Ultrasound of Ankle/Foot Pathology and Intervention

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Syllabus PDF

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Outline

- Tendon Pathology
- Ligament Pathology
- Inflammation
- Masses
- Miscellaneous

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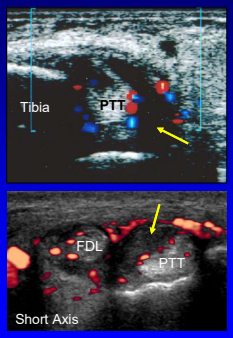
Tenosynovitis

- Fluid distending tendon sheath
  - Anechoic or hypoechoic
  - May be heterogeneous, complex
- Synovial hypertrophy:
  - Hypoechoic
  - May be isoechoic to tendon
  - Variable flow on color Doppler imaging



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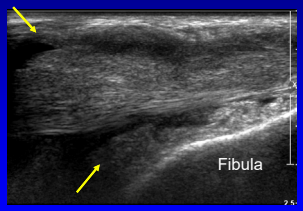
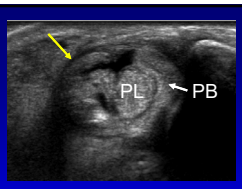
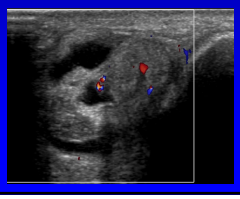
Tenosynovitis: peroneal tendons







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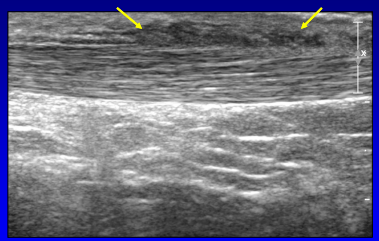
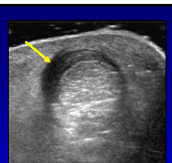
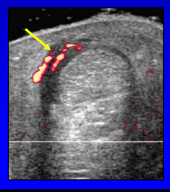
Paratenonitis: Achilles



Longitudinal





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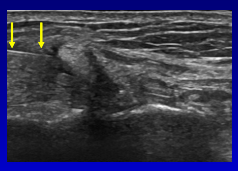
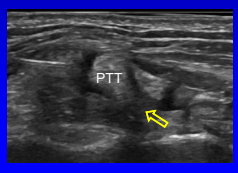
Tendon Sheath Injection

- Short axis to tendon
- Anterior or posterior
- Deep to tendon:
  - Decreased risk of depigmentation, fat atrophy
- 100% accurate

Muir JJ et al. Am J Phys Med Rehab 2011; 90:564





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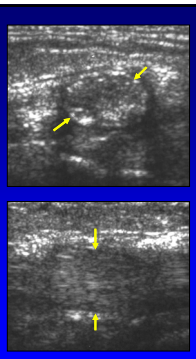
Tendinosis

- Tendon degeneration
- Not tendinitis: no acute inflammation
- Swollen, hypoechoic tendon
- Unlike tear:
  - Tendon fibers still continuous
  - No defined clefts



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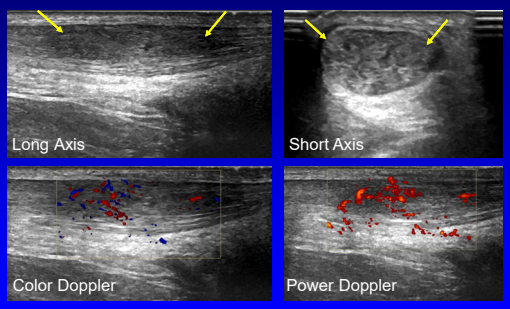
Tendinosis: Achilles



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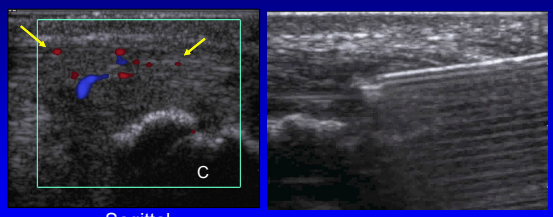
Achilles tendon: fenestration



Sagittal

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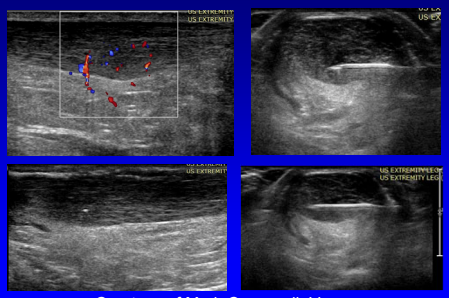
Achilles: hyperosmolar dextrose



