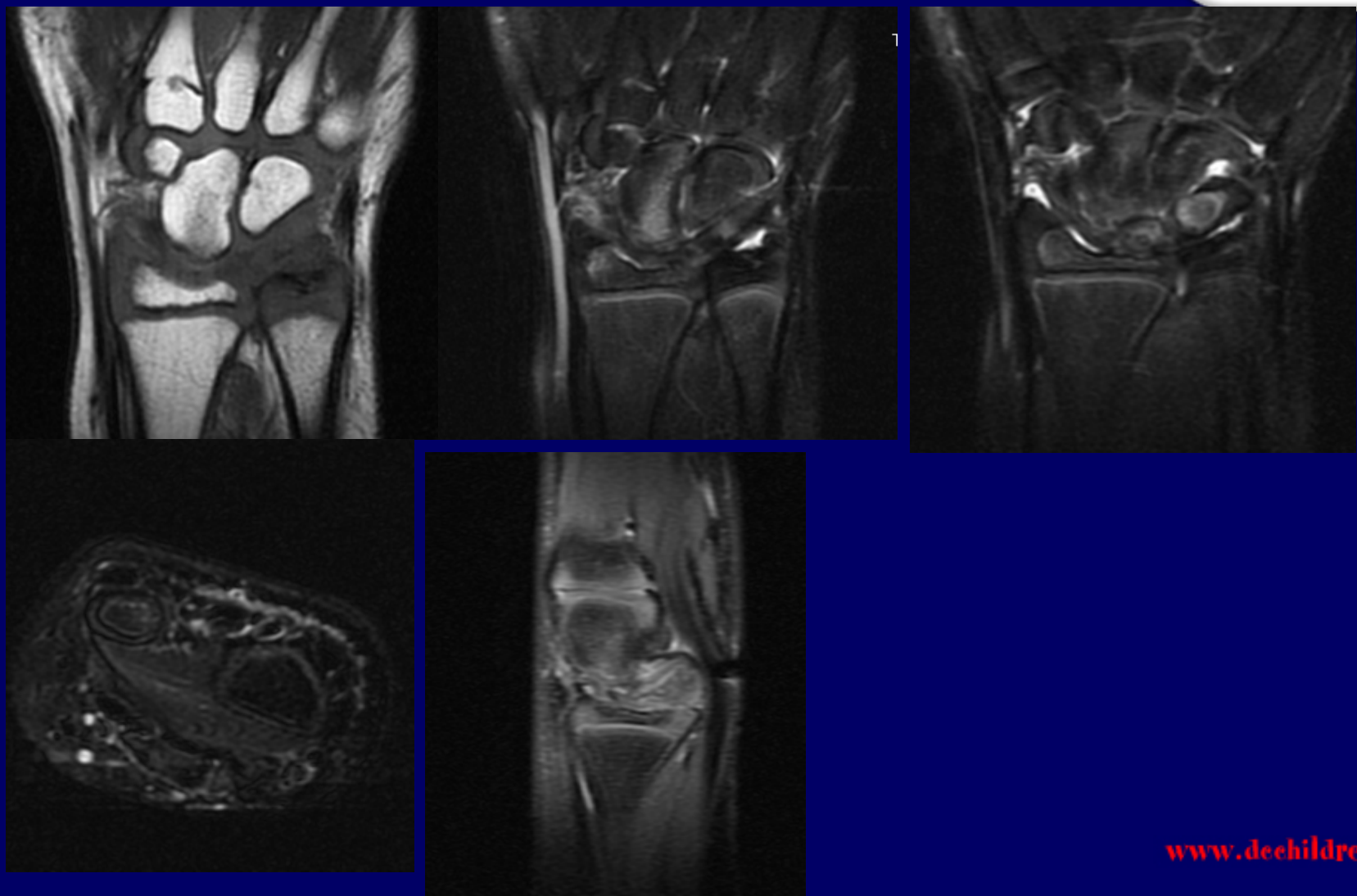
- Evaluate in combination with plain films
- Inactive erosions / subchondral cysts-do not enhance
- Active erosions / pre-erosive osteitis T2 bright and enhance
- Osteitis-cortex and cartilage intact over the subchondral edema
- Erosion-nonintact cortex and cart. / see on XRay

