

# Ultrasonography: Sports Injuries

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### Disclosures

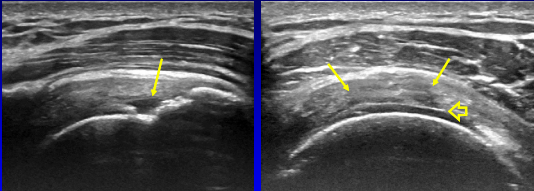
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- Book Royalties: Elsevier
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- Advisory Board: Philips
- Not relevant to this talk

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*Note: all images from the textbook Fundamentals of Musculoskeletal Ultrasound are copyrighted by Elsevier Inc.*

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### Case #1: Supraspinatus Tendon



Long Axis                      Short Axis

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### Case #1:

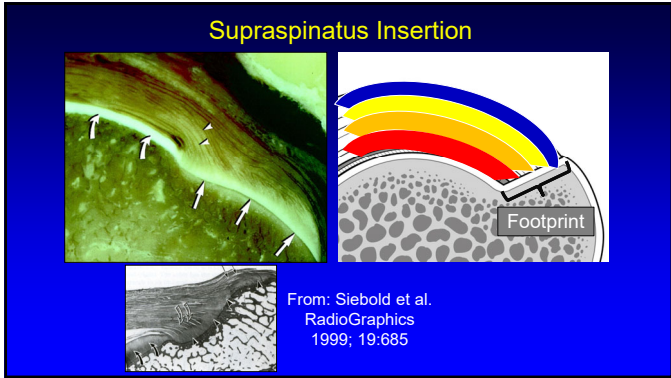
- Findings:
  - Well-defined hypoechoic defect
  - Cortical irregularity: greater tuberosity
  - Cartilage interface sign
- Diagnosis:
  - Articular-sided partial-thickness supraspinatus tear

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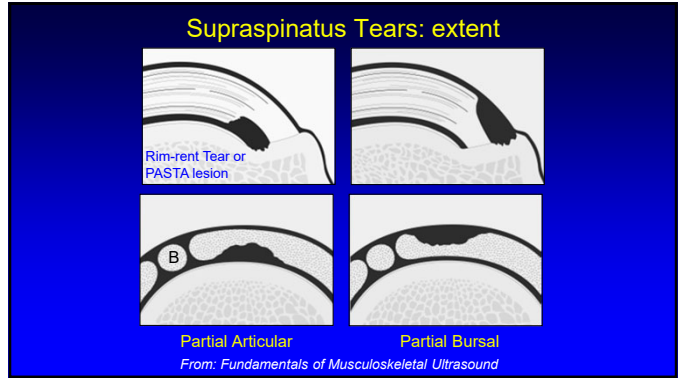
### Rotator Cuff Tears:

- Most tears are hypoechoic / anechoic
- Larger tears: deltoid dips into tendon gap
- Massive tear: non-visualization
- Adjacent cortical irregularity: important indirect sign of supraspinatus tear