Courtesy of Mark Cresswell, Vancouver

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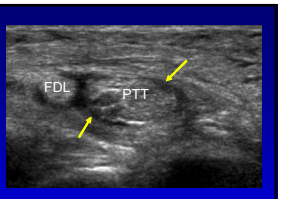
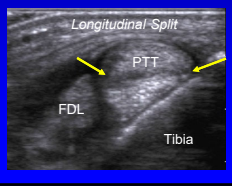
Partial Tear

- Anechoic / hypoechoic clefts
- Surface irregularity
- Longitudinal split
- Possible tenosynovitis
- Specific locations:
  - Where tendons curve around bone
  - Achilles: 2 - 6 cm proximal to calcaneus





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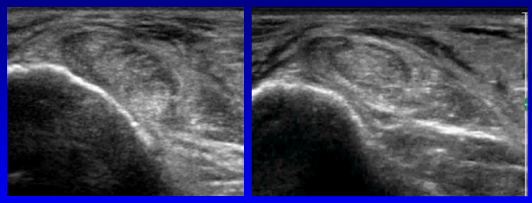
Peroneus Brevis Split Tear



Short Axis

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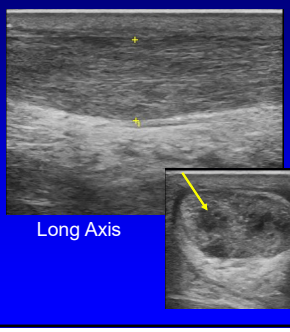
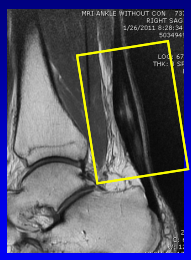
Achilles Tendon: partial-thickness tear



Long Axis



Courtesy of Jon Halperin, San Diego

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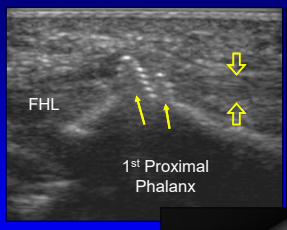
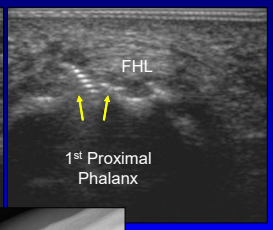
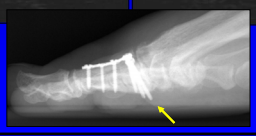
Flexor Hallucis: screws







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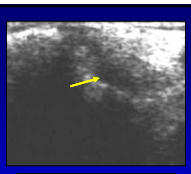
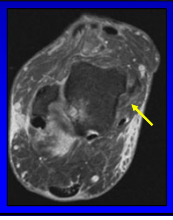
Full-thickness Tear

- Complete disruption of tendon fibers
- Hypoechoic or anechoic
- Transverse:
  - Absent tendon fibers
- Long axis imaging:
  - Tendon retraction (dynamic imaging)





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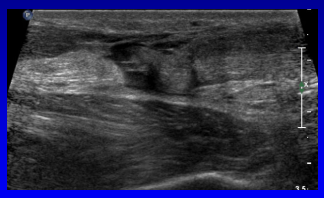
Achilles Tendon: *complete tear*

- Pitfall: misinterpretation of intact plantaris as Achilles fibers
- Dynamic imaging: look for
  - Widening of gap with passive dorsiflexion
  - Lack of tendon movement across tear
  - Determine if ends approximate



Long Axis

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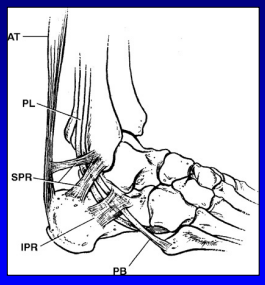
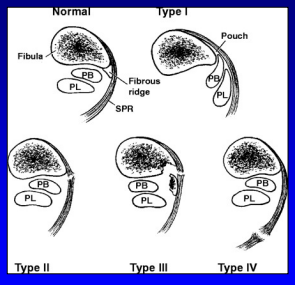
Peroneal Retinaculum





Rosenberg et al. AJR 2003; 181:1551

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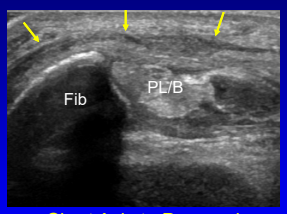
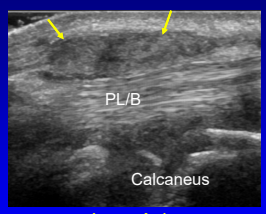
Superior Peroneal Retinaculum Injury



Short Axis to Peroneal Tendons



Long Axis

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Peroneal Tendon: *dynamic imaging*

Subluxation: Type 1 pouch

Dislocation and tendon tear

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Intrasheath Peroneal Subluxation

