Other Common Causes of Painful Hindfoot
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Objectives
- Explore differential diagnosis for hindfoot pain
- Consider etiologies beyond ligament/tendon injury
- Recognize imaging findings typical of impingement syndromes
- Heel pain
- Other hindfoot pain

Painful Hindfoot
- Impingement Syndromes
  - Anterior
  - Anterolateral
  - Anteromedial
  - Posteromedial
  - Posterior
  - Talocalcaneal & calcaneofibular
- Heel Pain
  - Plantar fasciitis
  - Plantar fibromatosis
  - Bursitis
  - Haglund deformity/syndrome
  - Calcaneal stress fractures
  - Os trigonum Syndrome
- Osteochondral Lesions
- Tarsal Coalition
- Sinus Tarsi Syndrome
- Tarsal Tunnel Syndrome
- Baxter’s neuropathy
- Synovial Disorders
- Multifocal bone marrow edema

Ankle Impingement Syndromes
- Pathologic conditions resulting in chronic, painful restriction to movement
- Secondary to soft-tissue or osseous abnormalities
- Typically related to an ankle sprain
- Classified according to its anatomic relationship to the tibiotalar joint

Ankle Impingement Syndromes
- Anterolateral
- Anterior
- Anteromedial
- Posteromedial
- Posterior
- Talocalcaneal & Calcaneofibular
- Lateral hindfoot
Anterior Impingement Syndrome

- Ballet dancers & soccer players
- Progressive symptoms due to impingement of hypertrophied soft tissue & bony spurs
  - Anterior tibiotalar spurs within joint capsule
  - Repeated dorsiflexion (ballet - plié)
  - Direct trauma from ball impact (soccer - ball strike)
  - Microfractured trabecular bone, periosteal hemorrhage, anterior chondral margin trauma result in new bone formation
- Effusion
- Hypertrophied synovium with impingement, irregular capsular thickening
- Marrow edema uncommon

Anterolateral Impingement

- Typically young athletes with minor trauma (inversion)
- Recurrent subclinical instability & microtrauma with hemorrhage, localized reactive synovial hypertrophy, scarring
- Eversion & dorsiflexion cause symptoms of impingement
- May form reactive hyalinized connective tissue mass: "meniscoid lesion"
- May be associated with distal/accessory fascicle of anterior inferior tibiofibular ligament (normal variant)
- Treatment: arthroscopic resection of hypertrophic synovium & scar tissue

Lateral drawing of ankle shows typical location of spur formation (orange) at anterior ankle projecting from anterior tibia and anterior talus. This spur results in decreased angle between tibia and talus, measuring less than 60°.
**Anterolateral Impingement**

- Accessory ligament or distal fascicle of anteroinferior tibiofibular ligament (white arrow)
- Normal variant
- Can cause impingement when thickened
- Black arrows = anterior tibiofibular ligament
- Arrowheads = anterior talofibular ligament

**Anterolateral Impingement Imaging**

- Ultrasound
  - Nodular, mixed echogenic, synovitic mass
  - Bone spurs
  - Anterior talofibular ligament injury
- MRI
  - Thickened anterior talofibular ligament
  - Lateral gutter fullness
- MR Arthrogram
  - Capsule adheres to tibia and fibula - scarring & synovitis

**Anteromedial Impingement**

- Low-signal-intensity meniscoid-shaped mass (arrow)
- Extends from thickened anterior talofibular ligament (arrowhead) into lateral gutter

**Anteromedial Impingement Imaging**

- Rare complication of inversion trauma
- Microtrauma & healing initiates synovial, ligamentous, capsular thickening in anteromedial compartment
- Compressed during dorsiflexion & inversion
- MR Arthrography
  - Anteromedial capsular thickening
  - Abnormal soft tissue anterior to the deltoid ligament & medial malleolus

**Anteromedial Impingement**

- 24-year-old woman
- Synovitis (arrow) in anteromedial gutter deep to superficial anterior deltoid fibers
- Synovitis extends posteriorly between flexor digitorum longus and posterior tibial tendons (arrowhead), suggesting concomitant posteromedial impingement

**Anteromedial Impingement Imaging**

- Synovitis in anteromedial gutter (arrow)
- Outlined by joint fluid
**Anteromedial Impingement**