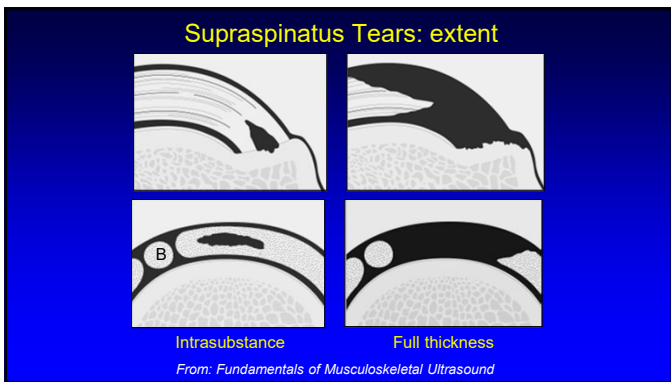
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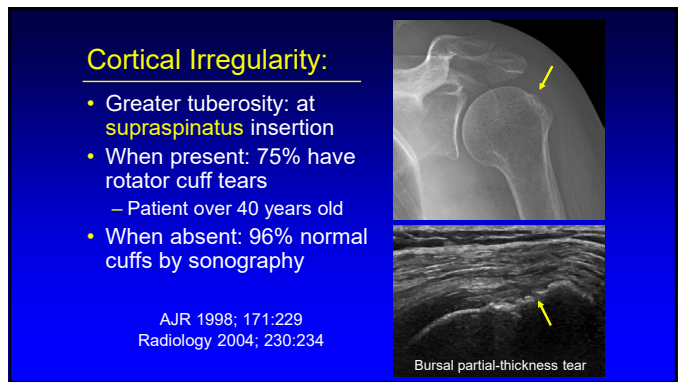
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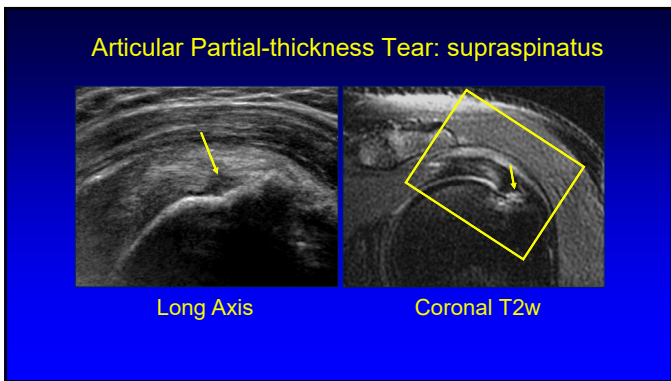
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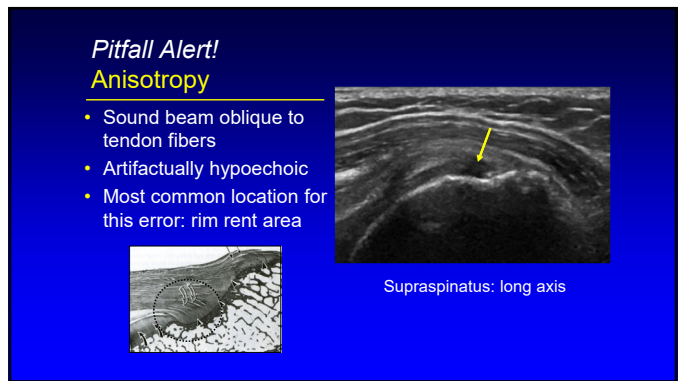
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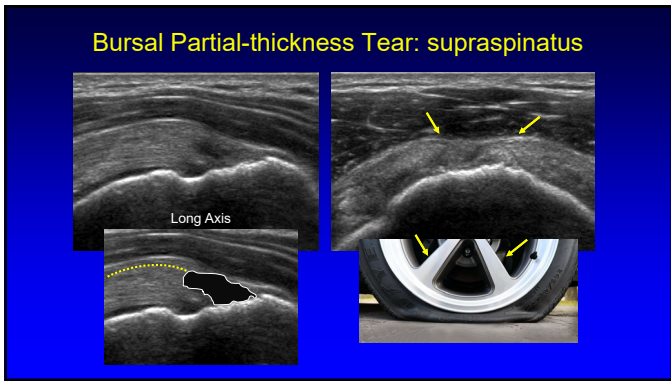
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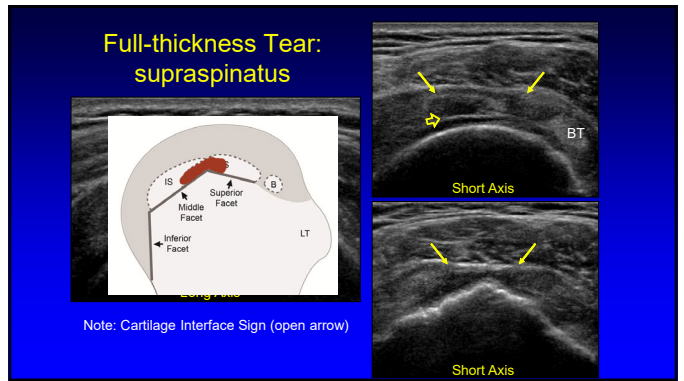
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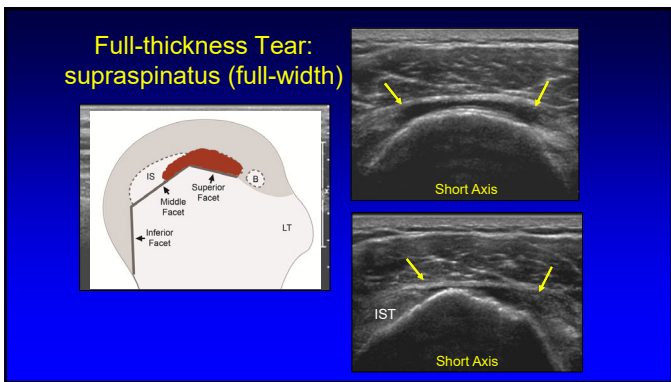
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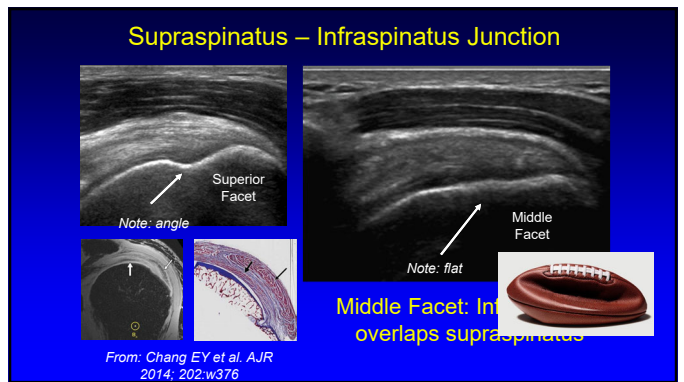
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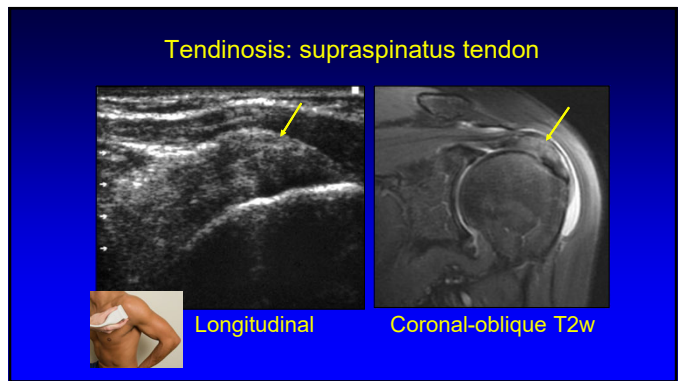
### Tendon Tear versus Tendinosis

*\*both may appear hypoechoic*

Tear	Tendinosis
• Anechoic	• Hypoechoic
• Well-defined	• Ill-defined
• Homogeneous	• Heterogeneous
• Thinned	• Swollen
• Bone irregularity*	• Smooth cortex

\*At supraspinatus tendon footprint in patients over 40 years old

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### Case #1: Take Home Points

- Tear: well-defined hypoechoic defect
- Cortical irregularity: supraspinatus footprint
- Cartilage interface: articular extension
- Pitfall: focal anisotropy
- Tuberosity anatomy

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### Case #2: Distal Biceps Brachii

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### Case #2:

- Findings:
  - Biceps brachii tendon defect
  - Tendon retraction
  - Posterior acoustic shadowing
- Diagnosis:
  - Biceps brachii tendon tear: retracted, full-thickness

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### Biceps Brachii:

- Insertion: radial tuberosity
  - Short head: superficial, distal
  - Long head; deep, proximal
- No synovial sheath
- Bicipitoradial bursa

From: Eames M. et al. J Bone Joint Surg 2007;89:1044

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### Biceps Brachii Tendon: distal