Additional MRI features

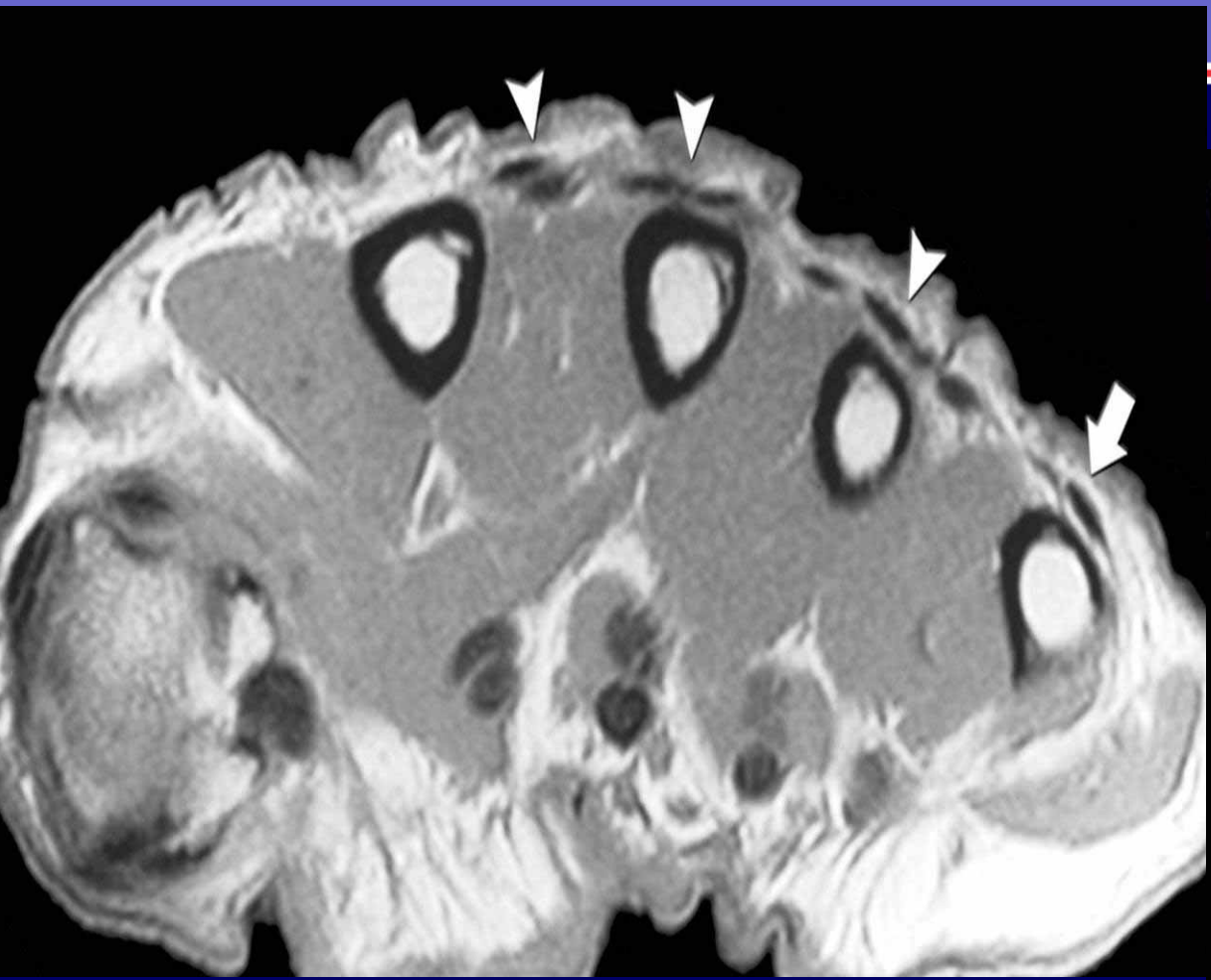
- **Tenosynovitis / myositis**
  - Primary manifestation of JRA
  - Secondary to adjacent arthritis
- **Extensor tendons wrist > flexor tendons**
- **Tendon thickening, edema, fluid in surrounding sheath, enhancement**
- **Tendons may rupture**

JRA erosion synovial enh.

