Imaging Evaluation of Heel Pain

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Goals and Objectives

• Review causes of heel pain with attention to various anatomic structures in the region
• Understand strengths and limitations of different imaging modalities in assessment of heel pain
Introduction

• Heel pain
  – Seen in patients of all ages
  – With varied activity levels
  – Including young athletes, middle-aged weekend warriors, people with sedentary lifestyle, or the very old
• Often debilitating whether from acute injury or due to chronic changes
• Imaging plays an important role
  – May be difficult to delineate cause of pain from physical exam alone
  – Often essential to make an accurate diagnosis
  – Helps with treatment planning
• Knowledge of relationship of anatomic structures in the region and anatomic variants is essential in reaching the correct diagnosis
Causes of Heel Pain

- Congenital
  - Accessory Muscles
  - Coalition
- Inflammatory processes
  - Enthesitis
  - Plantar fasciitis
  - Inflammatory arthropathies
  - Bursitis
  - Sever’s
- Infection
- Medical disorders
- Trauma
- Tendon related processes
  - Achilles tendon
  - Flexor tendons
  - Tarsal tunnel pathology
- Tumors
Accessory Soleus Muscle

A-D: Accessory muscle (oval) is seen deep to Achilles tendon (*) and superficial to the flexor retinaculum (blue arrow)

B & D: Edema is noted in the accessory soleus

May cause pain due to compartment syndrome, or mass affect on the tibial nerve

May be treated with excision, tendon release or fasciotomy
Accessory Tibiocalcaneus Internus Muscle

- One of the uncommon accessory muscles (blue oval) in the ankle
- Seen deep to flexor retinaculum (blue arrow) and posterior to the neurovascular bundle (yellow arrow) – distinct from the accessory soleus muscle
- B: Note edema in the muscle
- May have symptoms of tarsal tunnel syndrome
Talocalcaneal Coalition

- One of the two most common tarsal coalitions
- Present with symptoms in childhood or adolescence
- Coalition between the sustentaculum tali and the middle facet of the talus
- Note irregularity and edema along the calcaneus and navicular
  - Edema along the coalition suggests that this is a cartilaginous coalition
- Talar beak sign most commonly seen with this type of coalition
- C sign on radiographs
Calcaneonavicular Coalition

- One of the two most common tarsal coalitions
- Present with symptoms in childhood or adolescence
- Note irregularity and edema along the calcaneus and navicular
  - Edema along the coalition suggests that this is a cartilaginous coalition
- Anteater sign
Haglund’s Syndrome

- Associated with chronic trauma in patients wearing “pumps”
- Also known as "pump bump"
- Characterized by presence of
  - Retrocalcaneal bursitis (yellow arrow)
  - Pre-Achilles bursitis (blue arrow)
  - Achilles tendinopathy
  - Prominence of posterosuperior calcaneal tuberosity (*)
  - Bone marrow edema in the calcaneal tuberosity (*)
- Osseous prominence may be seen on radiographs
- MRI helpful in making the diagnosis
Os Trigonum Syndrome

- Prominent lateral tubercle of the posterior process of the talus – Stieda process
- Os trigonum – a variant with a separate ossicle
- May cause posterior impingement syndrome - Os Trigonum Syndrome
- Seen with activities causing extreme flexion such as with soccer or ballet
- May cause edema, erosions, or cystic changes along the talar tubercle and the ossicle (oval)
- Associated soft tissue changes including of the flexor hallucis longus tendon may be present
Stenosing Tenosynovitis

- Flexor hallucis longus tendon courses through a fibro-osseous tunnel
  - Between the lateral and medial talar tubercles, posterior to medial malleolus and deep to the flexor retinaculum
- Posterior impingement
  - Seen with activities involving extreme flexion such as ballet or soccer