- Abnormal snapping: peroneal tendons
- No lateral displacement, intact retinaculum
- Type A: no tear; B: tendon tear
- Associations:
  - Convex posterior fibula in 92%
  - Tendon tear in 86%
  - Low lying peroneus brevis muscle in 71%

J Bone Joint Surg Am 2008; 90:992
J Foot Ankle Surg 2009; 48:323

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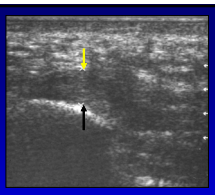
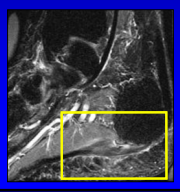
Plantar Aponeurosis

- Fasciopathy
  - Central cord, proximal
  - Degenerative, tendinosis-like, tear
- US:
  - Hypoechoic, thickened > 4 mm
  - Painful with transducer pressure

Cardinal, E. et al. Radiology 1996; 201:257





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Steroid Injection: plantar fascia

- Into fascia:
  - 2% risk of plantar fascia rupture[1]
  - Temporary pain relief: 4 weeks
  - No difference at 8, 12 weeks compared to saline[2]
- Deep to fascia: 1st branch of the lateral planter nerve (Baxter's nerve)
- Superficial to fascia:
  - Risk of fat atrophy theoretical using US guidance

[1]Kim C et al. Foot Ank Spec 2010; 3:335
[2]McMillan AM et al. BMJ 2012; 344:e3260

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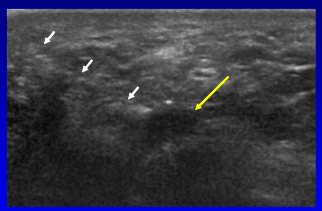
Steroid Injection: plantar fascia



- Transducer: short axis to plantar fascia
- Needle: in plane with transducer

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Outline

- Tendon Pathology
- Ligament Pathology
- Inflammation
- Masses
- Miscellaneous

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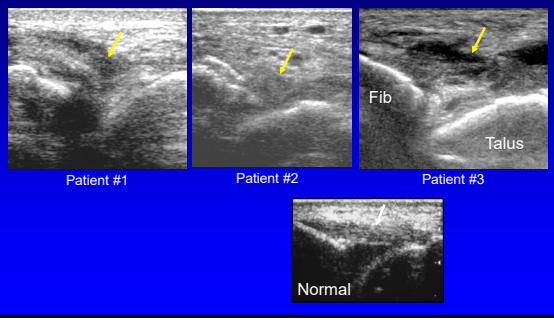
Anterior Talofibular Ligament Tear



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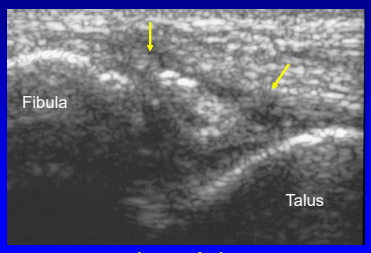
Anterior Talofibular Ligament Repair

Broström Procedure



Long Axis

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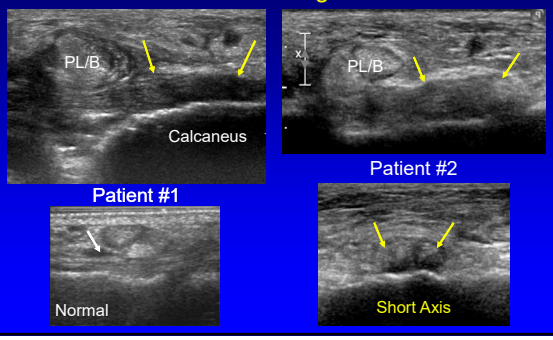
Calcaneofibular Ligament Tear



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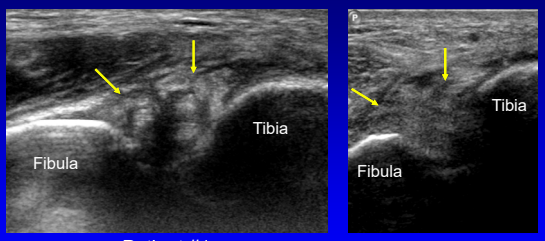
Anterior Inferior Tibiofibular Ligament Tear



Long Axis

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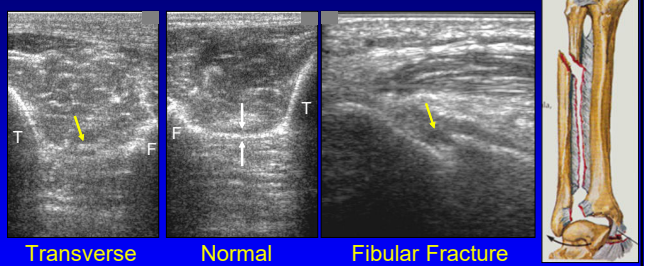
Maisonneuve Fracture