Juvenile Rheumatoid Arthritis (?)-7yr. Wrist pain



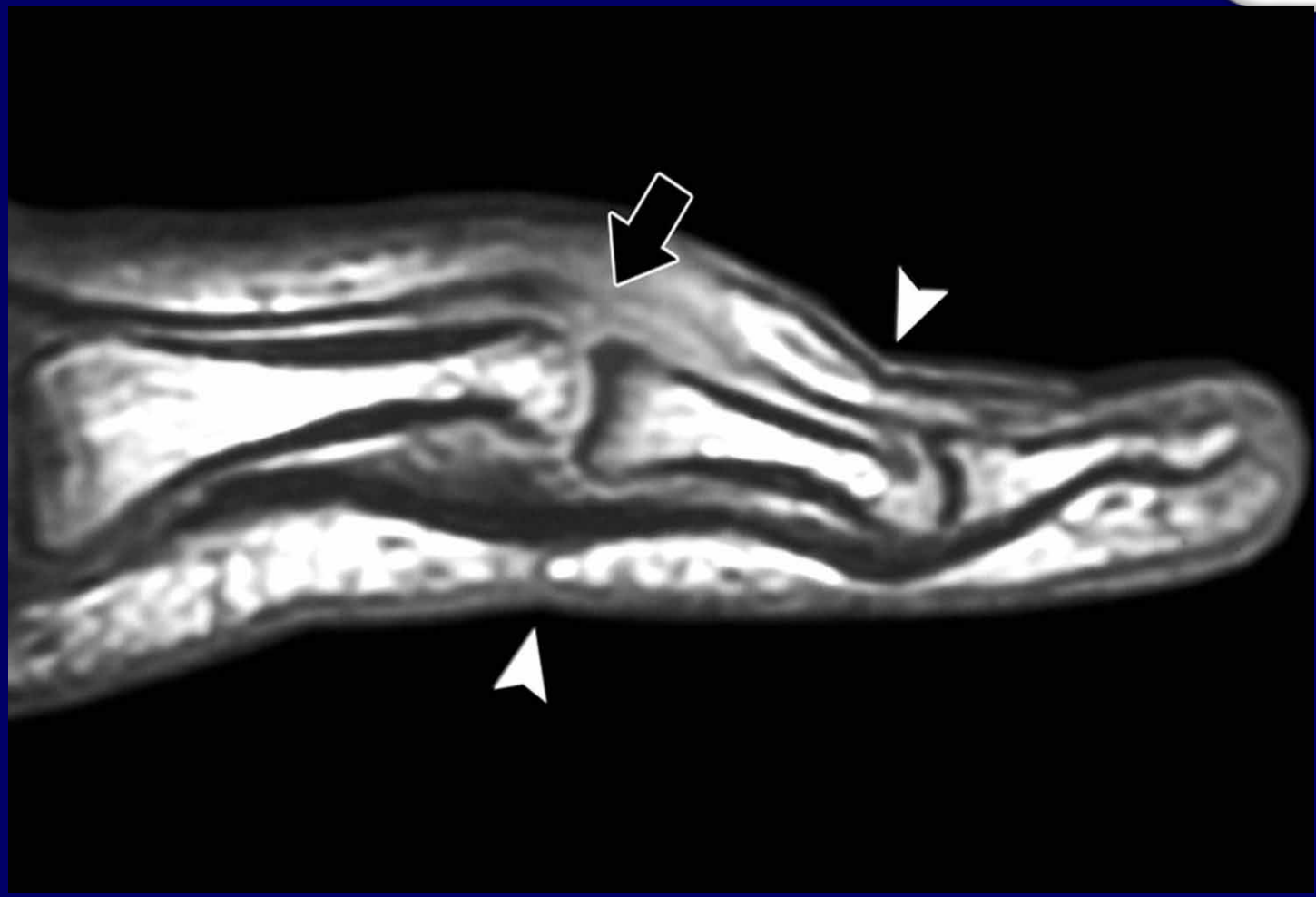
Extensor Tendons of the Hand



Extensor /Flexor Tendons Injury

- Tendons should be closely related to the phalanges
- Tear-discontinuous, intermediate signal, thickened
- Flexor Digitorum tendons close to adjacent bones-with rupture, tendon displaces, “bowstring appearance”
- Compare to adjacent digits

