# Ultrasound Evaluation of Wrist and Hand Pathology

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## Disclosures

- Consultant: Bioclinica
- Contractor: POCUS PRO
- Advisor: Philips
- Book Royalties: Elsevier
- Not relevant to this lecture



See www.jacobsonmskus.com for syllabus other educational material

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## Pathology:

- Joint effusion and synovitis
- Tendon abnormalities
- Nerve entrapment
- Ligament injury
- Cysts and masses

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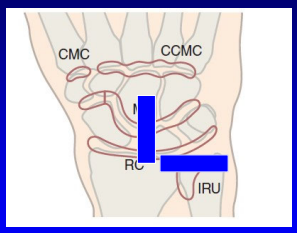
## Joint Assessment: dorsal

- Wrist:
  - Radiocarpal joint (RC)
  - Midcarpal joint (MC)
  - Distal or inferior radioulnar joint (IRU)
- Hand:
  - MCP and PIP joints
  - 1st CMC (if symptomatic)

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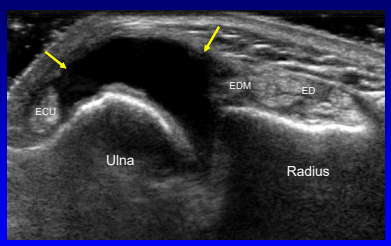
## Joint Effusion: distal radioulnar joint




Transverse

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## Joint Effusion and Synovitis

- Distention of joint recesses
  - Anechoic: simple fluid
  - Other: complicated fluid or synovium
- Sonography cannot differentiate sterile from septic joint fluid

AJR 2000; 174: 1353

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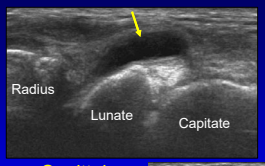
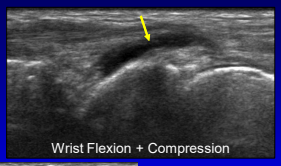
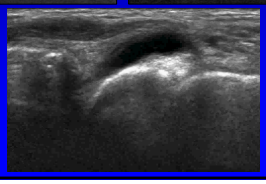
## Effusion: radiocarpal joint dorsal recess




Sagittal



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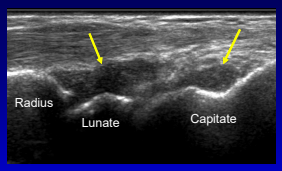
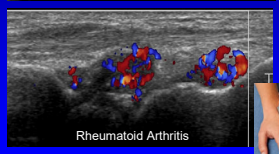
## Inflammatory Arthritis: role

- Identify synovitis and erosions
  - Prior to initiating treatment
- Determine activity: hyperemia
- Aspirate or inject
- Follow-up after therapy
  - Decreased hyperemia
  - Decreased synovial thickness

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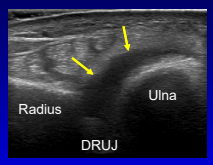
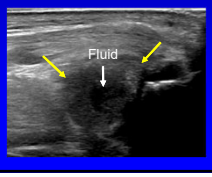
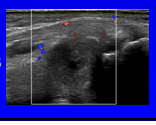
## Joint Effusion vs Synovial Hypertrophy

- Anechoic: fluid
- Hypoechoic:
  - Effusion vs. synovial hypertrophy
  - Compressible: fluid
  - Internal hyperemia: synovitis
    *flow may be absent



AJR 2000; 174: 1353

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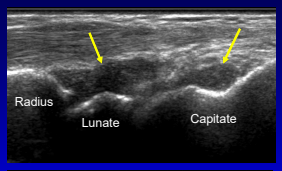


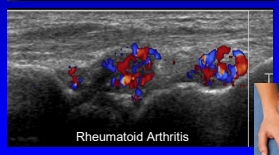


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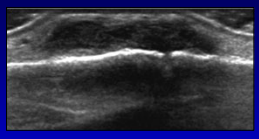
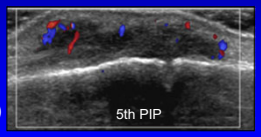
## Arthritis: synovitis

- Synovial locations:
  - Joint recess, bursa, tendon sheath
- Hypoechoic compared to adjacent subcutaneous fat
  - May be isoechoic or hyperechoic
- Hyperemia: variable
  - Represents activity of inflammation
  - Decreased: treatment (even NSAIDS)






Backhaus M, Arthritis and Rheum 1999; 42:1232

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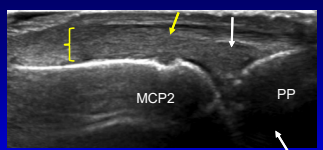
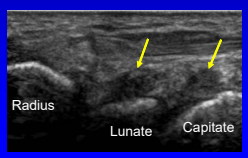
## *Pitfall Alert!* Normal Joint Capsule Appearance