- 51-year-old man
- Remote ankle sprain
- Thickening and ossification of deep (arrows) and superficial (arrowhead) deltoid ligament fibers

**Posteromedial Impingement**

- Following severe inversion injury with ATF ligament injury
- Allows compression of posteromedial structures between medial wall of talus & medial malleolus
  - Joint capsule
  - Posterior deltoid ligament
  - Posteromedial flexor tendons
- Forms thickened, disorganized fibrous tissue
- Accessory medial talar tubercle may contribute
- Treatment
  - Injection: steroid & local anesthetic
  - Surgical resection

**Posteromedial Impingement**

- MRI
  - Loss of normal fat striations in posterior deltoid ligament
  - Posteromedial synovitis
  - Thickening & abnormal signal posteromedial joint capsule
    - May displace/surround adjacent tendons
- US
  - Thickening posteromedial capsule
  - Posteromedial synovial hypertrophy
  - Displacement/entrapment of adjacent tendons

**Posteromedial Impingement**

- Marked scarring and loss of normal architecture of deep deltoid ligament (arrows)
- Medial displacement of posterior tibial tendon (arrowhead)
- Obolitation of fat planes between posterior tibial tendon and scarred ligament
- M = medial malleolus.

**Posteromedial Impingement**

- Posterior ankle pain with plantar flexion
- Compression of talus & soft tissues between posterior tibia & calcaneus
- AKA os trigonum syndrome, talar compression syndrome, posterior block
- Os-trigonum most common cause

**Posteromedial Impingement**

- Posterior talar process is bifid
  - Smaller medial process
    - Groove for flexor hallucis longus tendon
  - Larger lateral process
    - Steida process
    - Failure of fusion (14-25%): os trigonum (3 articular surfaces)
Posterior impingement

- Soft tissue impingement
  - Posterior capsule
  - Posterior talofibular, posterior intermalleolar & tibiofibular ligaments
    - Posterior intermalleolar ligament - anatomic variant – extends obliquely from posterior medial malleolus to posterior margin of fibular malleolar fossa

Chronic repetitive stress in plantar flexion

- Ballet dancers: en pointe
- Soccer players: ball strike

Posterior impingement Imaging

- Lateral x-ray (plantar flexion)
  - Impingement of os trigonum/lateral tubercle between calcaneus & posterior tibia
- US
  - Nodular, hypoechoic thickening of posterolateral joint capsule
- MRI
  - Posterolateral capsule thickening & synovitis
  - Bone marrow edema
  - Os trigonum/lateral tubercle fragmentation
  - Fluid along flexor hallucis tendon sheath

Posterior Impingement

- 27-year-old woman
  - Prominent Stieda process (black arrow)
  - Posterior osteophyte (white arrow) along distal tibia

27-year-old female ballet dancer with posterior impingement and os trigonum.

STIR: opposing talar and os trigonum marrow edema (arrows), adjacent soft-tissue edema, and joint effusion (star)
Posterior Impingement – Os trigonum

Posterior Impingement, FHL tenosynovitis

Posterior impingement Management

- Conservative initially
- Ultrasound guided anesthetic/steroid injection
- Surgical excision – osseous & soft tissue elements

Talocalcaneal & Calcaneofibular Impingements

- Extra articular soft-tissue and osseous impingements
- Lateral to the ankle joint
- Sequelae of flatfoot deformity & hindfoot valgus
- Posterior tibial tendon (PTT) deficiency
- Rheumatologic disorders
- Diabetes
- Calcaneal fractures
- Congenital flatfoot
- Calcaneal osteotomy is often necessary to correct hindfoot valgus and lateral hindfoot impingement

Lateral extra articular talocalcaneal & subfibular hindfoot impingements

Talocalcaneal and calcaneofibular impingement

- 66-year-old woman
- Pes planus and hindfoot valgus
- STIR: marrow edema of opposing lateral talar process (solid arrow) and calcaneus (open arrow)
Talocalcaneal and calcaneofibular impingement

- Sag T1: edema and scarring (arrowheads) surrounding thickened, entrapped calcaneofibular ligament (arrow)

- Hindfoot valgus angle, formed by intersection of line along medial calcaneal wall and line parallel to long axis of tibia, is increased (30°).