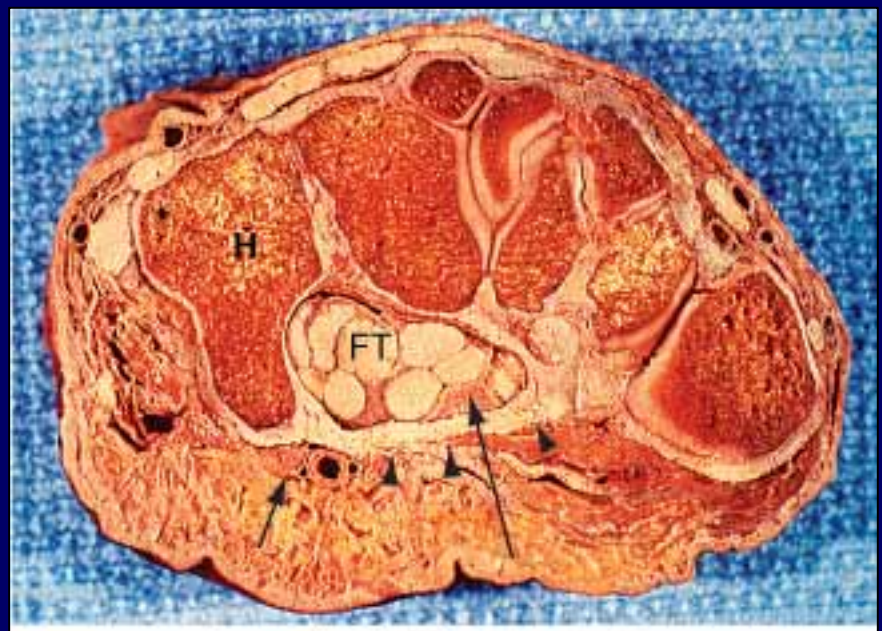
Finger-Disruption Extensor Tendon Slip

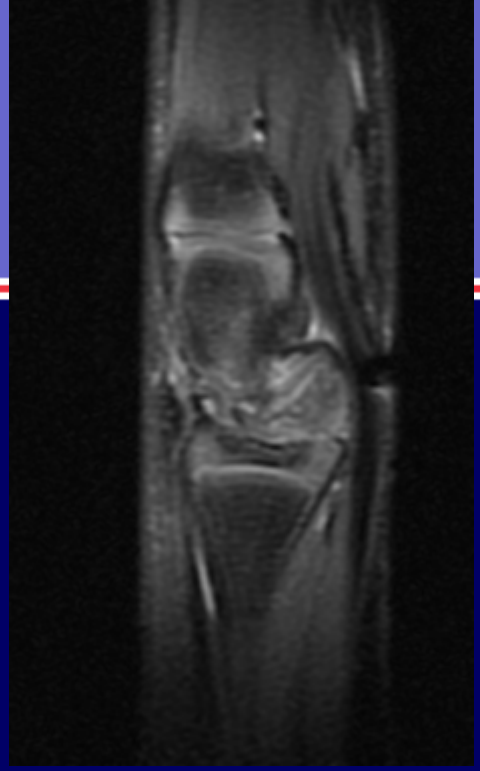