- Dorsal capsule thickness:
  - MCP 1: 6 mm
  - MCP 2: 4 mm
  - MCP 3-5: 3 mm
  - RC joint: 4 mm
  - MC joint: 3 mm
- Do not interpret as abnormal synovial hypertrophy

**Falkowski A et al. Eur J Radiology 2020; 124*




**Note normal echogenic triangular fibrocartilage (white arrow)*

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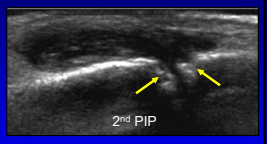
## Erosions

- Disrupted cortex in 2 planes
- Ultrasound not very good for erosions:
  - Better than radiographs
  - 40% sensitivity[1], 29% false positives[2]: wrist/hand compared with CT
  - Very non-specific, time consuming
- Adjacent synovitis adds specificity
- Correlate with radiographs, labs, distribution




[1]Dohn UF M. Arthritis Res Ther 2006; 8:1
[2]Finzel S. et al. Arth Rheumatism 2011; 63:1231

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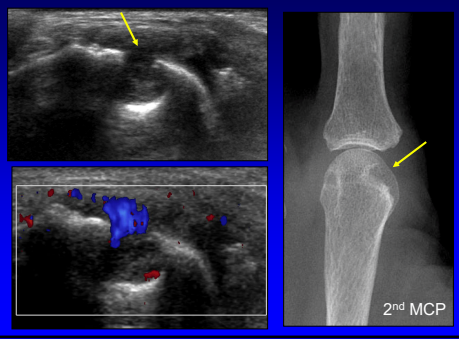
## Rheumatoid Arthritis

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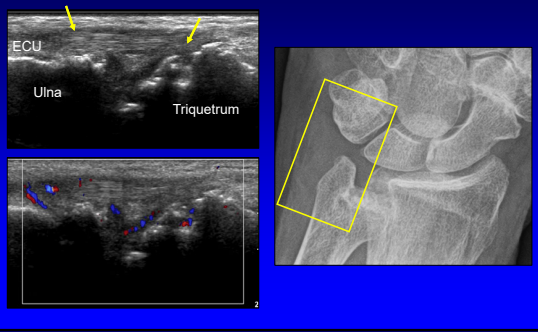
## Rheumatoid Arthritis

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## *Pitfall Alert!* Pseudoerosion

- Metacarpal head: dorsal
- Up to 37% of metacarpal heads: 2nd most common
- Bare area: no hyaline cartilage
- Unlike erosion:
  - Smooth
  - Maximum depth: 2 mm
  - No adjacent synovitis

Boutry N. et al. Radiology 2004; 232:716

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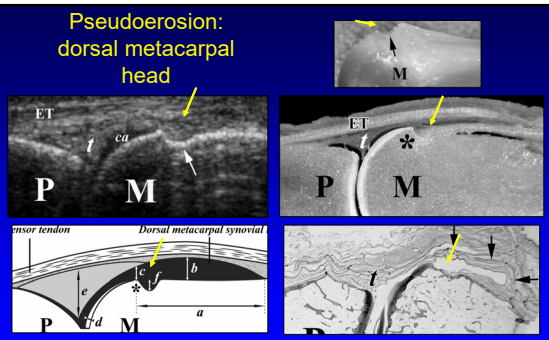
## Pseudoerosion: dorsal metacarpal head




Radiology 2004; 232:716

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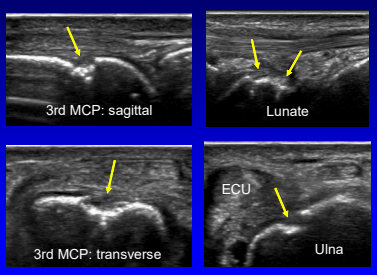
## *Pitfall Alert!* Pseudoerosions Are Everywhere!

- Pseudoerosions: 100%
- Metacarpal heads: all
  - 2nd: 92%
  - 3rd: 86%
- Carpal bones:
  - Lunate: 82%
  - Triquetrum: 84%
  - Distal ulna: 22%

**Falkowski A et al. Eur J Radiology 2020; 124*




**Note lack of adjacent synovitis*

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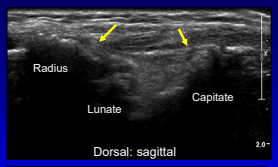
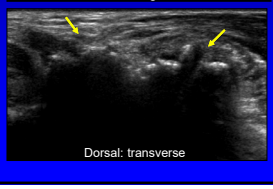
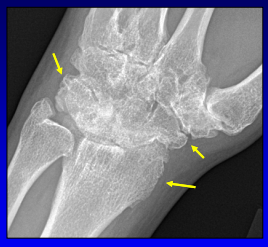
## Psoriatic Arthritis