Durkee, J Ultrasound Med 2003; 22:1369

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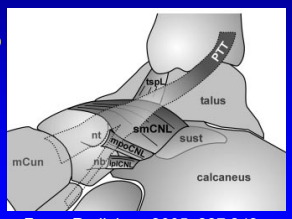
Spring Ligament Complex

- Calcaneonavicular ligament
  - Superomedial
    - Perpendicular to distal PTT
  - Medioplantar oblique
  - Inferoplantar longitudinal



From: Radiology 2005; 237:242

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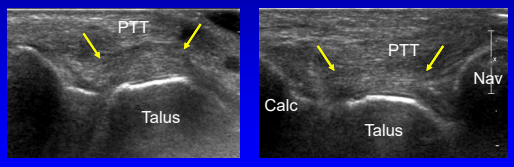
Spring Ligament Complex:

- Superomedial component
- Normal: hyperechoic, 2.8 – 3.4 mm thick



Harish, Skeletal Radiol 2007; 36:221

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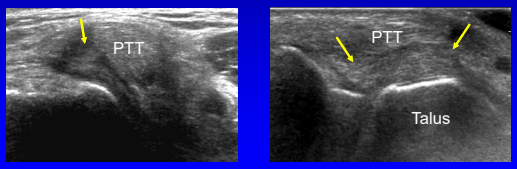
Superomedial Calcaneonavicular Ligament

- Associated with PTT dysfunction
- Abnormal: hypoechoic, thick > 4 mm, thinned or disrupted



Harish, J Ultrasound Med 2008; 27:1145

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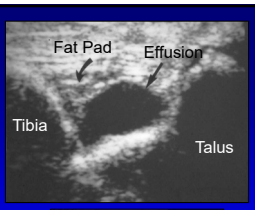
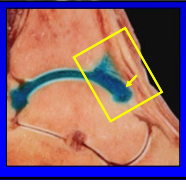
Tibiotalar Joint: *effusion*

- Anterior evaluation most sensitive
- Plantar flexion
- Hyperechoic fat pad displaced by anechoic or hypoechoic fluid
- Sensitivity: MRI > US > PF

Jacobson, JA et al. AJR 1998; 170:1231





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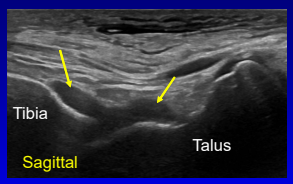
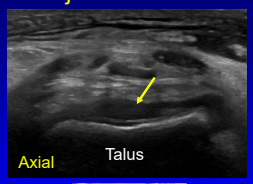
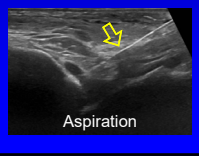
Effusion: tibiotalar joint







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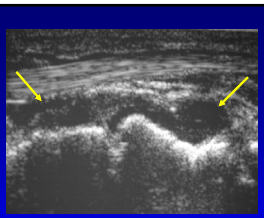
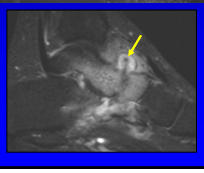
Septic Joint

- Anechoic or hypoechoic distention of joint recesses
- May be hyperechoic if complicated
  - Possible synovitis
- US or color Doppler cannot distinguish between septic and aseptic effusion*

*Strouse et al. Radiology 1998; 206:731





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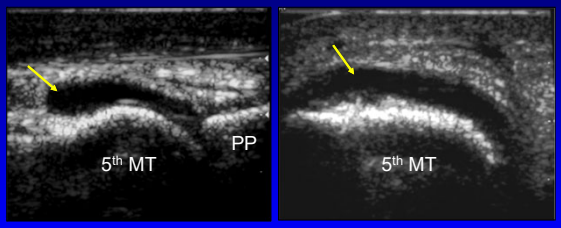
5th Metatarsal Phalangeal Joint: septic



Sagittal Coronal

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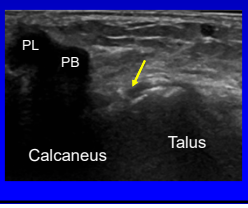
Posterior Subtalar Joint

- Lateral joint recess
- Out of plane
- Transducer: coronal
- Place roll: varus
- Avoid: peroneal tendons



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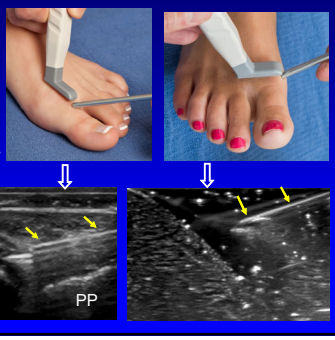
MTP Joints

- Dorsal recesses
- In plane
- Parasagittal or transverse
- Sterile gel stand off