1 = long head  
2 = short head

Tagliafico A., et al. Eur Radiol 2010

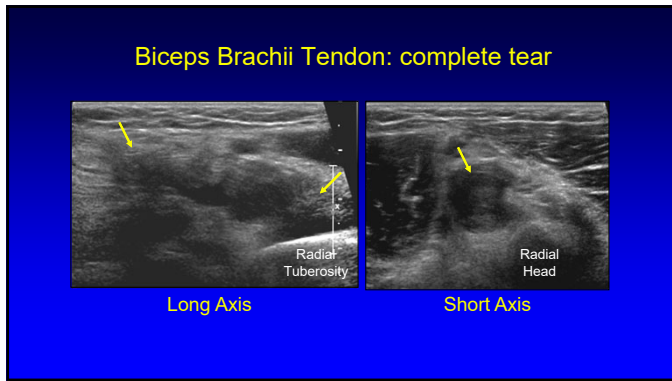
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### Biceps Brachii: terminal bifurcation

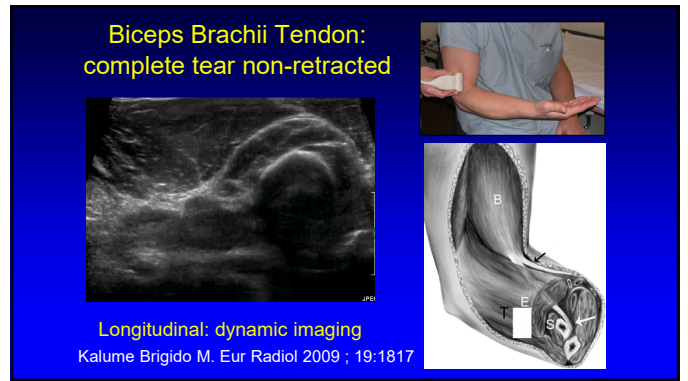
Note: toggling the transducer, which creates anisotropy allows visualization of two tendon heads

Courtesy of M. Chiavaras, Hamilton, Ontario

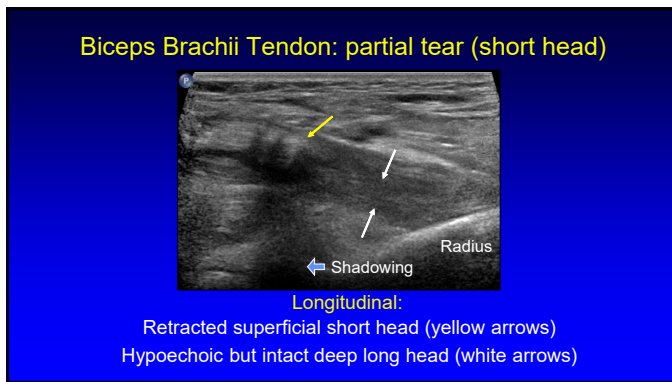
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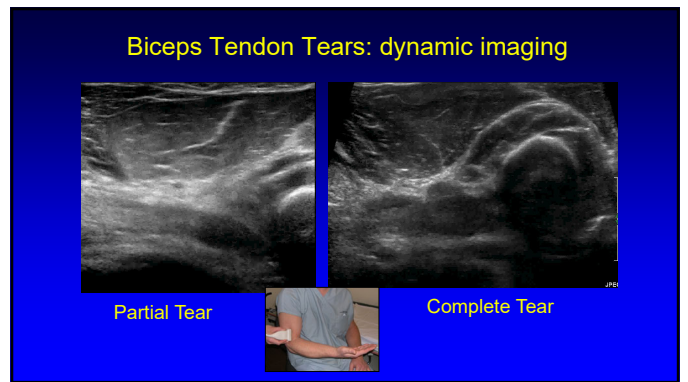
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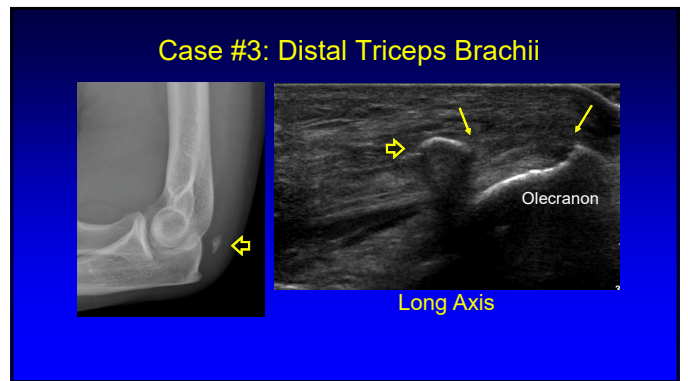


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### Case #2: Take Home Points

- Biceps brachii: terminal bifurcation
- Dynamic imaging:
  - Supination and pronation
  - Non-retracted full-thickness from partial-thickness tendon tear

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**Case #3:**

- Findings:
  - Triceps brachii tendon defect
  - Tendon retraction
  - Avulsion fracture fragment
- Diagnosis:
  - Triceps brachii tendon tear: retracted, partial-thickness

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**Anatomy of the Distal Triceps Brachii**

- Superficial (blue arrow): long + lateral heads
- Deep (black arrow): medial head
  - Primarily muscular insertion

\*From Resnick, Skeletal Radiol 2009; 38:171

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**Triceps Tear: partial thickness tear**

- Superficial layer torn
  - Long and lateral heads
- Intact deep layer (medial head)
- Associated enthesophyte bone fragment
  - 1 – 2 cm in size
  - 2.5 – 4 cm retraction
  - No donor site

J Ultrasound Med 2011; 30:1351

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**Triceps Tendon: partial tear + avulsion**

Olecranon Bone Fragment      Intact Medial Head

*Long Axis (Sagittal Plane)*

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**Case #3: Take Home Points**

- Triceps brachii: two distal tendons
- Partial-thickness tear:
  - Superficial: long and lateral heads
  - Avulsion olecranon bone fragment
  - Intact deep medial head

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**Case #4: Common Extensor Tendon**

Long Axis      Short Axis

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**Case #4:**

- Findings:
  - Hypoechoic swollen common extensor tendon
  - Hyperemia
  - Normal radial collateral ligament
- Diagnosis:
  - Tendinosis of common extensor tendon

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**Lateral Collateral Ligament Complex**

- Radial collateral ligament (arrows)
- Common extensor tendon (E)
- Annular ligament (arrowhead)
- Lateral ulnar collateral ligament (curved arrow)