Note: joint space narrowing and extensive bone proliferation

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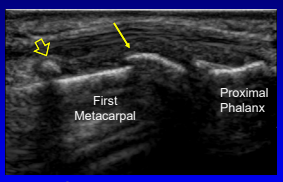
## Osteoarthritis: ultrasound

- Osteophytes
- Joint effusion
- Minimal synovial hypertrophy
- Variable hyperemia
- Possible intra-articular bodies

Keen HI et al. Radiol Clin N Am 2009; 47:581

First CMC Joint: Thumb




Sagittal Plane: dorsal

Note: osteophytes (arrow) and intra-articular body (open arrow)

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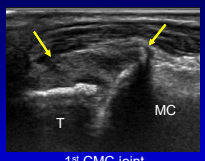
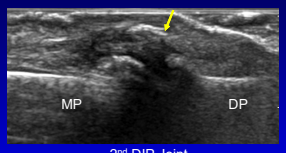
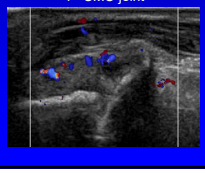
## Osteoarthritis

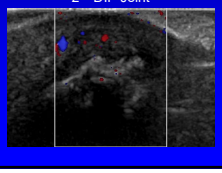



1st CMC joint




2nd DIP Joint





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## Erosions: specificity

- To add specificity to bone irregularity:
  - Correlate with history
  - Correlate with lab values
  - Review radiographs!
  - Look at distribution
  - Evaluate for adjacent synovitis (if acute)

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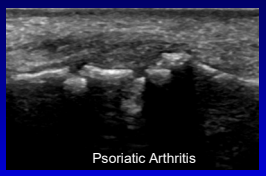
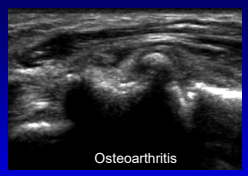
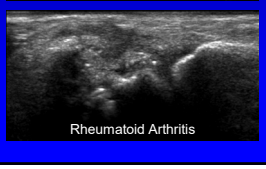
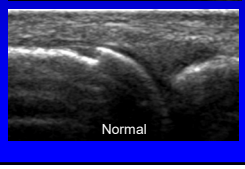
## Cortical Irregularity

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## Synovitis: screening (<10 minutes)

- Hand and wrist: *(6 joints – actually 10)*
  - Radiocarpal, midcarpal, distal radioulnar (dorsal)
  - MCP2 and 3 (dorsal): transverse and sagittal
  - Any symptomatic site
  - Cine: flexor and extensor tendons (short axis)
- Ankle and Foot:
  - Ankle joint
  - MTP5 (dorsal and plantar)
  - Any symptomatic site

Rosa J et al. J Clin Rheumatol 2016; 22: 179

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## Pathology:

- Joint effusion and synovitis
- Tendon abnormalities
- Nerve entrapment
- Ligament injury
- Cysts and masses

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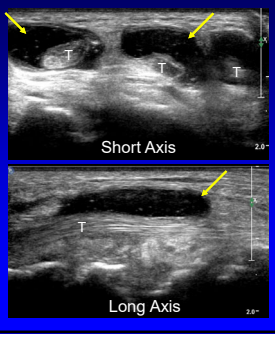
## Tenosynovitis (paratenonitis):

- Simple fluid: anechoic
- Complex fluid: mixed echogenicity
- Synovitis:
  - Hypoechoic
  - Echogenic if gout

Rheumatoid Arthritis







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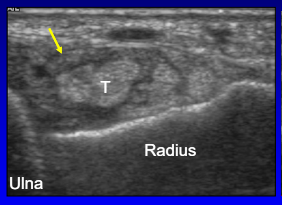
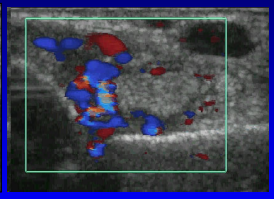
## Tenosynovitis: lupus




Short Axis



color Doppler

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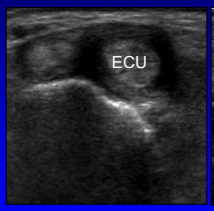
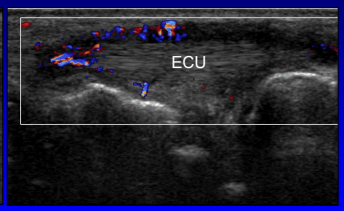
## Tenosynovitis: rheumatoid arthritis




Short Axis




Long Axis: color Doppler

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## de Quervain Tenosynovitis:

- Stenosing tenosynovitis
  - Overuse, primary care givers
- 1st dorsal wrist compartment:
  - Extensor pollicis brevis + abductor pollicis longus
- Ultrasound findings:
  - Thick synovial sheath
  - Tendinosis
  - Cortical irregularity, hyperemia

