Ultrasound of Ankle and Foot Pathology and Intervention

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Fundamentals of Musculoskeletal Ultrasound are copyrighted
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Outline:
• Tendon Pathology
• Ligament Pathology
• Inflammation
• Masses

Tibialis Posterior Tendon:
• Medial malleolus
  – Longitudinal split
  – Complete tear: rheumatoid arthritis
  – Subluxation: retinaculum injury
• Navicular
  – Avulsions: diabetic

Tenosynovitis: US
• Fluid distending tendon sheath
  – Anechoic or hypoechoic
  – May be heterogeneous, complex
• Synovial proliferation:
  – Hypoechoic
  – May be isoechoic to tendon
  – Variable flow on color Doppler imaging

Tenosynovitis: ankylosing spondylitis

Short Axis
**Tendon Sheath:**

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

**Tendinosis**

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

**Tendinosis: tibialis posterior**

- Transverse
- Longitudinal

**Partial-thickness Tear: tibialis posterior**

- Short Axis

**Full-thickness Tear: tibialis posterior**

- Transverse
- Contralateral Side

**Tenosynovitis: peroneal tendons**

- Transverse
- Longitudinal
**Peroneal Tendon Tears: US**

- 54 tendons (5 peroneal): surgery
  - US: 100% sensitivity, 93% accuracy\(^1\)
- 60 peroneal tendons: surgery
  - US: 100% sensitivity, 90% accuracy\(^2\)

\(^1\)Weitches et al. JUM 1998; 17:249
\(^2\)Grant et al. 2005; 87:1788

**Peroneal Tendon Subluxation:**

- Abnormal movement may only occur dynamically
- Predisposes to peroneal tendon tears
  - Longitudinal split of peroneus brevis
- US: examine with dorsiflexion / eversion
  - 100% accurate diagnosis with US

Neustadtler et al. AJR 2004; 183:985
**Intrasheath Subluxation**

- Abnormal snapping of peroneal tendons
- No lateral displacement, intact retinaculum
- 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

**Achilles Tendon:**

- 2 – 6 cm proximal to insertion
  - Tendinosis
  - Full-thickness tear
- Calcaneal attachment
  - Tendinosis, tear
  - Haglund Syndrome

**Tendinosis: Achilles**

- Long Axis
- Short Axis
- Color Doppler
- Power Doppler

**Achilles tendon: fenestration**

- Sagittal
Achilles tendon: fenestration

Prolotherapy
- Injection of an irritant
- Hyperosmolar dextrose or morrhuate sodium
- Unknown mechanism
  - Irritant attracts inflammatory mediators
  - Stimulate release of growth factors
  - Vascular sclerosant

Distel et al. PMR 2011; 3:S78

Achilles: hyperosmolar dextrose

Prolotherapy
- Achilles
  - 36 patients with chronic tendinosis
  - Hyperosmolar dextrose every 6 weeks
  - Significant reduction in pain
  - Decreased vascularity in 55%


Achilles Tendon
- Randomized controlled: 54 patients
- PRP versus saline injection
- No significant difference in outcomes
  - At 24 weeks¹
  - At 1 year²
- *Both groups: eccentric physical therapy

¹de Vos RJ et al. JAMA 2010; 303:145

Paratenonitis: Achilles

Longitudinal
**Achilles Tendon: tendinosis**
- Partial tear & tendinopathy coexist
- Severe intratendinous abnormalities and >10 mm thickness suggest partial tear*

*Skeletal Radiol 1996; 25:615

**Achilles Tendon: partial-thickness tear**

**Achilles Tendon: complete tear**
- Full-thickness fiber disruption
- Herniation of hyperechoic fat into tendon gap
- Posterior shadowing at torn tendon ends

Radiology 2001; 220:406

**Achilles Tendon: complete tear**
- Pitfall: intact plantaris tendon
  - Medial aspect of Achilles tendon
  - Misinterpreted as intact Achilles fibers

Radiology 2001; 220:406

**Achilles FTT + Intact Plantaris**
Achilles Tendon: complete tear
• Dynamic imaging: look for
  – Widening of gap with passive dorsiflexion
  – Lack of tendon movement across tear

Achilles Tendon: healing tear

Assessing Tendon Stump Approximation

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

Steroid Injection: plantar fascia

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

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

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Ligament Tear:

• Hypoechoic & thickened
• Acute: anechoic fluid tracking through defect indicates full-thickness tear
• Cortical avulsion: hyperechoic

Trauma: ligament

• Lateral:
  – Anterior talofibular: isolated tear in 66%
  – Calcaneofibular
    • 20% calcaneofibular + anterior talofibular
  – Posterior talofibular: dislocation
  – Anterior tibiofibular: high ankle sprain