Jacobson J. et al. J Ultrasound Medicine 2013; 33:1041

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**Lateral Collateral Ligament Complex**

- Common extensor tendon (curved arrows)
- Radial collateral ligament (arrowheads)
- Annular ligament (a)

Note: footprints

Common Extensor Tendon Removed

Jacobson J. et al. J Ultrasound Medicine 2014; 33:1041

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**“Epicondylitis”**

- Common flexor and extensor tendons
- Abnormal hypoechoogenicity
  - Mucoid degeneration, tendinosis
- Anechoic: partial-thickness tear
- No inflammatory cells\*

Potter, Radiology 1995; 196:43  
Connell, AJR 2001; 176:777

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**Common Extensor Tendon: elbow**

- Often called “tennis elbow” or “lateral epicondylitis” or “epicondylosis” or .....
- All terms are misnomers
- Those inflicted usually do not play tennis (professionally or correctly)
- It is not inflammatory
- It is not a primary problem of the epicondyle

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**Common Extensor Tendon: tendinosis**

Lateral Epicondyle

Radial Head

Patient #1

Patient #2

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### Case #4: Take Home Points

- The term “epicondylitis” is a misnomer
- Tendinosis and tendon tear
- No inflammation
- Radial collateral ligament tear: poor prognosis

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### Case #5: Ulnar Collateral Ligament

Neutral      Dynamic: Valgus Stress

Long Axis

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### Case #5:

- Findings:
  - Non-visualization of ulnar collateral ligament
  - Widening of medial elbow joint with valgus stress
- Diagnosis:
  - Ulnar collateral ligament tear: complete

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### Ulnar Collateral Ligament

Anterior, Posterior, and Transverse Bundles

From: AJR 2003; 180:389

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### UCL and Common Flexor Tendon

Coronal

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### Ulnar Collateral Ligament

- Valgus stress: 30 degrees elbow flexion
  - Unlock the olecranon
  - Stress: UCL anterior bundle
- Gravity stress is adequate, equal to Telos<sup>1</sup>
- Ultrasound measurements:
  - Reliable and precise<sup>2</sup>

Ulnar Collateral Ligament: partial tear

<sup>1</sup>Harada M et al. J Sho Elb Surg 2014; 23:561  
<sup>2</sup>Bica D et al. J Ultrasound Med 2015; 34:371

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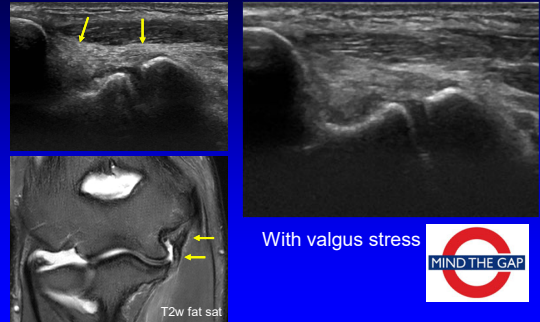
### Ulnar Collateral Ligament: valgus stress

- >1 mm asymmetric gapping = 87% accuracy in diagnosis of UCL tear
  - MR arthrography accuracy = 88%
  - US + MR arthrography: accuracy = 98%
- Asymmetric joint space widening with stress:
  - Normal: 1.3 mm or less
  - Partial tear: 1.2 – 3.0 mm
  - Full thickness tear: 2.8 – 4.8 mm

Roedl JB et al. Radiology 2016

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### Ulnar Collateral Ligament: laxity



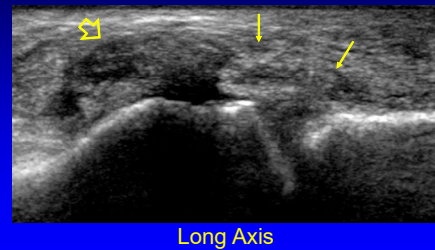
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### Case #5: Take Home Points

- Ultrasound can diagnosis UCL tears
- Dynamic imaging is essential:
  - Complete vs. partial tear
  - Intact but lax ligament
  - Complements MR arthrography

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### Case #6: Ulnar Collateral Ligament of Thumb



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### Case #6:

- Findings:
  - Non-visualization of ulnar collateral ligament
  - Hypochoic round structure proximal to adductor aponeurosis and MCP joint
- Diagnosis:
  - Displaced ulnar collateral ligament tear: Stener lesion

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### Gamekeeper's Thumb

- Injury of the ulnar collateral ligament (UCL) of the thumb MCP
  - Historically, chronic injury in Scottish gamekeepers
  - Frequently, due to acute MCP joint hyperabduction
  - Skier's thumb: up to 86% of thumb base injuries