J Ultrasound Med 1997; 16:685

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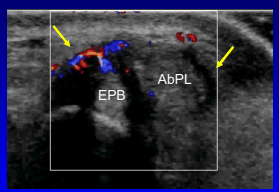
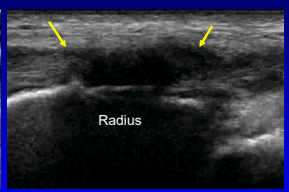
## De Quervain's Tenosynovitis




Short Axis




Long Axis

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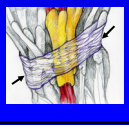
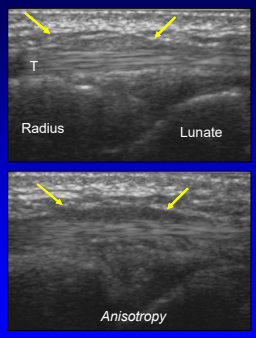
*Pitfall Alert!*
## Pseudo-tenosynovitis

- Extensor retinaculum
- Hypoechoic due to anisotropy
- Characteristic location
- Up to 1.7 mm thick and 23 mm in width



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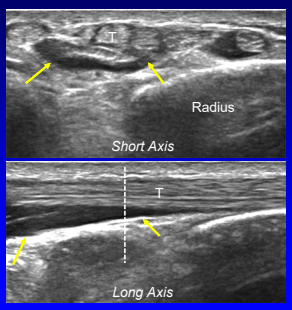
*Pitfall Alert!*
## Pseudo-tenosynovitis

- Hypoechoic muscle
- Musculotendinous junction
- Confirmed in long axis
- Normal tapering of muscle

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## Tendon Tear

- Hypoechoic or anechoic
- Disruption of tendon fibers
- Retraction: full-thickness
  - Dynamic imaging

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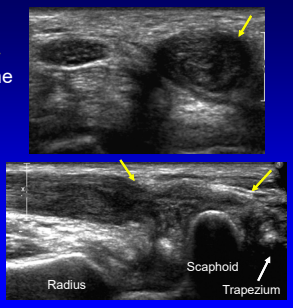
## Flexor Carpi Radialis

- Courses volar to triscaphe joint (scapho-trapezium-trapezoid compartment)
- FCR tendinosis and tear
- Associated triscaphe osteoarthritis




Parellada et al. Skeletal Radiol 2006; 35:572

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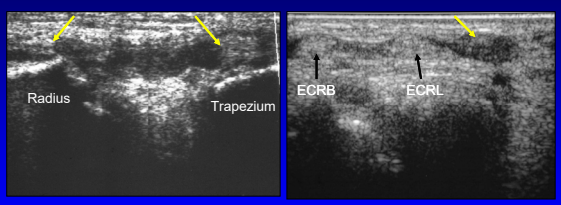
## Extensor Pollicis Longus: tear




Long Axis  Short Axis

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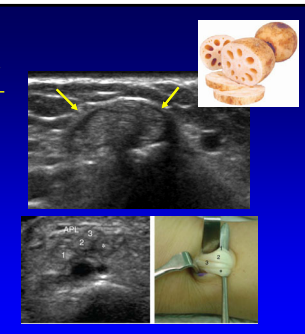
*Pitfall Alert!*
## Pseudo-tendon Tear

- Multiple tendon fascicles
- Abductor pollicis longus
  - Incidence: 80%
  - Up to 4 fascicles
- Extensor pollicis brevis
  - Incidence: 7%
  - Up to 2 fascicles
  - May be absent
- "Lotus Root Sign"
  - Seen best distal to radius



Rousset et al. Radiology 2010; 257:427
Choi et al. Radiology 2011; 260:480

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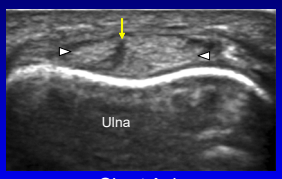
*Pitfall Alert!*
## Pseud-tendon tear

- Extensor carpi ulnaris
- 6th extensor compartment
- Short axis: hypoechoic cleft
- Due to fibrovascular tissue in between two heads of extensor carpi ulnaris



Short Axis

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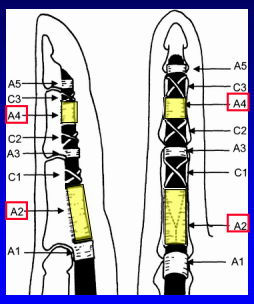
## Pulley Tear

- A2 and A4 pulleys: most important
- Sagittal image
  - Bowstringing
  - Hypoechoic edema / hemorrhage
- Dynamic evaluation*