- 61-year-old woman with severe hindfoot valgus
- Contact between calcaneus and fibula with opposing marrow edema and subchondral cysts (arrows)

- Coronal PD: neocalcaneal facet (solid arrow) articulating with distal fibula
- Lateral subluxation of calcaneus and subchondral changes in posterior subtalar facet (arrowheads)
- Peroneal tendons (open arrow) are minimally laterally subluxed

Lateral Hindfoot Impingement

- Characteristic bone marrow edema at the inferior apex of the lateral talar process (asterisk) as well as at the subjacent angle of Gissane (arrowhead)

- Heel pain (calcaneodynia)
  - Plantar fasciitis/ tear
  - Calcaneal stress fracture/ insufficiency avulsion fractures
  - Tarsal tunnel syndrome
  - Baxter's nerve impingement
  - Bursitis
  - Achillies
    - Tendinosis, Insertional tendinosis
    - Tendon tear
    - Paratendinitis & Paratendinitis
    - Haglund Deformity & Syndrome
    - Sever Disease (calcaneal apophysitis)
    - Os Trigonum Syndrome
Plantar fasciitis
- Most common cause of inferior heel pain
- Inflammation usually related to repetitive trauma
  - Microtears near its origin
  - Runners, obese patients
- Inflammatory arthropathies (enthesopathy)
  - Reactive arthritis, ankylosing spondylitis, psoriatic arthritis
- MRI
  - Intermediate signal (should be low) – intrafascial edema
  - Thickening 6-10mm (normally 2-4mm) – fusiform
  - Marrow edema calcaneal tuberosity
  - Surrounding hyperintense T2 (edema)
- Heel spur on X-ray not diagnostic

Plantar fasciitis

Plantar Fasciitis

Sports related (running, jumping)
- Chronic plantar fasciitis after corticosteroid injections
- Usually proximal, near calcaneal attachment
- Associated with tear of flexor digitorum brevis muscle
- MRI
  - Partial/complete disruption, edema & hemorrhage
  - Perifascial fluid

Plantar Fascia Tear

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Plantar Fascia Tear

Plantar Fibromatosis

- Benign fibroproliferative disorder, unclear etiology
- M.C. medial portion central fascial band
- One or more palpable nodules
- MRI
  - Nodules along plantar fascia
  - Low T1, intermediate to high T2/STIR
  - Enhancement varies (based on cellularity)
- Deeper lesions often solitary, aggressive, high recurrence following excision

Plantar Fibromatosis

Plantar Fibromatosis

T1 T2FS T1FS post

Plantar Fibromatosis

T1 T2FS T1FS+

Plantar fibromatosis

Bursitis

- Retrocalcaneal bursa (subachilles bursa)
  - Between posterosuperior calcaneus and Achilles tendon insertion
  - Should measure < 1-2mm AP
- Superficial Achilles bursa (retro-Achilles bursa, subcutaneous calcaneal bursa)
  - Between tendon and skin
  - Adventitial (acquired)
- Bursitis: edema without mass effect on skin
Retrocalcaneal bursitis

- With or without Achilles tendinosis
- Repetitive trauma (runners)
- Conservative treatment, sometimes corticosteroids
- X-ray: obliteration of normal retrocalcaneal fat pad
- MRI: enlarged bursa
  - >7mm long, 11mm trans, 1mm AP considered abnormal

Haglund Deformity & Syndrome

- Deformity: prominent bony projection of calcaneus
  - Superior, posterior aspect of calcaneal tuberosity
  - Associated with wearing low-back shoes
- Syndrome: mechanically induced inflammation
  - Inflammation of superficial bursa
  - Achilles tendinosis
  - Retrocalcaneal bursitis
  - Bony prominence

Haglund Deformity - XR

- Enlarged calcaneal tuberosity
- Draw parallel pitch lines along superior & inferior calcaneus
- Calcaneal tuberosity enlarged if extends above superior pitch line
- Syndrome: loss of radiolucent retrocalcaneal recess (indicates bursitis)