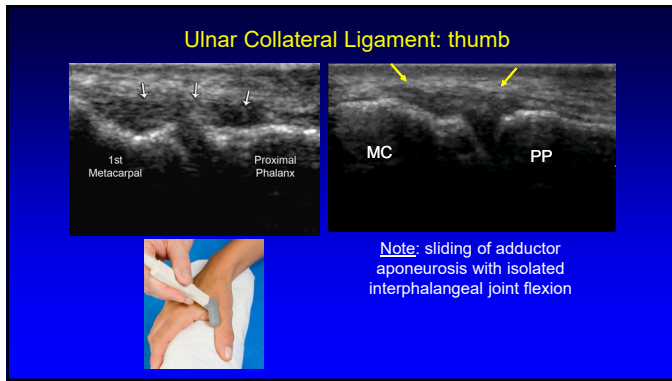
Acute Mechanism



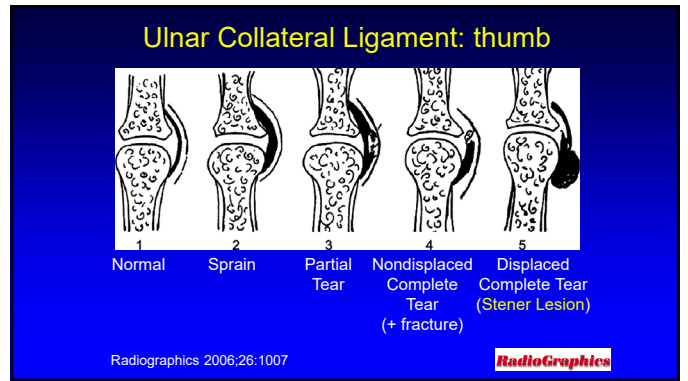
Chronic Mechanism



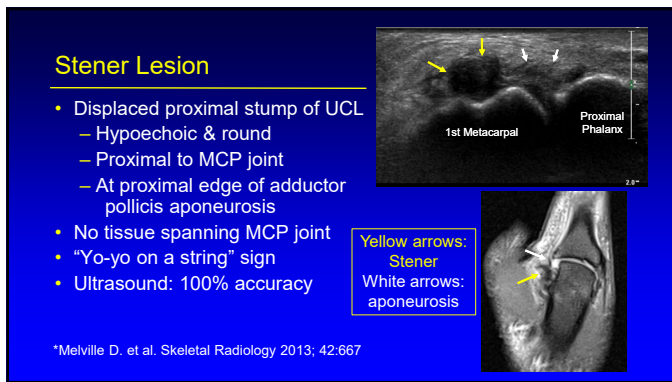
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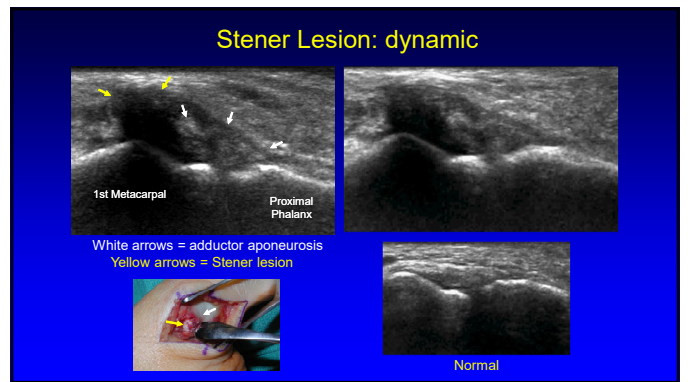
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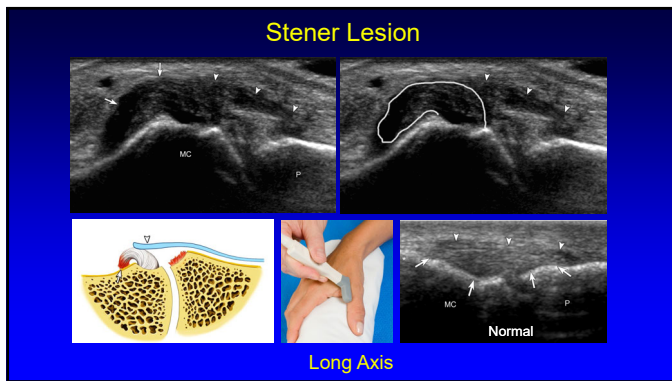
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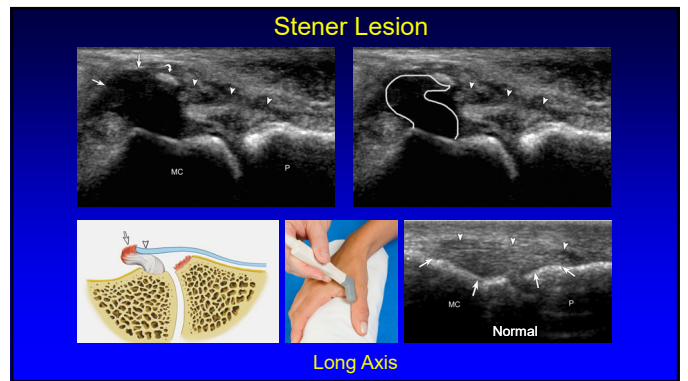
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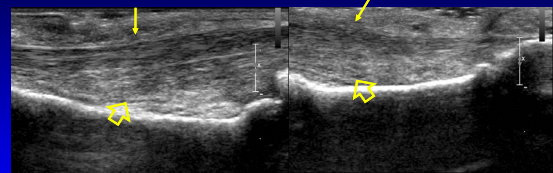
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### Case #6: Take Home Points

- Ultrasound is accurate for diagnosis of Stener lesion
- Stener: interposed aponeurosis
- Dynamic imaging is important:
  - Fluid tracks through ligament tear
  - Visualize the adductor aponeurosis

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### Case #7: flexor tendons of finger



Long Axis

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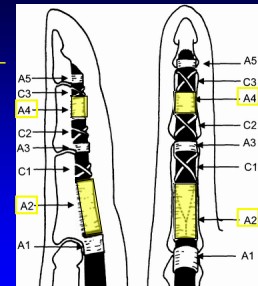
### Case #7:

- Findings:
  - Non-visualization A2 – A4 pulleys
  - Bowstringing of flexor tendons
- Diagnosis:
  - Pulley tears

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### Pulley Tear

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

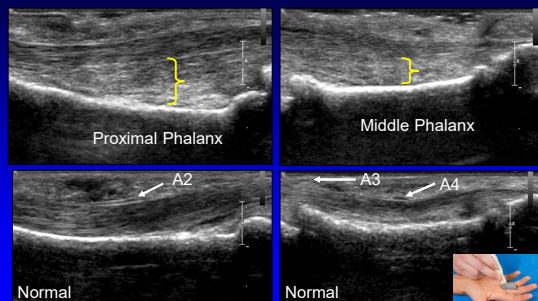


\*Radiology 2002; 222:755

Radiology 1998; 206:339

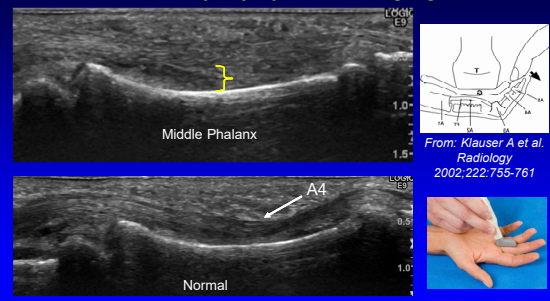
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### A2 – 4 Pulley Injury