*Radiology 2002; 222:755

Radiology 1998; 206:339

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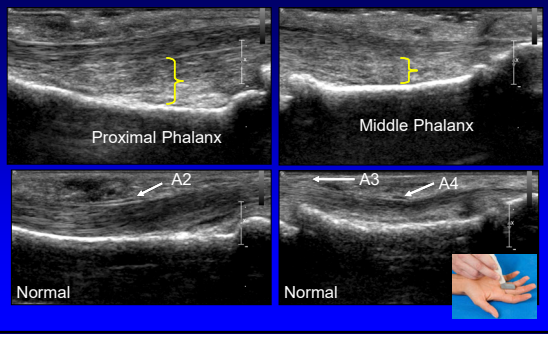
## A2 – 4 Pulley Injury

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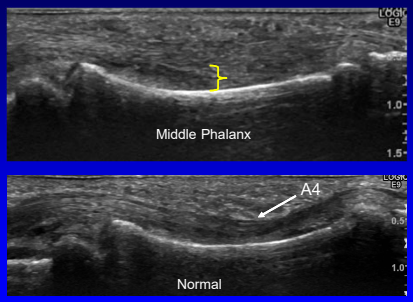
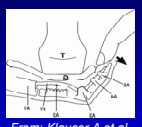
## A4 Pulley Injury: bowstringing



*From: Klauser A et al. Radiology 2002;222:755-761*

Normal: < 1 mm; incomplete rupture: 1 – 3 mm; complete: 3 mm

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## Trigger Finger:

- Stenosing tenosynovitis: A1 pulley
- Thick and hypoechoic pulley
- Hyperemia: 91%
- Tendinosis: 48%
- Tenosynovitis: 55%

Guerini et al. J Ultrasound Med 2008; 27:1407

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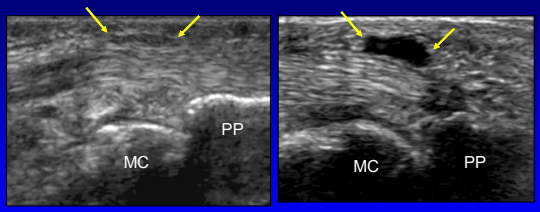
## Trigger Finger: A1 pulley




Case #1 Case #2

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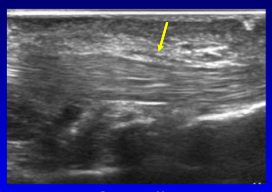
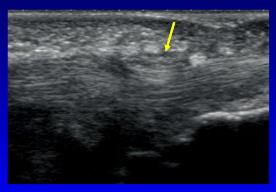
## Trigger Finger: thumb



Case #1



Case #2

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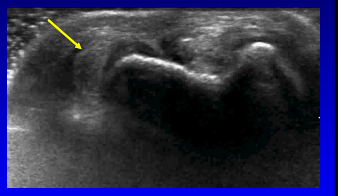
## Extensor Carpi Ulnaris

- 6th extensor wrist compartment
- Dislocation:
  - Dynamic
  - Supination/pronation
  - Subsheath tear or dysfunction
- Predisposes to tendon tear and tenosynovitis



Campbell D et al. Br J Sports Med 2013; 47:1105

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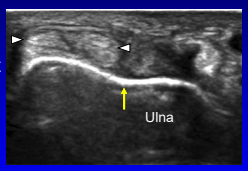
## *Pitfall Alert!* Pseudo-subluxation

- Extensor carpi ulnaris
- 6th extensor wrist compartment
- Asymptomatic subluxation
  - Supination
  - Up to 50% out of groove
  - No tear or tenosynovitis




Lee KS et al. AJR 2009; 193:651

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## Pathology:

- Joint effusion and synovitis
- Tendon abnormalities
- Nerve entrapment
- Ligament injury
- Cysts and masses

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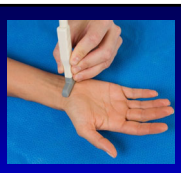
## Carpal Tunnel Syndrome:

- Proximal median nerve swelling
  - Area: circumferential trace
  - Normal: <9 $mm^2$
  - Borderline: 9 – 12 $mm^2$
  - Abnormal: > 12 $mm^2$
    - 12.8 $mm^2$ = moderate (83% sens, 95% spec)
    - 14.0 $mm^2$ = severe (77% sens, 100% spec)



Klauser AS et al. Sem Musculoskel Rad 2010; 14:487
Ooi et al. Skeletal Radiol 2014; 43:1387

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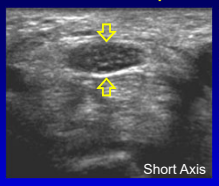
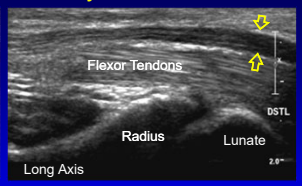
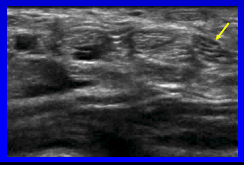
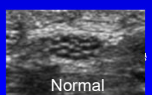
## Carpal Tunnel Syndrome