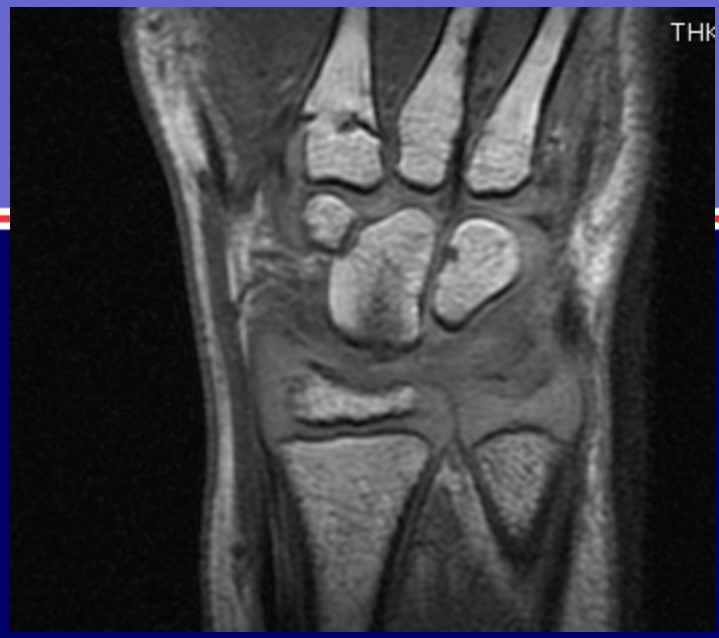
The End! Good Luck!

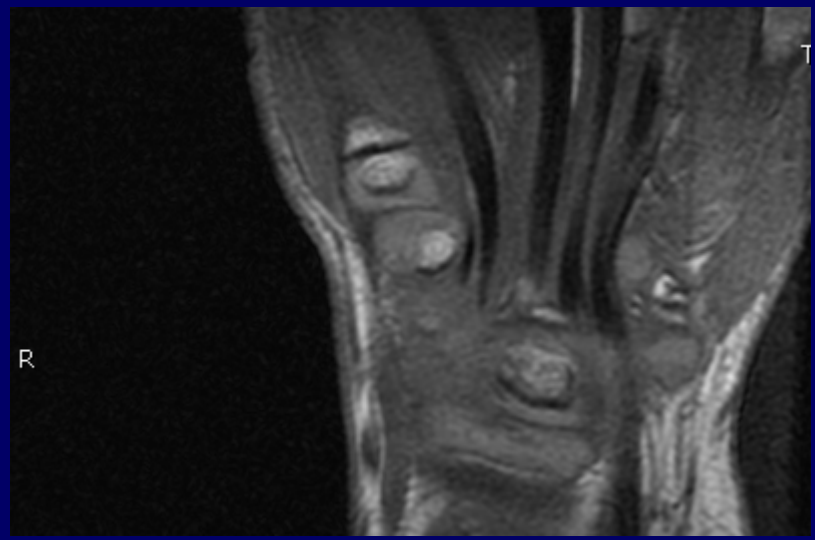
?navicular fx.