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### A4 Pulley Injury: bowstringing



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

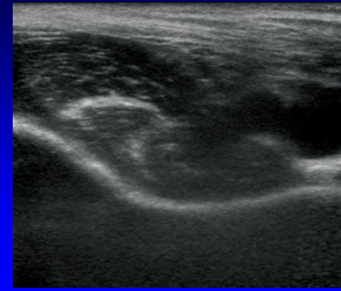
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### Case #7: Take Home Points

- Non-visualization of pulleys
- Bowstringing of flexor tendons
  - Use dynamic imaging

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### Case #8: Iliopsoas Tendon



Short Axis

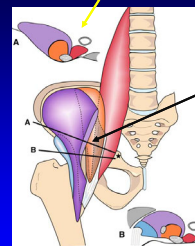
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### Case #8:

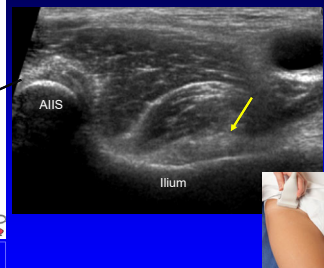
- Findings:
  - Abrupt snapping of psoas major tendon
  - Leg moved from abduction and flexion to straightening
- Diagnosis:
  - Snapping psoas major tendon

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### Iliopsoas Complex



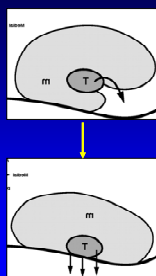
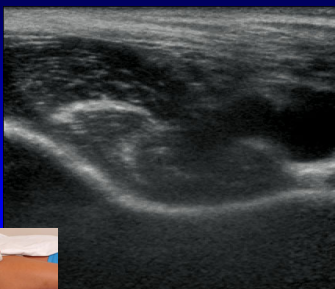
Red: psoas major  
Orange: medial iliac fibers  
Purple: lateral iliac fibers



From: Guillin R. et al. Eur Rad 2009; 19:995

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### Snapping Hip Syndrome: iliopsoas



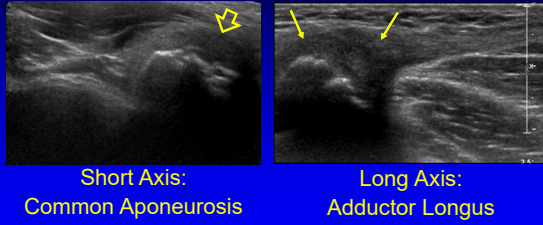
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### Case #8: Take Home Points

- Snapping iliopsoas
  - Conflict between psoas major tendon and iliacus muscle
  - Abrupt movement when straightening leg from abduction / flexion

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### Case #9: Pubis



Short Axis:  
Common Aponeurosis

Long Axis:  
Adductor Longus

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### Case #9:

- Findings:
  - Hypoechoic swelling of common aponeurosis
  - Cortical irregularity of pubis
  - Hypoechoic swelling of adductor longus
- Diagnosis:
  - Common aponeurosis injury "Sports Hernia"

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### Sports Hernia?:

- Bulge posterior wall of inguinal canal
  - Direct inguinal hernia
- Osteitis pubis
- Common aponeurosis abnormality:
  - Rectus abdominis and adductors tendons
- Obturator nerve entrapment

Omar IM, et al. Radiographics 2008; 28:1415  
Garvey JFW, et al. Hernia 2010; 14:17

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to Durant, who missed 17 games and returned to action on December 2, the general public learned quickly about the injury and its ramifications. Even seasoned athletes were mystified.

"I'm so old that when you got hurt they didn't have names for it," says NBA Hall of Famer and TNT analyst Charles Barkley. "They come up with names for injuries now. Back in my day [they'd say], 'Oh, he broke a foot.'"

Durant's Jones fracture isn't the first time the sports media has felt the need for an explanatory article. Back in the mid-'90s, when Cincinnati Reds shortstop and future Hall of Famer Barry Larkin suffered an injury in the groin area that defied any straight-ahead medical vernacular—it was kind of like a hernia, but not quite—reporters hounded the Reds' medical director and chief orthopedic surgeon, Dr. Timothy Kremchek.

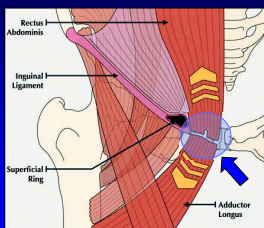
"The newspaper writers—there was no HIPAA back then, nothing—kept asking me about it," Kremchek says now, "so I said he's got a sports hernia. I had never even heard of it. I made it up."

Kremchek is referring to the privacy rule of the Health Insurance Portability and Accountability Act (HIPAA), which Congress passed in 1996 and which forbids public disclosure of medical information without appropriate consent.

Author: Joe Lemire, Hemisphere Magazine, Feb. 2015

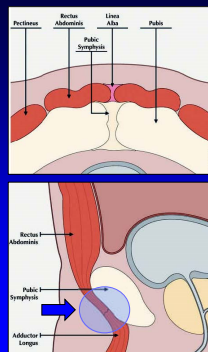
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### Rectus Abdominis + Adductor: "Sports Hernia"



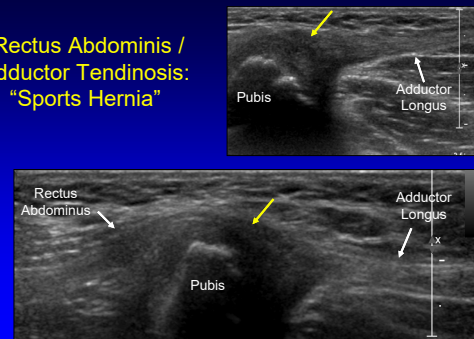
Note: common aponeurosis

From: RadioGraphics 2008; 28:1415



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### Rectus Abdominis / Adductor Tendinosis: "Sports Hernia"