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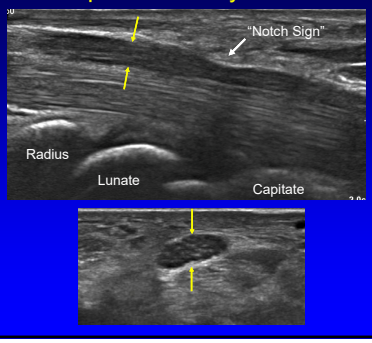
## Carpal Tunnel Syndrome



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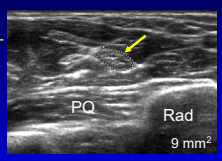
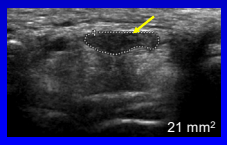
## Carpal Tunnel Syndrome

- Compare areas:
  - Proximal: pronator quadratus
  - Distal: carpal tunnel
- = or >2 mm$^2$ = carpal tunnel syndrome
- 99% sensitivity
- 100% specificity

Klauser AS. Radiology 2009; 250:171

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## Median Nerve: how to measure

- Short axis
- Toggle transducer: defined borders
- Site of maximal enlargement
- Circumferential trace
- Inner border of hyperechoic epineurium

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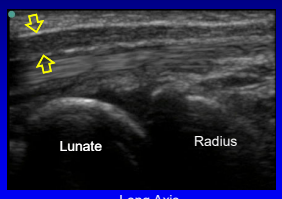
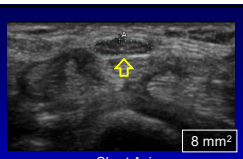
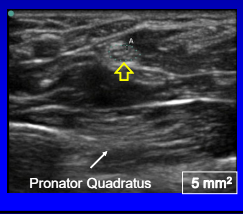
## Carpal Tunnel Syndrome




Long Axis




Short Axis

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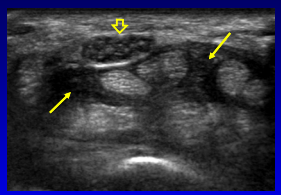
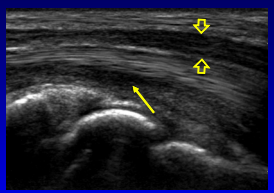
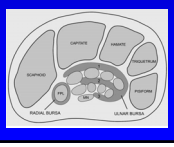
## Carpal Tunnel Syndrome: ulnar bursa distention







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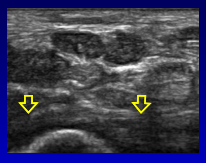
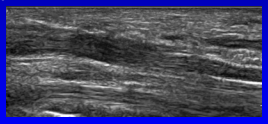
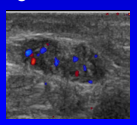
## Bifid Median Nerve + CTS

- Carpal tunnel syndrome[1]
  - Increase in cross-sectional area of ≥ 4 mm$^2$
- Intraneural hypervascularity: 95% accuracy in diagnosis of CTS[2]







[1]Klauser et al. Radiology 2011; 259; 808
[2]Mallouhi et al. AJR 2006; 186:1240

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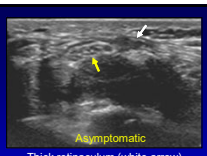
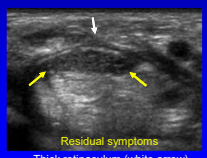
## Postoperative Carpal Tunnel

- Discontinuous or thickened transverse carpal ligament
- Anterior displacement of transverse carpal ligament[1]
- Median nerve size:
  - May decrease[2]
  - Does not correlate with success[3]

[1]Lee CH et al. Ann Plast Surg 2005; 54:143
[2]Abicalaf CA et al. Clin Radiol 2007; 62:891
[3]Naranjo A et al. Scand J Rheum 2010; 39:49



Thick retinaculum (white arrow)
Normal median nerve size (yellow arrow)



Thick retinaculum (white arrow)
Enlarged median nerve (yellow arrow)

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## Pathology:

- Joint effusion and synovitis
- Tendon abnormalities
- Nerve entrapment
- Ligament injury
- Cysts and masses

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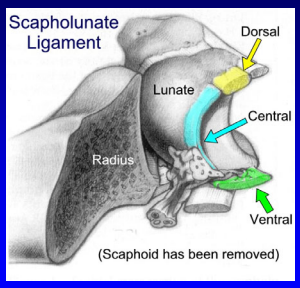
## Scapholunate Ligament