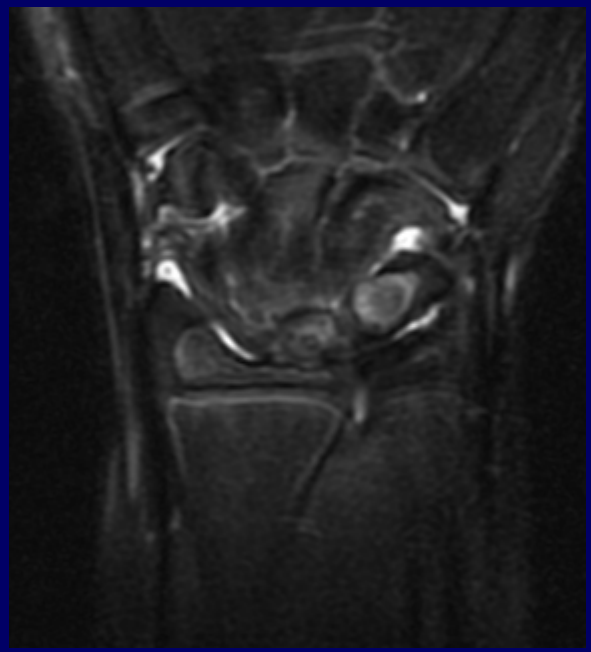
Carpal Tunnel

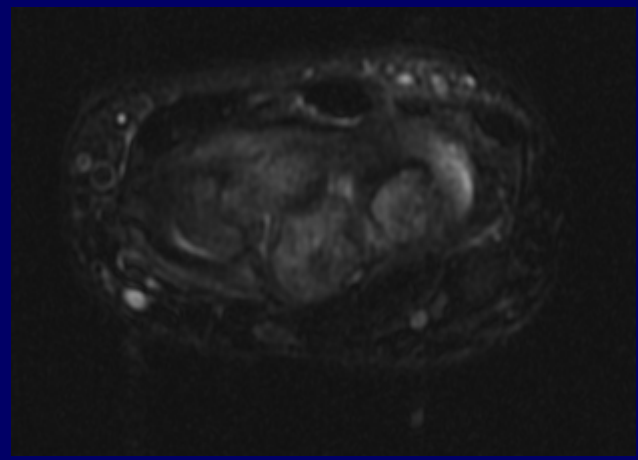


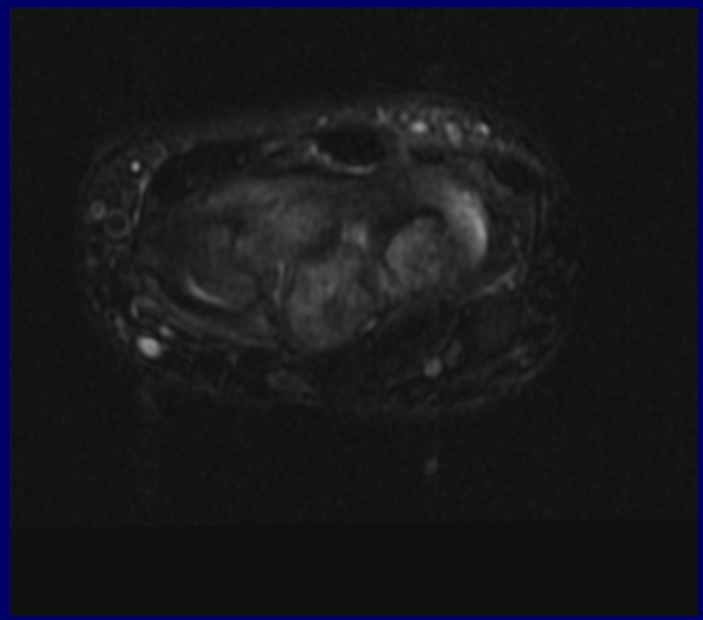


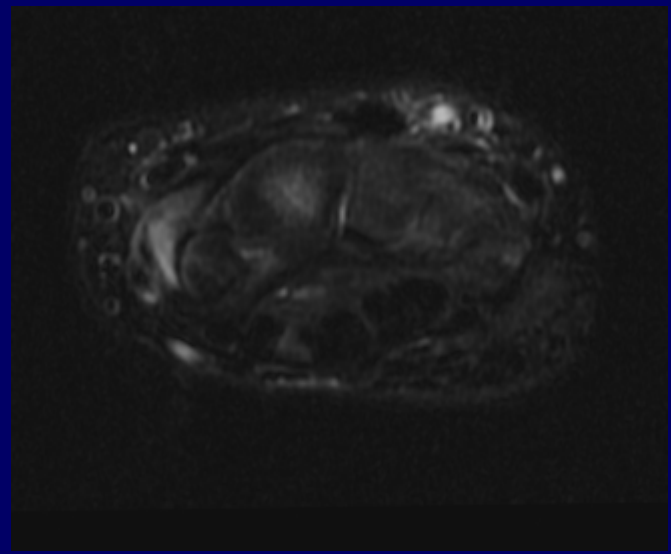


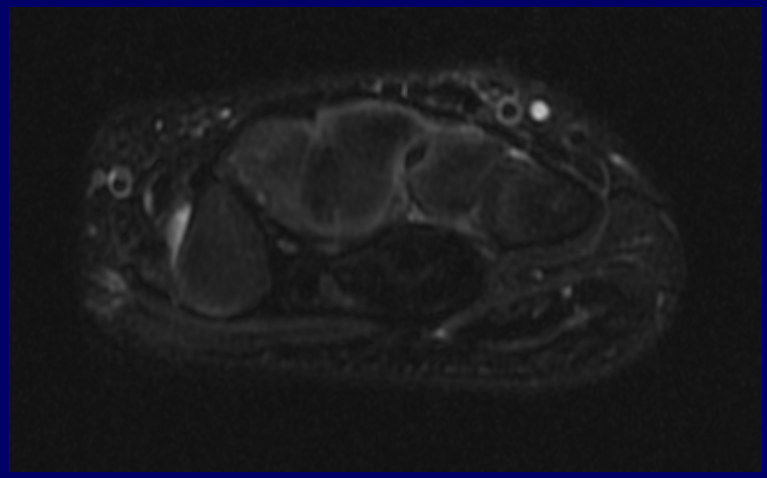