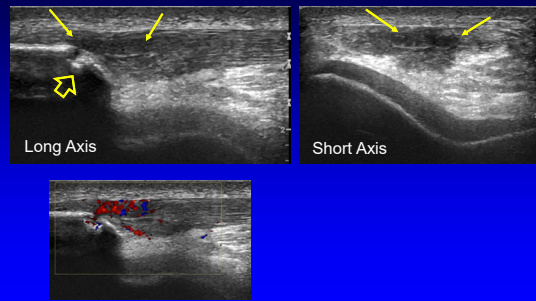
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### Case #9: Take Home Points

- Several proposed causes for “Sports Hernia”
- Injury to common aponeurosis is one cause
  - Between rectus abdominis and adductor longus

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### Case #10: Patellar Tendon



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### Case #10:

- Findings:
  - Hypoechoic enlargement of proximal patellar tendon
  - Hyperemia
  - Cortical irregularity
- Diagnosis:
  - Tendinosis (Jumper’s Knee)

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### Patellar Tendinosis:

- Jumper’s knee
- Hypoechoic swelling
- Mucoïd degeneration, possible interstitial tearing
- Hyperemia: neovascularity
- No inflammatory cells

Radiology 1996; 200:821

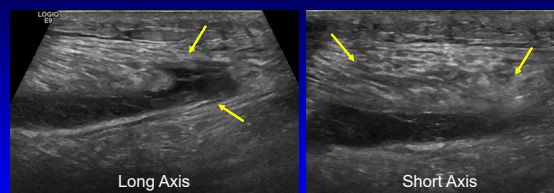
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### Case #10: Take Home Points

- Focal hypoechoic swelling of proximal patellar tendon
- Jumper’s knee
- Hyperemia = neovascularity
  - Correlates with pain

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### Case #11: Medial Head, Gastrocnemius



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### Case #11:

- Findings:
  - Hypoechoic hemorrhage
  - Distal muscle retracted proximal to aponeurosis
- Diagnosis:
  - Tear, medial head of gastrocnemius

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### Gastrocnemius

- Medial and lateral heads
- Origin: femur
- Insertion: calcaneus combined with soleus as Achilles tendon (triceps surae)
- Broad anterior or deep distal aponeurosis
- Fast twitch Type 2 fibers crossing 2 joints: injury prone

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### Gastrocnemius

- Aponeurosis of gastrocnemius in contact with aponeurosis of soleus but not connected proximally
- Note "free gastrocnemius aponeurosis" (FGA) (yellow arrow) between gastrocnemius muscle and junction with soleus aponeurosis forming Achilles tendon (AT)

From: Pedret C et al. Scand J Med Sci Sports 2020; 30:2456

From: Blitz NM et al. J Foot Ank Surg 2008; 47:533

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### Ultrasound: gastrocnemius injury

- Type 1: myoaponeurotic injury (no intermuscular hematoma)
- Type 2: aponeurotic injury (most common)
  - 2A: <50% width; 2B: >50% width
- Type 3: free gastrocnemius aponeurosis injury
  - Longest return to play
- Type 4: mixed type 2 and 3
- Worse prognosis: intermuscular hematoma and asynchronous gastrocnemius-soleus movement (with plantar flexion) + Type 2B

Pedret C et al. Scand J Med Sci Sports 2020; 30:2456

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### Medial Head of Gastrocnemius Tear: Type 1 Injury

MC  
Soleus  
Long Axis

MG  
Soleus  
Short Axis

Isolated Myoaponeurosis Injury

Illustrations from: Pedret C et al. Scand J Med Sci Sports 2020; 30:2456

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### Medial Head of Gastrocnemius Tear: Type 2B Injury

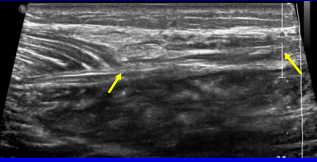
MG  
Soleus  
Long Axis

MG  
Soleus  
Short Axis

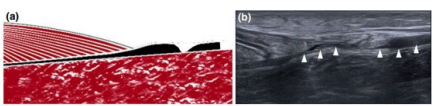
Note: muscle abnormality (myoaponeurosis injury) and adjacent gastrocnemius aponeurosis discontinuity and >50% involvement (short axis)

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### Medial Head Gastrocnemius Tear: Type 3 Injury



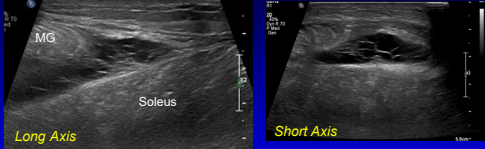
Note: injury to free gastrocnemius aponeurosis



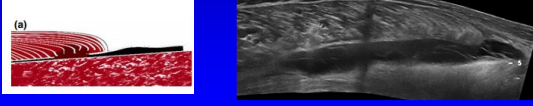
From: Pedret C et al. Scand J Med Sci Sports 2020; 30:2456

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### Medial Head Gastrocnemius Tear: Type 4 Injury



Note: mixed Types 2 and 3 injury and asynchronous movement of soleus and gastrocnemius

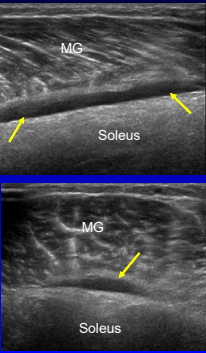


From: Pedret C et al. Scand J Med Sci Sports 2020; 30:2456

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### Plantaris Tendon: tear

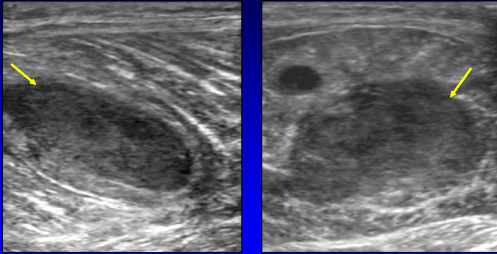
- Between medial gastrocnemius & soleus muscle bellies
- Hypochoic fluid: tubular – \*Mid-calf level
- Plantaris tendon fiber disruption
- Normal gastrocnemius muscle and aponeurosis