*From*: Linkous MD, et al. Radiology 2000; 216:846

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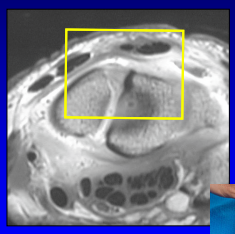
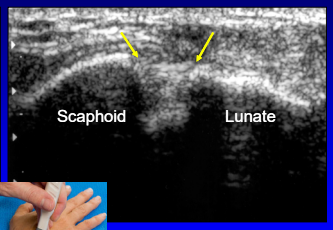
## Dorsal Wrist: scapholunate ligament


Axial T1w



Transverse

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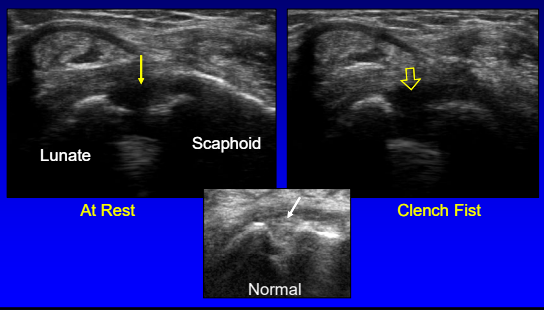
## Scapholunate Ligament Tear

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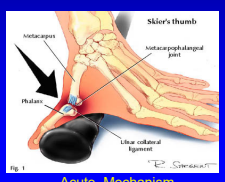
## Gamekeeper's or Skier's Thumb

- Injury: ulnar collateral ligament of first MCP joint
- Chronic (gamekeeper's thumb): historically in Scottish gamekeepers
- Acute (skier's thumb): acute hyperabduction



Acute Mechanism

Chronic Mechanism

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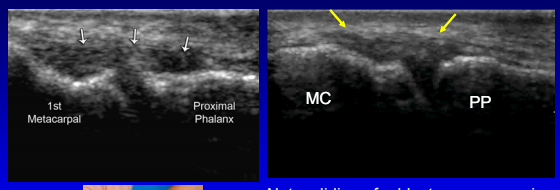
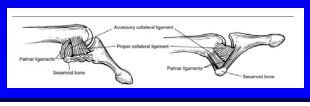
## Ulnar Collateral Ligament: thumb




Note: sliding of adductor aponeurosis with isolated interphalangeal joint flexion



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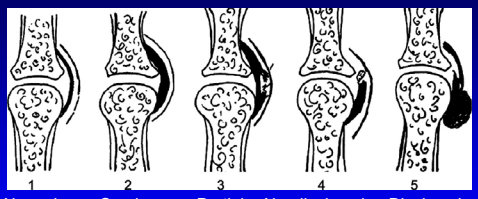
## Ulnar Collateral Ligament: thumb




Normal | Sprain | Partial Tear | Nondisplaced Complete Tear (+ fracture) | Displaced Complete Tear (Stener Lesion)

Radiographics 2006;26:1007

RadioGraphics

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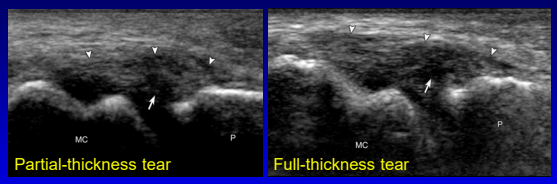
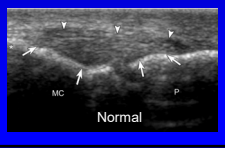
## UCL: tears

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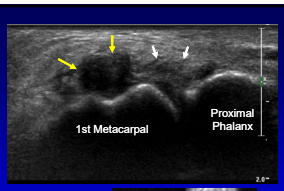
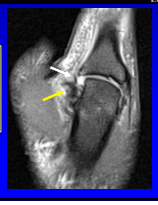
## Stener Lesion

- Displaced proximal stump of UCL
  - Hypoechoic & round
  - Proximal to MCP joint
  - At proximal edge of adductor pollicis aponeurosis
- No tissue spanning MCP joint
- "Yo-yo on a string" sign
- Ultrasound: 100% accuracy




Yellow arrows: Stener
White arrows: aponeurosis



*Melville D. et al. Skeletal Radiology 2013; 42:667

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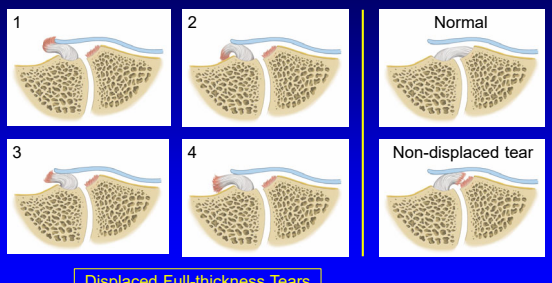
## Stener Lesion: variations