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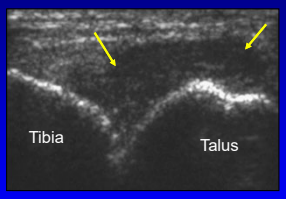
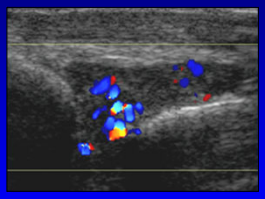
Synovitis: color flow



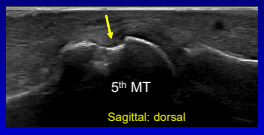
RA Ankle
No flow

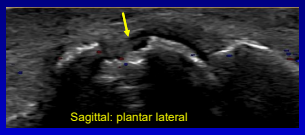


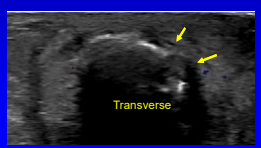
RA ankle
Positive flow

40

Rheumatoid Arthritis







- 5th metatarsal head
  - Most common site for involvement
- Supplement dorsal evaluation with lateral and plantar view

Inanc N et al. US Bio Med 2016; 42:865

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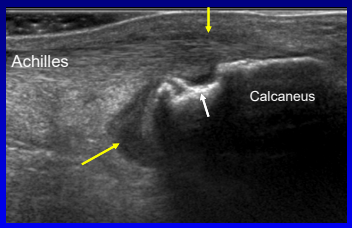
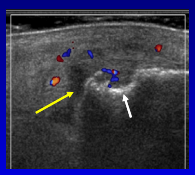
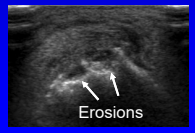
Bursitis and Erosion: Rheumatoid Arthritis

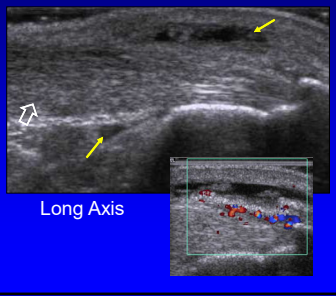


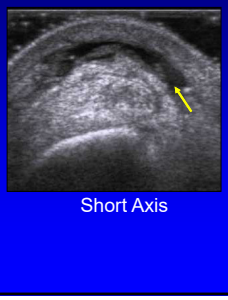




42

Haglund Syndrome

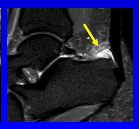


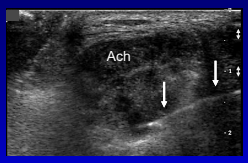


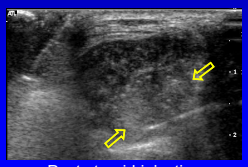
43

Retrocalcaneal Bursa

- Injection
- Medial to lateral
- Short axis to Achilles
- Needle perpendicular to ultrasound beam







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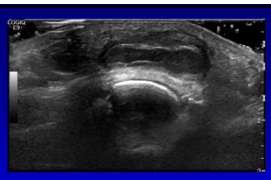
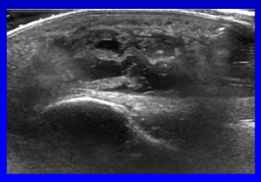
Adventitious Bursa

- Heterogenous
- Predominantly hypoechoic
- Variable surrounding hyperemia
- Plantar to distal metatarsals or at heel
- Compressible





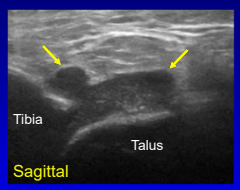
45

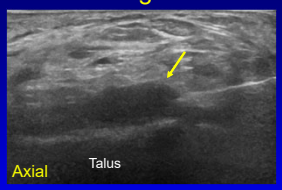
Gout:

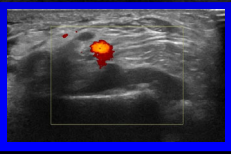
- Joint effusion / synovial hypertrophy
- Double contour sign:
  - Monosodium urate crystal icing on cartilage
- Tophi:
  - Hyperechoic with hypoechoic rim
- Erosions:
  - Adjacent to tophi
  - Medial 1st metatarsal head

46

Tibiotalar Joint Effusion: gout







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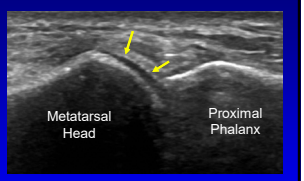
Gout

- Double contour sign:
  - Hyperechoic foci on surface of hyaline cartilage
  - Does not demonstrate anisotropy
    - Unlike normal cartilage interface
  - Disappears with serum urate < 6 ml/dl