Leekam RN et al. AJR 1999; 172:185

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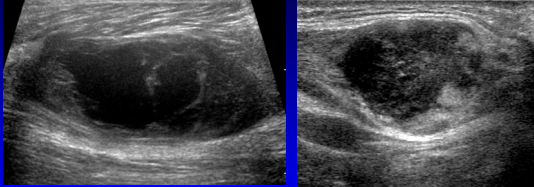
### Soleus Hematoma



Long Axis Short Axis

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### Tumor



Metastasis: Renal Cell Carcinoma      Sarcoma: high grade

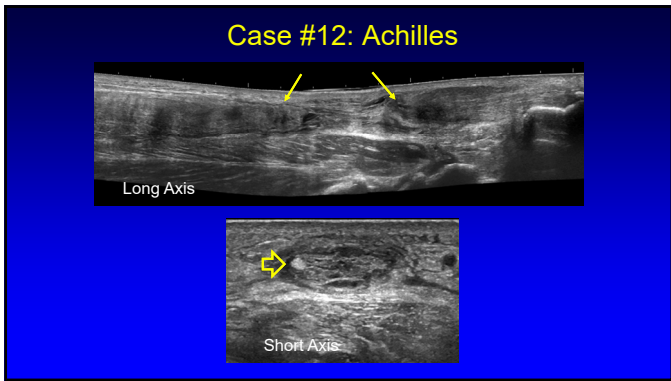
95

### Case #11: Take Home Points

- Abnormal hypochoic hemorrhage at normal distal tapering
- Hemorrhage
- Characteristic location for tear of medial head of gastrocnemius

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- Case #12:**
- Findings:
    - Complete Achilles discontinuity
    - Intact plantaris tendon: medial
  - **Diagnosis:**
    - Achilles full-thickness tear

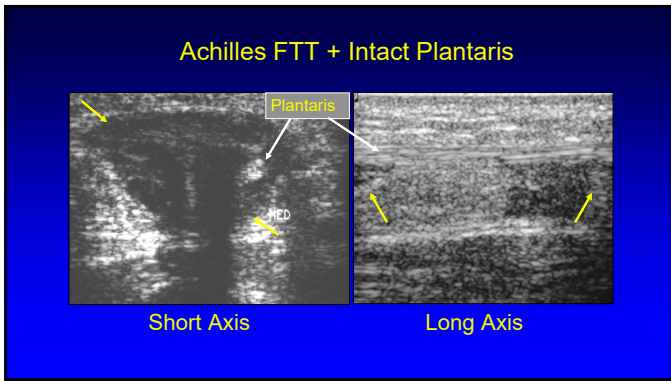
98

- Achilles Tendon: *complete tear***
- Full-thickness fiber disruption
  - Herniation of hyperechoic fat into tendon gap
  - Posterior shadowing at torn tendon ends
- Hartgerink, P et al. Radiology 2001; 220:406

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- Achilles Tendon: *complete tear***
- **Pitfall:** intact plantaris tendon
    - Medial aspect of Achilles tendon
    - Misinterpreted as intact Achilles fibers
- Radiology 2001; 220:406

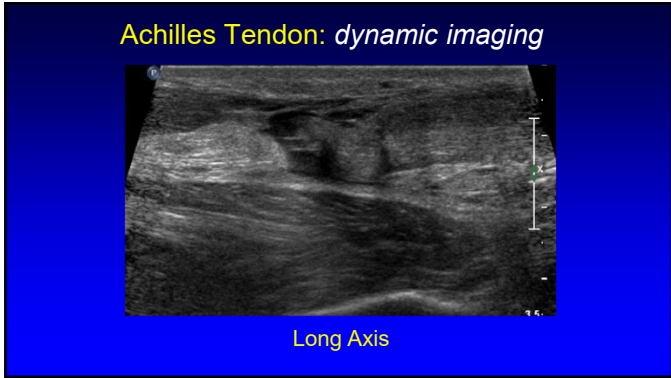
100



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- Achilles Tendon: *Dynamic Imaging***
- Increase accuracy for full-thickness tear:
    - Widening of gap with passive dorsiflexion
    - Lack of tendon movement across tear
  - Determine if ends approximate
    - Conservative versus surgical treatment

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**Case #12: Take Home Points**

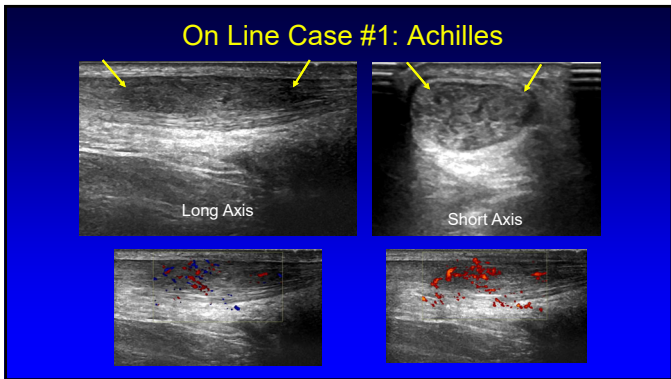
- Dynamic imaging:
  - Differentiates partial from full-thickness tear
  - Assesses if stumps approximate
- Pitfall:
  - Do not misinterpret intact plantaris as Achilles fibers

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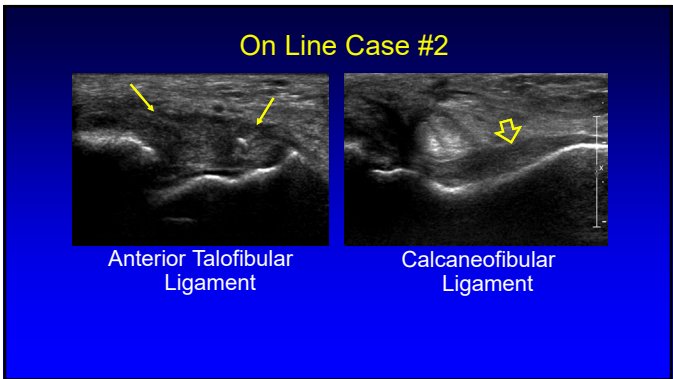
Syllabus on line and additional educational material:  
[www.jacobsonmuskus.com](http://www.jacobsonmuskus.com)

Twitter handle: @jjacobsn

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