Displaced Full-thickness Tears

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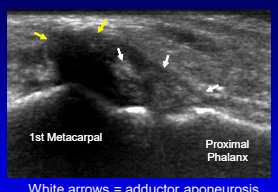
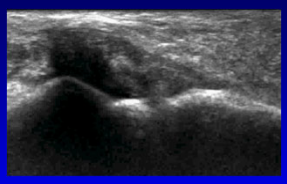
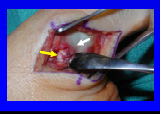
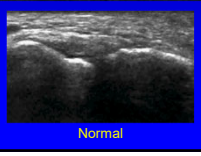
## Stener Lesion: dynamic



White arrows = adductor aponeurosis
Yellow arrows = Stener lesion





Normal

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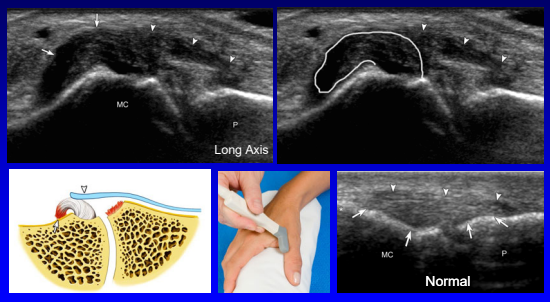
## Stener Lesion




*From: Melville D. et al. Skeletal Radiology 2013; 42:667*

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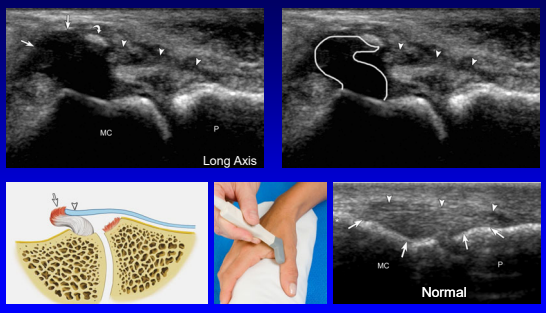
## Stener Lesion




*From: Melville D. et al. Skeletal Radiology 2013; 42:667*

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## Pathology:

- Joint effusion and synovitis
- Tendon abnormalities
- Nerve entrapment
- Ligament injury
- Cysts and masses

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## Soft Tissue Mass: wrist ganglia

- Most wrist masses are ganglion cysts
- Volar (69%): radial artery & flexor carpi radialis
  - Proximal from radioscaphoid joint capsule
- Dorsal: scapholunate ligament
  - Not compressible (unlike joint recess)

*Skeletal Radiol 1994; 23:201

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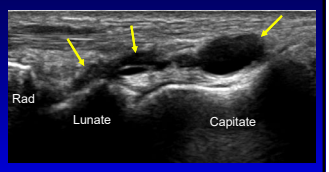
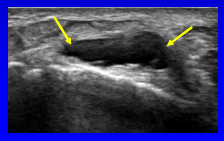
## Ganglion: wrist

- Anechoic or hypoechoic
- Multilocular (except digits)
- Non-compressible
- Joint or tendon sheath communication
- <10 mm: hypoechoic without posterior acoustic enhancement

*Wang et al. J Ultrasound Med 2007; 26:1323

Dorsal Wrist



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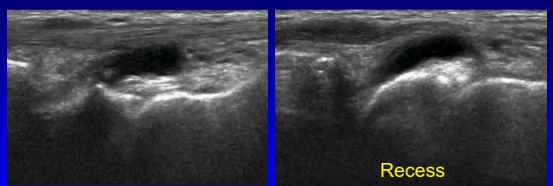
## Ganglion Cyst vs Dorsal Recess




Ganglion: not compressible

Recess: compressible

Sagittal with Wrist Flexion

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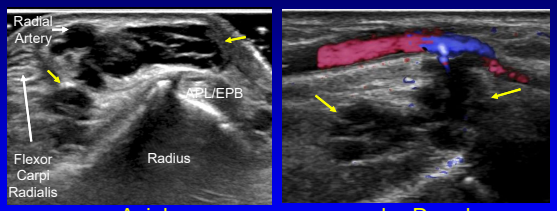
## Ganglion: volar




Axial color Doppler

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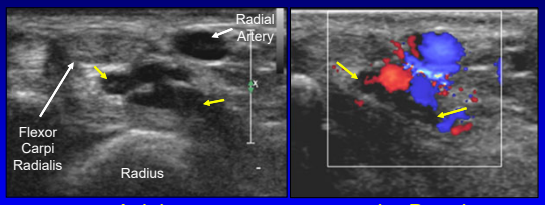
## Ganglion Cyst: volar




Axial color Doppler

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## Take Home Points:

- Arthritis: emphasize synovitis
- Nerve: swelling at entrapment site
- Stener:
  - Proximal to MCP joint and aponeurosis
  - Dynamic imaging
- Ganglion cysts:
  - Volar at FCR and radial artery
  - Dorsal over SL ligament

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Thank you!

Syllabus on line and other educational material:
www.jacobsonmskus.com

Twitter handle: @jjacobsn

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