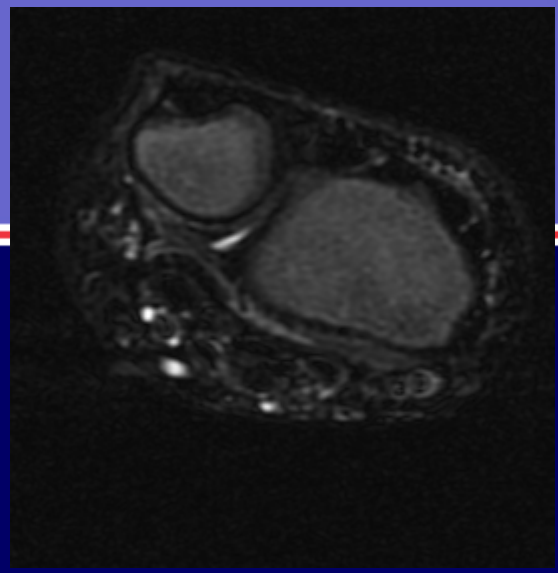


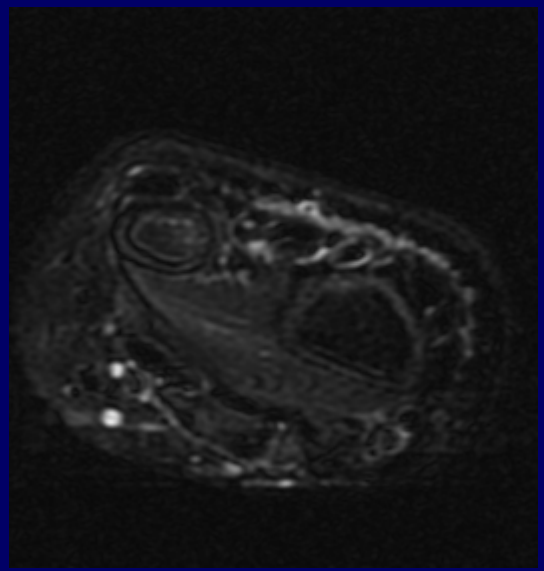


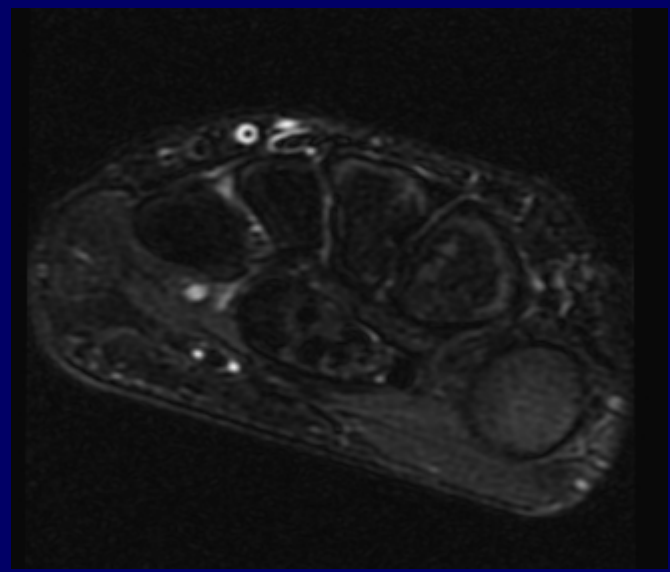












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