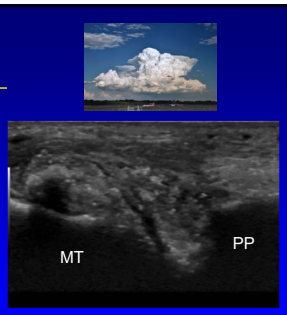


Thiele RG, Rheumatol Int 2010; 30:495

48

Tophi

- Hyperechoic heterogeneous with hypoechoic rim
- Tiny internal speckles*
- "wet clump of sugar" appearance
- Variable shadowing: even without calcification



Fernandes et al. Skeletal Radiol 2011; 40:309

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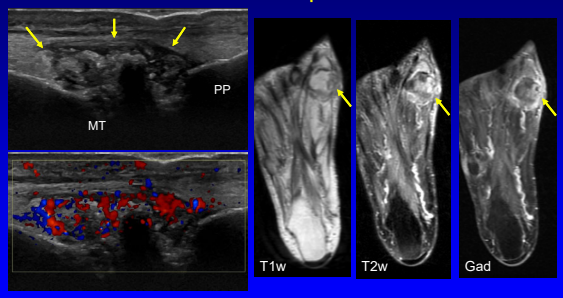
Gout: tophus



1st Metatarsophalangeal Joint

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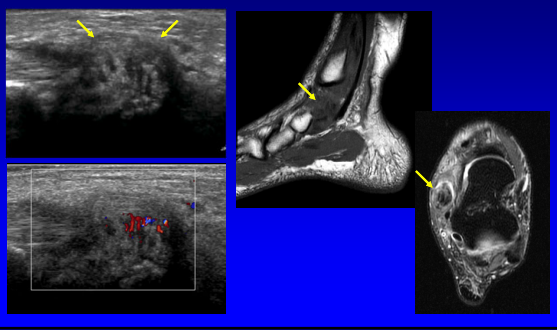
Gout: tibialis posterior tendon



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Outline

- Tendon Pathology
- Ligament Pathology
- Inflammation
- Masses
- Miscellaneous

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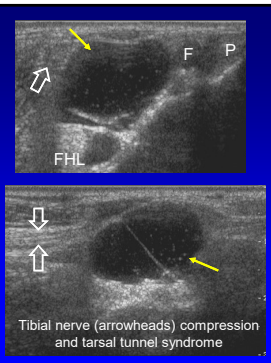
Ganglion Cyst

- Hypoechoic or anechoic
- Multilocular
- Non-compressible
- Possible increased through-transmission
- Joint or tendon sheath communication

Ortega et al. AJR 2002; 178.1445



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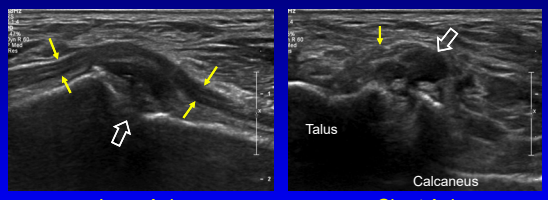
Ganglion Cyst: tarsal tunnel syndrome

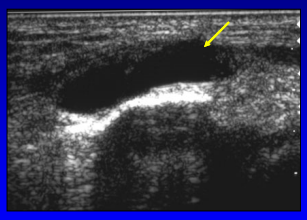


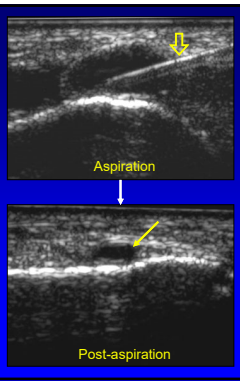
Long Axis | Short Axis

Medial plantar nerve impingement from ganglion cyst originating from middle facet of anterior subtalar joint

54

Ganglion Cyst: aspiration





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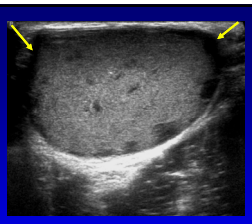
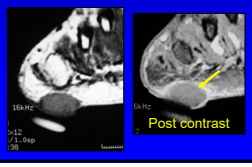
Epidermal Inclusion Cyst

- Etiology: implantation of epithelium, congenital, squamous metaplasia, hair follicle obstruction
- US findings:
  - Low level echoes and hypoechoic halo
  - Through transmission
  - Hypoechoic clefts
  - Periscope sign: extension to skin

Kim et al. Skeletal Radiol 2011; 40:1415





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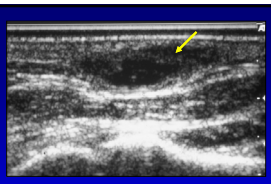
Plantar Fibroma

- Benign fibrous proliferation
- Multiple: 33%, bilateral: 20 – 50%
- Hypoechoic mass or masses
- Plantar aponeurosis
- Variable vascularity
- "Comb" sign