Calcaneal stress fracture

- 2nd most common site of fatigue stress fracture (after metatarsals)
- Insufficiency fractures (RA, neurologic disorders, DM)
- Repetitive trauma (jumping)
- Posteroanterior or posterior calcaneus
  - Oriented vertically (perpendicular to long axis of calcaneus)
- X-ray: variable sclerotic band
- MRI:
  - Band-like low T1, high T2 in intramedullary space, extends to cortex
  - Extensive surrounding edema, hemorrhage
  - Periosteal callus – hypointense line parallel to cortex
Calcaneal stress fracture
- 24 year old military recruit
- Fracture line (arrow) and intense surrounding marrow edema
- Associated retrocalcaneal bursitis (arrowhead)

Sever Disease (calcaneal apophysitis)
- Skeletally immature
- Traction: at site of Achilles tendon insertion
- X-ray nonspecific
  - Increased density, fragmentation of apophysis (also seen in healthy kids)
- MRI
  - Edema in calcaneal apophysis, may extend to calcaneal tuberosity

Calcanegal Insufficiency Avulsion (CIA) Fractures
- Avulsion fracture involving posterior 1/3 of calcaneus
- Same plane as fatigue type calcaneal fracture
- No significant force
- Displaced 10-30 mm, often rotated
- Mean time from diagnosis of diabetes mellitus to CIA fracture: 20 years
Calcaneal Insufficiency Avulsion (CIA) Fractures

Osteochondral Lesions (OCL)
- Post-traumatic injury of articular (hyaline) cartilage and underlying subchondral bone
- Common locations (in order of frequency)
  - Femoral condyles
  - Capitellum of elbow
  - Talar dome
  - Patella
- Talar dome OCL
  - Medial more common than lateral
  - Deeper
  - Greater surface area
Stable v Unstable OCL
- Unstable
  - Hyperintense T2 signal (equal to joint fluid) between detached osteochondral fragment and parent bone
  - Cystic change at donor site
  - Extensive bone marrow edema
  - Collapse of articular surface
  - Arthrogram may help delineate, if necessary

- Stable
  - Non-weightbearing cast immobilization
  - Progressive weightbearing over 3-4 months

Unstable
- Surgery: remove subchondral fragment & Debris
  - Microfracture of remnant bone to promote growth of new fibrocartilage
  - Internal fixation (fragment > 7.5mm)
  - Osteochondral allografts or autografts
  - OATS (Osteochondral autograft transfer system)
  - Heal with type II collagen instead of fibrocartilage

OCL Differential Diagnosis
- AVN – Avascular Necrosis
  - Significant bone marrow edema
  - Spares articular surface
  - End stage OCL and AVN can result in collapse of articular surface
- OA – Osteoarthritis
  - Changes involve both sides of joint
  - Eburnation
  - Osteophytes
  - OCL may result in OA
Osteoid Osteoma Talus

Tarsal Coalition
- Congenital connection between 2 or more bones
- Bony, cartilaginous, or fibrous
- Prevent normal joint motion
- Subtalar coalition
- Calcaneonavicular coalition
- Coalitions cause abnormal bone overgrowth
  - Osseous coalition: continuous bony bar
  - Nonosseous coalition: bony overgrowth with irregular cleft

Tarsal Coalition – Radiographic features
- Subtalar coalition (best seen on Harris view)
  - C-sign (lateral) – continuity of inferomedial talus and ST
  - Dysmorphic Sustentaculum Tali – inferior border rounded, enlarged
  - Talar beak – articular surface flares superiorly to accommodate increased motion at talonavicular joint
  - Talar osteophyte – proximal to joint and arcs over joint
  - Talar ridge – normal attachment ankle joint capsule, proximal
  - Absent Middle facet sign
- Calcaneonavicular coalition
  - Anteater sign (lateral) – elongated anterior process of calcaneus
  - Elongated Navicular sign (AP) – reverse anteater – elongated lateral navicular

C-sign, talar beak

Subtalar coalition: CT/MRI
- Osseous: bony continuity across middle subtalar facet
- Nonosseous: fibrous or cartilaginous coalition
  - Narrow, obliquely oriented, undulating contour
  - Subchondral cysts
  - Bone marrow edema
  - Enlarged ST, rounded contour inferiorly
  - Peroneal or flexor tendon tenosynovitis

