Ankle and Foot Sonography with MRI Correlation

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Outline
- Trauma:
  - Tendon, Ligament, Bone
- Infection and Inflammation
- Developmental Anomalies
- Tumors and Tumor-like Abnormalities

Suggested Classification System
- Tenosynovitis: paratenon inflammation
- Tendinosis: tendon degeneration
- Tendon tear
  - Partial-thickness
  - Full-thickness tear: incomplete or complete

Khoury NJ et al.
MRI of posterior tibial tendon dysfunction
AJR 1996; 167:675

Tenosynovitis: flexor hallucis longus

Tenosynovitis: flexor tendons

Khoury NJ et al.
MRI of posterior tibial tendon dysfunction
AJR 1996; 167:675
Tenosynovitis: ankylosing spondylitis

Rheumatoid Arthritis

Peroneal Tendons: tenosynovitis and adjacent erosions

Tendinosis: tibialis posterior

Tendon Tear Terminology

- Partial-thickness:
  - Interstitial or
  - Extends to one surface

- Full-thickness, incomplete:
  - Extends to two surfaces
  - i.e. longitudinal split

- Full-thickness, complete:
  - Entire tendon discontinuous

Longitudinal Split: tibialis posterior

Full-thickness Tear: tibialis posterior
Longitudinal split: peroneus brevis

Short Axis Coronal T2w

Rosenberg et al. AJR 2003; 181:1551

Peroneal Retinaculum

Peroneal Subluxation: dynamic imaging

Posterior Anterior

Short Axis

Dislocation: peroneus brevis & longus

Anterior Posterior

Short axis

Intrasheath Peroneal 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
Intrasheath Peroneal Subluxation: Type A

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

Paratenonitis: Achilles

Achilles Tendon: Paratenonitis

Tendinosis: Achilles

Achilles Tendon: partial-thickness tear

Courtesy of Jon Halperin, San Diego
Achilles Tendon: complete tear

- Full-thickness fiber disruption
- Herniation of hyperechoic fat into tendon gap
- Posterior shadowing at torn tendon ends
- Non-surgical management:
  - >5 mm diastasis: worse outcomes
  - >10 mm diastasis: higher re-tear rate

1Hartgerink, P et al. 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 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
**Achilles Tendon:** healing tear

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


**Plantar Fasciopathy**

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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

Anterior Talofibular Ligament Tear

- Axial T1w + gado

Fibula
Talus
Normal

Patient #1
Patient #2
Patient #3

Anterior Talofibular Ligament Tear

Patient #1
Patient #2
Patient #3

Normal

Calcaneofibular Ligament Tear

PL/B
Calcaneus
Patient #1
Patient #2

Normal
Short Axis

Anterior Talofibular Ligament: Partial Tear

Long Axis: Dynamic Anterior Drawer Test

Anterior Tibiofibular Ligament

- Dynamic: widening of syndesmosis\(^1\)
  - Dorsiflexion and external rotation
- If normal:
  - Interosseous ligament usually normal
- Impingement
  - Thick inferior fascicle (Bassett ligament)\(^2\)

\(^1\)Am J Sports Med 2009; 37:1009
\(^2\)Skeletal Radiol 2008; 37:27
**Anterior Inferior Tibiofibular Ligament Tear**

- Patient #1
- Patient #2

**Ligament Tear:**
- Anterior inferior tibiofibular ligament:
  - Look for interosseous membrane tear if absent lower fibular fracture
  - Maisonneuve fracture

**Maisonneuve Fracture**

- Transverse
- Normal
- Fibular Fracture

- Durkee, J Ultrasound Med 2003; 22:1369
- Radiology 2010; 254:827

**Superomedial Calcaneonavicular Ligament**

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

- Patient #1
- Patient #2

- Harish, J Ultrasound Med 2008; 27:1145
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Stress Fracture: navicular

Metatarsal Fatigue Fracture

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Bursitis and Erosion: Rheumatoid Arthritis

Adventitious Bursa
- Site of friction, pressure
- Connective tissue degeneration
- Fibrous tissue: 84% asymptomatic volunteers
- Subcutaneous cavity: RA
- Fat pads plantar to MT heads

Studler U et al. Radiology 2008; 246:863
**Haglund Syndrome:**
- Achilles abnormality
- Retrocalcaneal bursitis
- Superficial tendo-Achilles bursitis
- Enlarged posterior calcaneal tuberosity
  - Correlate with radiography

**Sinus Tarsi Bursa of Gruberi:**
- Between extensor digitorum longus and distal talus
- Commonly asymptomatic
- Shouldn’t be confused with ganglion
  - Bursa: unilocular, compressible
  - Ganglion: multilocular, non-compressible

**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
**Effusion: tibiotalar joint**

- Fat Pad
- Effusion
- Tibia
- Talus

**Sagittal**

**Effusion: tibiotalar joint**

- Tibia
- Talus

**Axial**

**Aspiration**

**Pitfall: normal hyaline cartilage**

- Tibia
- Talus

**Sagittal**

**Axial**

**Synovitis: color flow**

- RA Ankle
  - No flow
- RA ankle
  - Positive flow

**Septic Joint: talonavicular**

- 5th Metatarsal Phalangeal Joint: septic

- 5th MT
- PP

**Sagittal**

**Coronal**
Outline:

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Type 2 Accessory Navicular:

- Synchondrosis between accessory and native navicular
- Repetitive injury, synchondrosis injury
- Ultrasound:
  - Cleft
  - Pain with transducer pressure

Symptomatic Accessory Navicular

Peroneus Quartus

- Accessory tendon
- Present in 22%
- Origin: peroneus brevis muscle
- Insertion: retrotrochlear eminence of calcaneus

*Radiology 2001; 218:415

Outline:

- Ultrasound technique, anatomy
- Trauma
- Infection and Inflammation
- Developmental Anomalies
- Tumors and Tumor-like Abnormalities
Soft Tissue Ganglion:
- Well-defined, lobular
- Often multilocular
- Hypoechoic to anechoic
- Increased through-transmission
- Joint or tendon sheath communication

Ortega et al. AJR 2002; 178.1445

Ganglion Cyst

Ganglion Cyst: tarsal tunnel syndrome

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

Kim et al. Skeletal Radiol 2010; 40:1415

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

Griffith JF et al. AJR 2002; 179:1167

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**Morton Neuroma:**
- Interdigital nerve entrapment
- Edema, fibrosis, necrosis
- 3rd intermetatarsal space > 2nd
- Sharp, burning pain from metatarsal head to toes
- Females: pliable foot, high-heeled narrow-toed shoes

From: Martinoli, RadioGraphics 2000; 20:S199
Morton Neuroma

- Hypoechoic 5 mm mass
  - Sensitivity: 100%; Specificity: 83%
  - Accuracy equal to MRI
  - Nerve continuity: sagittal plane
- Intermetatarsal bursa
  - Associated with neuroma
  - “Neuroma-bursal complex”

Quinn T et al. AJR 2000; 174:1723

Morton Neuroma: nerve continuity

Proximal           Distal
Longitudinal

Courtesy of Mark Murphey, MD

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

Dynamic imaging: Mulder’s Maneuver
Take Home Points

- Tendon: at malleolus
- Peroneal: dynamic evaluation
- Achilles: dynamic evaluation
- Infection: aspirate if suspected
- Ganglion: hypoechoic, multilocular
- Morton neuroma: Mulder maneuver

Syllabus on line and other educational material:
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