Cohen BE et al. J Ultrasound Med 2018; 2725
Griffith JF et al. AJR 2002; 179:1167



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Interdigital Neuroma

- Common plantar digital nerve entrapment
- Edema, fibrosis, necrosis
- 3rd intermetatarsal space > 2nd
- Sharp, burning pain to toes
- Females: pliable foot, high-heeled, narrow-toed shoes
- Asymptomatic neuromas in up to 33%
- Neuromas < 5 mm mediolateral: often asymptomatic

Zanetti M et al. Radiology 1997; 203:516

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Neuromas: eponyms

- Medial to first metatarsal: Joplin
- 1st webspace: Heuter
- 2nd webspace: Hauser
- 3rd webspace: Morton
- 4th webspace: Iselin

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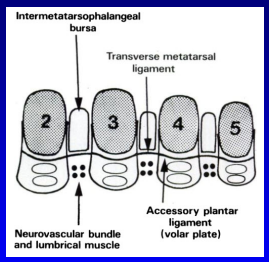
Anatomy

- At level of metatarsal heads:
  - Transverse metatarsal ligament
    - Attaches to plantar plates
  - Intermetatarsal bursa: dorsal
  - Neurovascular bundle: plantar



Zanetti M et al. Radiology 2014; 203:516

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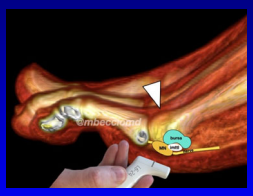
Interdigital Neuroma

- Pathophysiology:
  - Neuroma forms where common plantar digital nerve passes distal around transverse metatarsal ligament at distal metatarsal heads
  - Note: intermetarsal bursa is more dorsal and more proximal at level of transverse metatarsal ligament



From: youtube @mbecciomd

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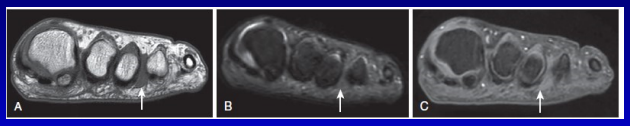
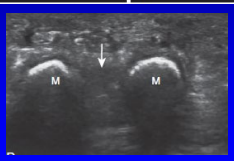
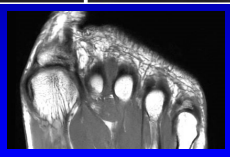
Interdigital Neuroma







Note: location of neuroma located plantar extending beyond metatarsal heads

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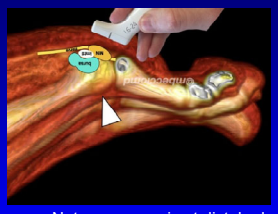
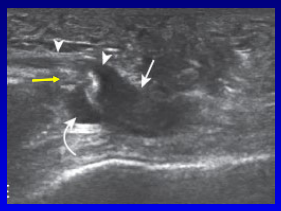
Interdigital Neuroma





Note: neuroma is at distal edge of transverse metatarsal ligament
White arrow: neuroma
Arrowheads: common plantar digital nerve
Curved arrow: intermetarsal bursa
Yellow arrow: transverse metatarsal ligament

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Ultrasound Evaluation

- #1: plantar, short axis
  - With dorsal compression
- #2: plantar, long axis
  - With dorsal compression
- #3: Mulder maneuver
  - With side-to-side compression

*Neuroma of 5 mm or larger: 100% sensitivity, 83% specificity

Redd et al. Radiology 1989; 171:415
Quinn et al. AJR 2000; 174:1723

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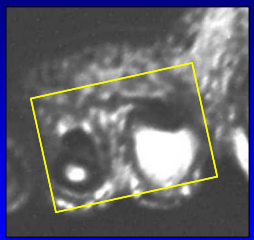
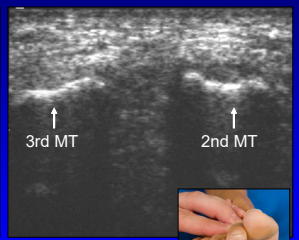
Interdigital Space: normal





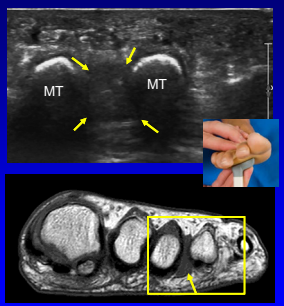
Short Axis to Metatarsals

65

Step #1

- Plantar, short axis
- Dorsal compression
- Neuroma: more plantar
- Bursa: dorsal, anechoic, compressible