Subtalar (talocalcaneal) coalition
Calcaneonavicular Coalition – CT/MRI

- Sagittal: elongated anterior calcaneal process with blunted tip
- Axial: Abnormal shape anterior calcaneus and lateral navicular
- Subchondral cysts & bone marrow edema anterior calcaneus

Calcaneonavicular Coalition

- T1: elongated & broadened anterior process of calcaneus (arrowhead)
- Irregular articulation (arrow) with the navicular: "anteater’s nose".
- STIR: bony hypertrophy & subarticular marrow edema (asterisks) at the abnormal calcaneonavicular articulation
- T1: slightly widened mediolateral dimension of the naviculare (black arrow) tapers laterally and articulates (white arrow) with the enlarged anterior process of the calcaneus (arrowhead)
Sinus Tarsi Syndrome

- Lateral pain, perceived hindfoot instability
- Subtalar region, anterior to posterior subtalar joint
- Normally fat-filled
- Talocalcaneal (Interosseous) Ligament
  - Cervical ligament: anterior
    - Best seen on Coronal: vertical course
  - Interosseous talocalcaneal ligament: posterior & medial
    - Coronal: oblique orientation inferior talus to superior calcaneus
  - Inferior extensor retinaculum (superficial)

Etiology:

- Trauma (70%)
- Inflammation (RA, gout, Ank spond)
- Foot deformities (pes cavus/planus)

MRI: replacement of normal fat signal

- Inflammatory infiltrate, fibrosis
- Low T1, high T2
- Ligaments obscured or ruptured
- High association with lateral ligament disruption

Differential diagnosis: Lateral hindfoot impingement

Sinus tarsi syndrome

52 year-old male with ankle pain and swelling

T1: absence of fat signal at the sinus

STIR: edema throughout the sinus tarsi with subcortical bone marrow edema along the talus and calcaneus at margins of the sinus (arrows)
Tarsal tunnel syndrome

- Entrapment neuropathy of posterior tibial nerve or of its branches within the tarsal tunnel
- Usually unilateral
- Clinical presentation
  - Pain & paresthesia in the toes, sole, or heel
  - Physical exam: Tinel sign (distal paresthesias produced by percussion over the affected portion of nerve)
  - Electromyography and nerve conduction studies are useful in confirming the diagnosis

Tarsal tunnel anatomy

- Fibro-osseous canal, medial ankle
- Boundaries
  - Roof: flexor retinaculum
  - Floor: medial surfaces of talus & calcaneus
- Contents (from anterior to posterior)
  - Tibialis posterior tendon
  - Flexor digitorum longus tendon
  - Neurovascular bundle
    - Posterior tibial artery & vein
    - Posterior tibial nerve
  - Flexor hallucis longus tendon
- A mnemonic to remember the order is: Tom, Dick and Very Nervous Harry
- Divided by fibrous septae joining the retinaculum to calcaneus, forming four separate compartments - one for each of the tendons and one for the neurovascular bundle

Tarsal Tunnel Anatomy

Tarsal tunnel syndrome

- Compression of posterior tibial nerve between medial surface of ankle and overlying flexor retinaculum
- Pain, sensory deficits, and muscle weakness
- MRI: mechanical causes of compression
  - tenosynovitis
  - neural tumors
  - ganglion cysts
  - posttraumatic fibrosis
  - accessory muscle - flexor digitorum accessorius longus (FDAL)

Tarsal tunnel syndrome: flexor digitorum accessorius longus (FDAL)

Tarsal Tunnel Syndrome: ganglion cyst
Baxter’s neuropathy - MRI

- **Acute phase** of muscle denervation
  - Decreased T1, increased T2FS signal intensity
  - Increased extracellular water content
  - Decreased muscle fiber volumes

- **Chronic phase** of muscle denervation
  - Amyotrophy or fatty degeneration
  - Abductor digiti minimi muscle
  - Less commonly: flexor digitorum brevis & quadratus plantae muscles

Baxter’s Nerve Impingement

- Fatty degeneration of the abductor digiti minimi muscle

Baxter’s neuropathy

- Nerve entrapment syndrome: compression of the inferior calcaneal nerve
  - 1st branch of the lateral plantar nerve - courses through tarsal tunnel

