Ultrasound and MRI in the rheumatoid foot

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• Foot disease in RA is a common problem, with at least 90% of patients affected during the course of the disease.

• Involvement usually begins in the forefoot and later progresses to involve the midfoot and hindfoot.
• Since early changes are nonosseous in nature, US and MRI are superior to conventional radiography and CT in terms of disease detection.

  – For the early treatment, US and MRI are the imaging methods of choice.

  – Both imaging techniques can detect preerosive synovitis.

  => Plain radiography
     ; peri-articular osteoporosis, joint space widening and soft tissue swelling.
     ; difficult to detect.
Background

• Increasing trend for early and more aggressive treatment of synovitis with DMARDs, which may demonstrate benefit when prescribed even within weeks to months of the onset of disease.
• The emphasis in early disease detection
  – *Erosion* → *Synovitis*
• The earliest detectable abnormality within the small joints of the hands and feet is *effusion.*
Background

• Small joint US following treatment
  – Changes in synovial thickening and vascularization following treatment can occur rapidly.
Pattern of Disease

- Bilateral and symmetric involvement of foot joints is typical manifestation of RA.
- The MTP and the interphalangeal (great toe) joints are favored sites.
- All midfoot joints may be involved.
  - The talonavicular, subtalar, and tarsometatarsal joints are specific target areas.
  - Involvement of the talocrural joint may be associated with a sinus tarsi and tarsal tunnel (compression of the tibial nerve) syndrome.
Pattern of Disease

- Retrocalcaneal bursitis
- Changes may occur at the insertion of the plantar aponeurosis and the Achilles tendon.
- Tenosynovitis, tendinitis, and rupture of the tibialis anterior tendon may complicate the process, further destabilizing the joint.
Technique of Ultrasound

• The MTP and PIP joints of the toes are best examined from the extensor aspect.

• The big toe is usually not included in the general rheumatological screen, as effusion and bone irregularity are frequently encountered in the asymptomatic population.
FOREFOOT INVOLVEMENT IN RHEUMATOID ARTHRITIS
Hyperemia

- The first step in the inflammatory cascade that can be identified with imaging.
- Power Doppler contrast-enhanced sonography and MR imaging (especially T1CE with FS and water-weighted inversion-recovery images) are very helpful in identifying the pathologic condition.
Synovitis

• Cytokines $\rightarrow$ capillary leakage and edema $\rightarrow$ synovial swelling and effusion
  – Reversible
• Initially, the inflammatory tissue thickens at the bare areas, gradually extending into the joint space across the cartilaginous surfaces.
• MRI reveals proliferative synovitis as thickening of the synovial membrane that appears as quick enhancement after the administration of gadolinium.
Synovitis

• Definition on US
  – Nondisplaceable, intra-articular, poorly compressible tissue, which may exhibit Doppler signal.

• Pannus
  – Tumor-like focal proliferation of inflammatory tissue.
  – MRI is an excellent tool for assessing synovial swelling and volume.
  – Contrast-enhanced color Doppler US helps detect and define synovial changes and evaluation of pannus.
Tenosynovitis

- MRI
  - Thickening of the synovial sheath with marked enhancement on FS T1CE.

- US
  - Hypoechoic thickening of the synovial sheath with hyperemia on Doppler imaging.
Synovitis

Tenosynovitis

Hypovascular Pannus

Synovitis and tenosynovitis
Effusion

- Occurs early in the disease
- Commonly associated with acute inflammation or exacerbation
- Definition
  - completely transonic, compressible, and with no increase in Doppler signal
Changes in the Bone Marrow

• BME may precede the development of bone erosions.

• BME
  – A lesion with ill-defined margins with high SI, typically located at the insertion of the synovial membrane.

• US
  – Provides no information on BME.
Bursitis

• Located between or beneath the metatarsal heads.
• MRI
  – Intermetatarsal and submetatarsal bursitis show significant enhancement.
• US
  – Heterogeneous (hypo- and hyperechoic) collections that can be well- or ill-defined.
Narrowing of the Joint Space

- Progression of the destructive process and the formation of scar tissue and fibrosis lead to concentric joint space narrowing.
  - Indicates an advanced stage of RA
Erosions

• Up to 47% of patients may develop erosions within 1 year after onset of RA.
  – Arise at the bare areas of MTP joints first.
  – In the feet, the 5th > 3rd > 2nd ray
• MR imaging demonstrates erosions first.
  – Usually appear at the metatarsal heads
  – Sometimes, contrast enhancement helps distinguish erosions and pre-erosions from simple and degenerative bone cysts.
Erosions

- **MRI**
  - Sharply marginated areas of trabecular bone loss with a cortical defect, often associated with synovitis.

- **US**
  - Intraarticular discontinuities of the bone surface that are visible in two perpendicular planes.
Bone erosion in a patient with RA. Longitudinal high-resolution sonogram shows an irregular erosion of the metacarpophalangeal joint (arrowheads). The diagnosis was confirmed with CT.
HINDFOOT INVOLVEMENT IN RHEUMATOID ARTHRITIS
Synovitis

- Synovial inflammation in the talonavicular joint or the talocalcaneal joints is common.
- Involvement of the talocalcaneal joints may be associated with a sinus tarsi syndrome.
Bone Lesions

- Marginal bone erosions can be seen and usually result from synovitis.
- Subchondral bone marrow edema also represents one of the earliest MR finding in the hindfoot.
Cartilage Destruction

- Compared with findings with forefoot involvement, joint space narrowing and direct visualization of cartilage damage are easier to detect in the hindfoot, especially at the tibiotalar joint.
Tenosynovitis and Tendon Disease

- Many tendons around the ankle can be involved, especially the extensor tendons, the peroneal tendons, and the posterior tibial tendon.
  - tendinosis, partial rupture, and finally complete rupture
- Spontaneous tibial tendon rupture is a well known feature of RA
Bursitis

- Retrocalcaneal bursitis is common in RA.
Rheumatoid Nodules

- Occur in 20 to 30% of patients with RA.
- Rheumatoid nodules in the foot are unusual and represent 1% of all rheumatoid nodules.
  - Occur in soft tissues dorsally, adjacent to the Achilles tendon, and especially in the heel pad.
Sinus Tarsi Syndrome

- Results from synovial proliferation in the sinus tarsi space.
- MR abnormalities in the sinus tarsi space are commonly associated with flatfoot deformity.
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Pes Planovalgus or Flatfoot Deformity

• Common (46 to 64%)
• Laxity of capsule and ligaments, posterior tibial tendon rupture
Intraarticular Loose Bodies

- Intraarticular small loose bodies are a frequent by-product of the destructive inflammatory process, often including osseous and cartilaginous fragments.
- Some of the fragments are embedded in the inflamed synovial tissue.
- Rice bodies represent a special type of loose bodies that may contain fibrin.
• http://www.youtube.com/watch?v=THqUBTDkHjs

• http://www.youtube.com/watch?v=3PC5M37YOJU