Note: coronal-oblique plane moving distal to metatarsal heads



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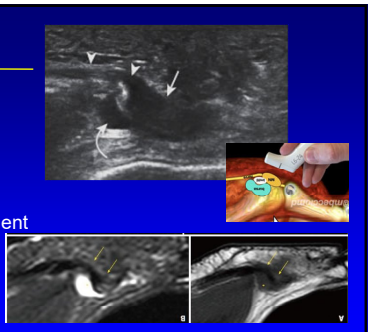
Step #2

- Plantar, long axis
  - Follow MT head curvature
- Dorsal compression
  - Move finger distal, proximal
  - See neuroma sliding over transverse metatarsal ligament
- Neuroma: plantar, distal
- Bursa: curved arrow
  - Dorsal, proximal
  - Anechoic, compressible



MRI flipped upside down to simulate US

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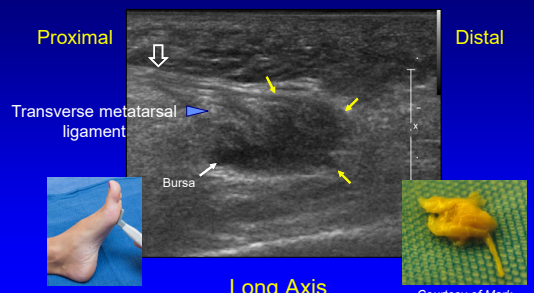
Neuroma: nerve continuity (white open arrow)



Long Axis

Courtesy of Mark Murphey, MD

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Step #3: Mulder's maneuver

- Transducer: plantar, short axis
- Squeeze foot side-to-side
- Neuroma moves plantar
  - Palpable click, elicits symptoms
  - Important to document
  - Improved accuracy, measurements
- Make sure to perform distal to intermetatarsal ligament
- Bursa: remains dorsal

Torriani M et al. AJR 2003; 180:1121

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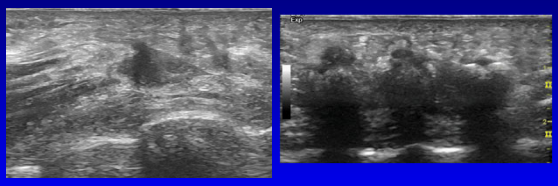
Dynamic: Interdigital Neuroma + Bursa



Dorsal Mulder's Maneuver

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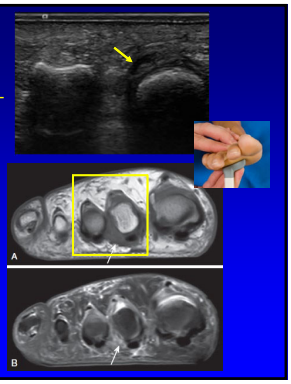
Differential Diagnosis

- Pericapsular fibrosis
- Associated with capsule injury
- Hypoechoic
- Eccentric
- Not truly intermetarsal
- Negative Mulder's maneuver



Umans H et al. Skeletal Radiol 2014

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Outline

- Tendon Pathology
- Ligament Pathology
- Inflammation
- Masses
- Miscellaneous

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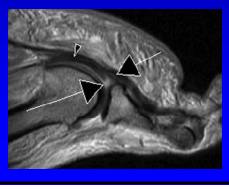
Plantar Plate Injury

- US: hypoechoic defect
- At proximal phalanx
- Partial tear: articular surface
- Full-thickness tear: complete detachment
- May be asymptomatic finding in 47% (MTP 2 – 4)



From: Gregg JM et al. AJR 2006; 186:984
Gregg JM et al. Eur Radiol 2006; 16:2661

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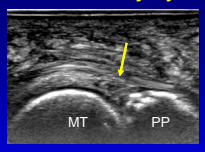
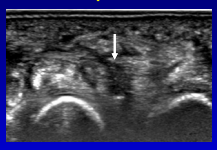
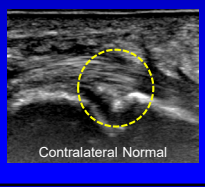
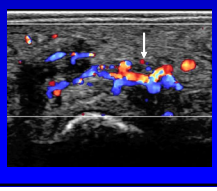
Plantar Plate Injury and Pericapsular Fibrosis









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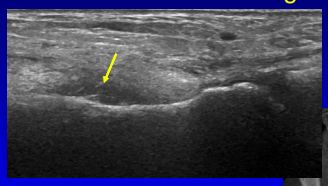
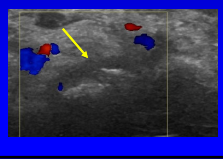
Metatarsal Fatigue Fracture





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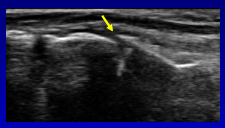
Metatarsal Fatigue Fracture



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Take Home Points

- Tendon, ligament, joint assessment
- Gout: specific findings
- Dynamic imaging
  - Peroneal subluxation
  - Achilles tear
  - Interdigital neuroma

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Thank you!

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

Twitter handle: @jjacobsn

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