- Clinical presentation
  - Heel pain (plantar medial foot and anterior/medial calcaneus)
  - Paresthesia with motor weakness of the abductor digiti minimi muscle
  - No associated cutaneous sensory deficit

Baxter’s neuropathy - chronic

- October 2009 Radiology, 253, 160-166.
Synovial Disorders
- PVNS – Pigmented Villonodular Synovitis
- Synovial chondromatosis
- Synovitis

PVNS
- Proliferative disorder of synovium
- Joints, tendon sheaths, bursae
- Hemorrhage results in hemosiderin deposition
- MRI variable: intermediate/low T1, low and high T2, blooming artifact GRE
- Diffuse form involves joints (knee > hip > ankle)
- Focal form: tendon sheath (GCTTS giant cell tumor of tendon sheath)

PVNS Ankle

FHL Giant Cell Tumor Tendon Sheath

FHL GCTTS post Gad

Synovial chondromatosis
- Synovial metaplasia
- Benign, monoarticular
- Lining cells produce cartilage nodules
- May or may not ossify
- Treatment: synovectomy
Synovial chondromatosis

- Mass-like signal distending ankle joint

Multifocal Bone Marrow Edema
- High turnover - children <15 years
  - Multiple foci of high T2 signal in several ankle/foot bones
  - Asymptomatic, self limiting
  - Altered gait
  - Strenuous exercise
  - Bone impaction/bone contusions
  - Trabecular microfractures, edema, hemorrhage
  - Immobilization – patchy, subcortical, subchondral
  - CRPS – Complex Regional Pain Syndrome
    - Skin edema & thickening
    - Muscle atrophy in later stages
    - Patchy bone marrow edema signal (particularly subcortical, periarticular)

High Turnover
- 12-year-old girl
- Sagittal STIR image shows multiple foci of increased bone marrow signal
  - Associated with increased sports-related activity

Immobilization
- MR image obtained after 6 weeks of bracing shows talar osteochondral lesion (arrow, reason for bracing)
- Extensive bone marrow edema in multiple bones related to disuse osteoporosis

CPRS
- Soft tissue edema and enhancement, skin thickening
- Muscle atrophy in later stages
- Patchy bone marrow edema signal (particularly subcortical, periarticular)
Objectives

- Explore differential diagnosis for hindfoot pain
- Consider etiologies beyond ligament/tendon injury
- Recognize imaging findings typical of impingement syndromes
- Heel pain
- Other hindfoot pain

References

References

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Diabetes

- Pedal osteomyelitis
- Charcot joint
- Calcaneal insufficiency avulsion fractures

Skin Callus

- Develop at pressure points
  - Normal: 1st/5th metatarsal head, heel
  - Hallux valgus: medial to 1st metatarsal
  - Rocker-bottom: beneath cuboid
- MRI: focal prominence in subcutaneous fat
  - Low T1, low to intermediate T2
  - May enhance
  - Adjacent fat normal (helps distinguish from infection)
- Adventitial bursa
  - Thin, flat fluid collection
  - Adjacent to callus

Ulceration & Sinus Tract

- Callus breakdown
- Focal skin interruption, “heaped up” margins, soft tissue defect
- T2 bright, intense peripheral enhancement (granulation tissue)
- Sinus tract ("tram track" enhancement) leads to bony prominence

Plantar ulcer with cuboid osteomyelitis
Sinus tract – no osteo

Soft tissue swelling, cellulitis, abscess

- Edema & cellulitis: fat reticulation with intermediate T1 & high T2 signal
- Cellulitis enhances, edema does not
- Phlegmon: ill-defined low T1, intermediate to high T2 (not as bright as fluid)
- Vague enhancement
- Abscess: fluid signal collection
- Peripheral rim enhancement

Cellulitis, fistula and associated osteomyelitis and septic arthritis

- High T2 signal and significant skin enhancement in cellulitis (arrowheads)
- Deep ulcer in the medial portion of the first toe
- Fistula (white arrow) traversing the distal phalanx
- Abnormal signal of the proximal and distal phalanges due to osteomyelitis & septic arthritis (black arrow)