- Entrapment in the fibro-osseous tunnel
  - Inflammation of synovium along tendon sheath
  - Large amount of fluid in the tendon sheath
- Stenosing tenosynovitis
  - Loculated fluid in the tendon sheath posterior to talus
  - Normal appearing tendon
- MRI – sagittal images most useful for diagnosis
- Ultrasound is also useful to detect loculated fluid

A: Ax T2 FS

B: Sag STIR
Retrocalcaneal Bursitis

- **Retrocalcaneal bursal fluid**
  - Maybe secondary to chronic repetitive trauma
  - Associated with Achilles tendinopathy
  - Maybe seen with inflammatory processes such as spondyloarthropathies or rheumatoid arthritis

- **May often be associated with adjacent soft tissue inflammatory changes**
  - Note edema in Kager’s fat pad (*)/paratendinitis in the example shown here
  - Mild Achilles tendinopathy is also present

- **MRI**
  - Sagittal and axial fluid sensitive sequences most useful for diagnosis as seen here

- **US**
  - Also equally useful to make the diagnosis
Pigmented Villonodular Synovitis

- Nodular and villous synovial proliferation
  - Pigmentation secondary to hemosiderin
- Considered to be a benign neoplastic process
  - May affect a joint, bursa or tendon sheath
- MRI is the most useful imaging modality for diagnosis
  - Blooming artifact from the hemosiderin maybe seen on gradient echo imaging
- Ultrasound may help with the diagnosis
  - Maybe difficult to distinguish from other neoplasms
Sever’s Disease

- AKA - Calcaneal Apophysitis
- Inflammatory process at tendon insertion
- Seen in skeletally immature patients
- Associated with repetitive trauma
- Usually resolves with rest
- MRI
  - Useful to identify edema in the calcaneal apophysis (yellow arrows)
  - Exclude other pathologies that may result in heel pain
Calcaneal Enthesitis

- May be seen with inflammatory processes such as Reiter syndrome, psoriasis, ankylosing spondylitis
- Bone resorption at enthesis may be seen with chronic renal insufficiency
- Repetitive microtrauma resulting in rupture of plantar fascia may also cause enthysopathy
- Erosions may also be seen secondary to infection
Plantar Fasciitis

- A common cause of heel pain
  - Considered to be secondary to repetitive stress resulting in microtears
- Plantar fascia may be thickened, have partial tear or complete rupture
- Inflammation may be seen at the calcaneal attachment – in the soft tissues and calcaneus
- Radiographs and CT
  - Erosions may be seen in the calcaneus at the enthesis

MRI
- Edema may be present in the soft tissues along the plantar fascia and in the calcaneus at the attachment
- Tears are readily diagnosed

US
- Useful tool to see tears of plantar fascia
- Hyperemias in the soft tissues can be seen with color Doppler
Achilles Tendon Rupture

- Achilles Tendinopathy
  - Intratendinous degeneration is the most common cause
  - Fusiform thickening of the tendon with abnormal intrasubstance signal on MRI
- Degenerated tendon may result in partial tear or complete rupture
  - More often in middle aged men and weekend warriors
  - Rupture in younger athletes may be secondary to trauma
  - Tears may be seen with systemic diseases such as diabetes, gout or other arthropathies
  - Tears are known to be associated with fluoroquinolone use

- A-B: MRI - Complete rupture
- C-D: US - Complete rupture on the left side and partial tear on the right in the same patient
- Imaging useful for surgical planning
Achilles Tendon Repair & Re-tear

- A-C:
  - Markedly thickened tendon after rupture and repair
  - Foci of susceptibility artifact in the tendon related to surgery (blue arrow)
  - Focal intrasubstance fluid signal in the tendon with recurrent pain indicative of partial re-tear (yellow arrow)
A: US of Achilles tendon after repair shows thickened but intact tendon

B-C: High grade retear of tendon and fluid (*) with hyperemia along the tendon and in the surrounding soft tissues in a patient with clinical findings of infection at the repair site