**Calcaneofibular Ligament Tear**

- PL/B PL/B
- Normal
- Short Axis

**Inferior Tibiofibular Ligament**

- Several bands
- Accessory inferior band (Bassett ligament)
  - Seen in 80 – 90%; more horizontal
  - Potential site of impingement

Radiology 2010; 254:827

**Anterior Inferior Tibiofibular Ligament Tear**

- Longitudinal
- Axial T2w

**Maisonneuve Fracture**

- Transverse
- Normal
- Fibular Fracture

Durkee, J Ultrasound Med 2003; 22:1369

**Deltoid Ligament Tear**
Spring Ligament Complex
- Calcaneonavicular ligament
  - Superomedial
  - Perpendicular to distal PTT
  - Medioplantar oblique
  - Inferoplantar longitudinal

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

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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

Effusion: tibiotalar joint

Pitfall: normal hyaline cartilage
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

5th Metatarsal Phalangeal Joint: septic

Synovitis: color flow

Rheumatoid Arthritis

Ankle Joint
• Anterior joint recess
• In plane
• Transducer: sagittal
• Needle: inferior to superior

Ankle Joint
• Anterior joint recess
• Out of plane
• Transducer: axial
• Needle: medial to lateral
• Deep to dorsalis pedis
Posterior Subtalar Joint

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

MTP Joints

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

Bursitis:

- Specific bursa:
  - Retrocalcaneal
  - Superficial tendo-Achilles
- Adventitious bursa
  - Sites of pressure contact
  - Plantar aspect of foot

Bursitis and Erosion: Rheumatoid Arthritis

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

Retrocalcaneal Bursa

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

Post steroid injection
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

Tibiotalar Joint Effusion: gout

Gout: tophus and intra-articular microtophi

Gout: Double Contour Sign

Tophi
- Ultrasound\(^1\): specific
  - Hyperechoic heterogeneous with hypoechoic rim
  - "Wet clump of sugar" appearance
  - Variable shadowing: even without calcification
- MRI\(^2\): non-specific
  - T1w: low to intermediate
  - T2w: heterogeneous mixed signal
  - Heterogeneous enhancement

\(^1\)Fernandes et al. Skeletal Radiol 2011; 40:309
**Outline:**
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**Soft Tissue Ganglion:**
- Well-defined, lobular
- Often multilocular
- Hypoechoic to anechoic
- Increased through-transmission
- Joint or tendon sheath communication

**Epidermal Inclusion Cyst:**
- Trauma: implantation of epithelium
- Congenital
- Squamous metaplasia
- Hair follicle obstruction

**Gout: tophus**

**Gout: tibialis posterior tendon**

**Ganglion Cyst: tarsal tunnel syndrome**

**Axial**

**Sagittal**
**Epidermal Inclusion Cyst**

- Not ruptured:
  - Hyperechoic, round to oval
  - Internal hypoechoic clefts: characteristic
  - Hyperechoic foci: keratin
  - Surrounding hypoechoic halo
  - Increased through-transmission
- Ruptured: irregular shape, no halo

Kim et al. Skeletal Radiol 2010; 40:1415

**Plantar Fibromatosis:**

- Hypoechoic mass or masses
- Plantar subcutaneous tissues
- May invade aponeurosis
- Non-specific: except if bilateral

J Clin Ultrasound 1991; 19:578

**Morton Neuroma:**

- Hypoechoic 5 mm mass
  - Sensitivity: 100% ; Specificity: 83%
  - Digital nerve continuity*
    - Excludes other causes for mass
  - Compression:
    - Produces symptoms
    - Bursa (compressible) vs. neuroma (not compressible)

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

![Morton Neuroma](image1)

**Transverse**

**Coronal T1w**

**Morton Neuroma: nerve continuity**

![Morton Neuroma](image2)

**Proximal**

**Distal**

**Longitudinal**

Courtesy of Mark Murphey, MD

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**Dynamic Evaluation**

- **Compression**
  - Between transducer and palpation
  - Bursae (dorsal) compress, neuromas (plantar) do not
- **Sonographic Mulder Sign**
  - Scan plantar: coronal plane
  - Neuroma displaces: plantar
  - Palpable click

Torriani M et al. AJR 2003; 180:1121
Zanetti M et al. Radiology 1997; 203:516

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**Take Home Points**

- Know where tendon pathology is commonly located
- If concern for infection: aspirate
- Gout: specific findings
- **Dynamic imaging**
  - Peroneal subluxation
  - Achilles tear
  - Morton neuroma

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**Dynamic imaging: Mulder's Maneuver**

![Dynamic imaging: Mulder's Maneuver](image3)

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**Syllabus on line and other educational material:**

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