Gangrene

- Clinical diagnosis – imaging usually unnecessary
- Dry – noninfected, devitalized tissue
- Wet – superimposed infection
- MRI – delineate areas of soft tissue devascularization
  - Nonenhancing area
  - Sharp demarcation from viable tissue
  - Reactive hyperemia/enhancement of periphery
  - Wet gangrene – look for soft tissue gas
  - GRE most sensitive - blooming

Gas gangrene

- Widespread low-signal-intensity foci demonstrating blooming artifact (arrowheads) along the dorsum of the foot, indicating soft tissue gas
- Fluid collections (white arrows), with peripheral enhancement (black arrows)
- Subcutaneous tissue, fascial and muscular enhancement (asterisks) are present

Osteomyelitis

- Confluent low T1 signal, high T2
- High T2 signal without low T1 – reactive edema (may enhance)
- Periosteal reaction: circumferential high T2, enhances
- Adjacent soft tissue findings (ulcer, sinus tract, cellulitis, abscess, foreign body)
Osteomyelitis
- 3 phase bone scan
  - Increased activity blood flow, blood pool, delayed phases distal 1st MT
  - Consistent with osteomyelitis.
- MRI
  - Confluent hypointense T1, hypointense T2
  - Indicate presence of osteomyelitis in the first metatarsal head (white arrows)

Septic arthritis
- Contiguous spread from adjacent soft tissue infection
  - Achilles & subtalar joints in hindfoot related to ulceration at malleoli or calcaneus
  - Complex joint effusion, thick synovial enhancement
  - Soft tissue & subchondral marrow edema, marginal erosions
  - Confluent low T1 - osteomyelitis

Septic tenosynovitis
- Spread from adjacent ulceration
  - Peroneals – lateral malleolus ulcer
  - Achilles (peritenonitis) – calcaneal ulcer

Neuropathic arthropathy
- Acute stage may mimic osteomyelitis
  - MRI: soft tissue edema, fluid collections, effusions, marrow changes, enhancement
  - Subacute stage (coalescence): bone resorption
  - Chronic, consolidation stage: debris, destruction, dislocation, density (x-ray)
  - MRI: deformity, osseous fragmentation, joint effusions
Chronic neuropathic osteoarthropathy
- XR: fragmentation & subluxation (arrowheads) at the midfoot with dorsal soft tissue swelling
- XR: extensive midfoot bone marrow edema
- Multiple midfoot fluid collections
- Diffuse bone marrow enhancement and associated periarticular subchondral cysts suggestive for neuroarthropathy only
- No associated ulcer, sinus tract or abscess formation. Clinical evaluation revealed no signs of infection.

Osteomyelitis v Charcot
- Osteomyelitis
  - Contiguous spread of infection from skin ulceration
  - Distal to Lisfranc's joint, calcaneus, malleoli
- Charcot
  - Articular disease
  - Lisfranc's joint, metatarsophalangeal joints

Neuropathic arthropathy with superimposed infection
- Diffuse marrow changes (periarticular in Charcot joint without infection)
- Positive “Ghost sign” = superimposed infection
  - Bones “disappear” on T1
  - “Appear” & become more distinct on T2 and post-contrast images
- Negative ghost sign = neuropathic foot
  - Bones are truly dissolved and destroyed

Ghost Sign = Osteomyelitis
- Poor definition of the margins of a bone on T1-weighted images, which become clear after contrast administration
- Indicative of neuro-osteoarthropathy with superimposed osteomyelitis

Masses - benign
- Plantar fibromatosis
- Peripheral nerve sheath tumors
- Lipomas
- Glomus tumors
- Ganglion cysts
- Abscess
- Epidermal Inclusion Cysts
- Subcutaneous Granuloma Annulare

Masses - malignant
- MFH – Malignant Fibrous Histiocytoma
  - Spreads from calf
  - Infiltrating, rapid growth
- Synovial Sarcoma
  - Cells resemble synovial membrane, only 5% intraarticular
  - 2/3 lower extremity
  - Slow growing, infiltrative
  - Lobulated, with cysts/necrosis, fluid levels
- Liposarcoma
  - Nonspecific