- US performed for surgical planning
Foreign Body with Abscess

- A: Faint calcifications (yellow arrow) related to oyster shells seen in retrospect in the soft tissues along the heel
- B-C: The calcification (yellow arrow) are readily visible by CT
  - An abscess (oval) is also seen on CT
- D: Edema signal (*) in the calcaneus on MRI is concerning for osteomyelitis
Heel Ulcer & Osteomyelitis

- A-C: Large heel ulcer in a patient with diabetes (yellow arrow)
- A-C: Erosion in the plantar aspect of the calcaneus secondary to osteomyelitis
- B-C: Bone marrow signal abnormality (*) in the calcaneus on MRI confirms osteomyelitis
- MRI with contrast may help in delineating an abscess or necrotic tissue and for surgical planning
Calcaneal Stress Fracture

- Associated with repetitive activity – fatigue fractures
- Maybe seen with arthritides, diabetes or neuropathies – insufficiency fractures
- Most often in the posterior aspect of calcaneus
- Usually vertically oriented
- Maybe difficult to see on radiographs or CT
  - Subtle linear sclerotic changes
- MRI – imaging modality of choice
  - Linear low signal on T1 weighted sequences and high signal on fluid sensitive sequences
Talocalcaneal & Subfibular Impingement

- Extra-articular Impingement
  - Seen with pes planus and hindfoot valgus deformity
- Associated with
  - Tibialis posterior tendon dysfunction
  - Neuropathic changes
  - Inflammatory arthropathies
  - Prior trauma
- Changes are progressive
  - Talocalcaneal impingement typically occurring prior to subfibular impingement
- With advanced changes as seen in this case
  - Contact between the talus and calcaneus along lateral aspect of posterior subtalar joint
  - Contact between the fibula and the calcaneus
  - Resultant bone marrow signal changes and cystic changes along the points of contact
- Additional ligament and tendon injuries maybe present
Multiple xanthomas of Achilles tendon are seen with heterozygous familial hypercholesterolemia.

US and MRI are useful imaging modalities to detect xanthomas of Achilles tendon.

US: Appear as lobular hypoechoic nodules in the Achilles tendon.
Tarsal Tunnel Tumor

- **Tarsal tunnel**
  - A fibro-osseous tunnel between flexor retinaculum superficially with talus and calcaneus along the deeper aspect

- **Entrapment of the tibial nerve or its branches in the tunnel may result in pain**

- **Causes include**
  - Tumors, adjacent fractures, tendon pathology, accessory muscles, and vascular abnormalities

- **A-C: Tumor of the tibial nerve**

- **MRI and US are the imaging modalities of choice**
Tarsal Tunnel Syndrome

- Lobular ganglion cyst in tarsal tunnel (blue oval)
- Note mass affect (red arrows) on tibial nerve (yellow arrows) due to the ganglion cyst
- Edema signal is seen in the tibial nerve
Heel Tumor

- Soft tissue or osseous neoplasms may cause heel pain.
- A-B: Large lobular soft tissue lesion (yellow arrows) in the heel seen on CT.
- C-D: US is useful to characterize the solid nature of this neoplasm.
- D: US is helpful in performing a biopsy—Note needle (blue arrows) in the lesion—Schwannoma by pathology.
Heel Mass

- Soft tissue palpable mass along heel
- US
  - Large lobulated anechoic mass
  - No internal flow seen in the mass on color Doppler
  - Cystic mass - a ganglion cyst
Heel pain is a common problem seen in patients of all ages and activity levels. Causes include congenital abnormalities, inflammatory processes, tendon pathologies, trauma, infection, neoplasms and nerve injuries. Knowledge of the anatomic structures in the region and their relationship to each other is important to make the correct diagnosis. MRI and ultrasound are often the imaging modalities of choice. Optimal imaging is important in reaching an accurate diagnosis and in surgical planning.
References

- Lawrence et al. MR imaging findings of entrapment of the flexor hallucis longus tendon. AJR 2001;176:1145-1148.
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