OPTIMIZED MRI PROTOCOLS FOR THE ANKLE AND FOOT

1) ANKLE / HINDFOOT
   • Coil selection
     o Phased array “ski-boot” coil
     o Quadrature “chimney” extremity coil
     o Standard knee coil
   • Imaging strategy
     o High spatial and contrast resolution assessment of articular cartilage in the ankle and subtalar joints
     o Demonstration of bone marrow oedema
       • Frequency selective fat suppression
       • STIR
       • IDEAL
     o Adequate depiction of ligaments and synovial fluid / synovitis
     o Demonstration of tendons
       • Scan planes to compensate for curved course of peronei
       • Minimise magic angle effect with use of a heavily T2 weighted sequence
     o Coverage should include
       • Achilles insertion
       • Plantar fascia
       • Peroneus longus insertion base 1st metatarsal
       • Peroneus brevis insertion base 5th metatarsal
     o Optional additional sequences
     o Long axis PD fat sat sequence through midfoot if ? midfoot arthrosis in addition to ? pathology in hindfoot
     o MR arthrography has been advocated as a means of improving sensitivity for detection of synovitis, scar tissue and fibrous bands that may predispose to soft tissue impingement. The authors clinical experience has been that a high spatial and contrast resolution approach is sufficient to demonstrate these pathologies
     o Intravenous contrast has been advocated as a means of rendering more conspicuous for synovitis that may cause impingement symptoms and also as a means of differentiating inert tendon sheath effusions from an active tenosynovitis
   • Case studies

2) ACHILLES
   a) Study tailored for Achilles tendonopathy & insertional Achilles path
     o Use standard ankle coil, ankle neutral (avoid plantar flexion)
     o Axial sequences through Achilles tendon
       • Fat sat T2
• Fat sat T1 gradient echo (most sensitive routine sequence for tendinopathy)
  o Thin slice sagittal sequences through Achilles tendon, angled perpendicular to tendon off axial images
    • T1
    • Fat sat T2
    • Fat sat T1 gradient echo (most sensitive routine sequence for tendinopathy)
  o Optional sequences
    • Coronal T2 2mm
    • UTSE sequence for Achilles insertion
  o Case study

b) **Study tailored for acute Achilles tendon tear**
  o Often require more coverage than can be achieved with standard ankle coil
    • Scans must get above level of injury
  o Coil options
    • Use ankle coil and move up calf if required
    • Spine coil
    • Head coil
    • Long flex coil
  o Use a combination of PD, T2 and fat sat PD sequencing in 3 planes
  o Fat sat T1 gradient echo sequencing unhelpful in this setting
  o Case study

3) MID-FOOT
• Coil selection
  o Standard ankle coil
  o Knee coil, foot flat
    • Less pt comfort but may offer higher SNR
  o Flex coil
• Long axis PD and PD fat sat
  o Angle off short axis for ROI eg Lisfranc vs lat midfoot
• Sagittal PD fat sat +/- sag PD
• Short axis PD fat +/- short axis PD
  o Use short axis PD for ? tib ant path, post op setting or ? DPN
• Coverage
  o Transverse tarsal jt to mid metatarsal shaft
• Case study

4) FOREFOOT
• Central forefoot and great toe are separate anatomic regions, with differing orientation, requiring separate differing, tailored imaging technique

a) Central Forefoot
• Indications
  o ? mortons neuroma or 2nd MTP joint capsulitis
• Coil selection
  o Wrist coil – older” non-moulded” coils usually accommodate forefoot and afford high SNR. Newer moulded coils often unsuitable.
- Flex coil – preferably phased array construct
- Knee coil – esp if 8 channel phased array & pt able to position foot flat
- Ankle coil – esp if newer ski boot 8 channel phased array

- Pulse sequences
  - Short axis T1 & T2 perpendicular to P1 2nd / 3rd toes
  - Sagittal PD & PD fat sat optimised for visualisation of common plantar interdigital nerves and plantar plates
  - Long axis PD fat sat

- Case study

**a) Great Toe**

- Indications
  - ? turf toe, ? 1st MTPJ chondral injury

- Coil selection
  - Wrist coil – older” non-moulded” coils usually accommodate forefoot and afford high SNR. Newer moulded coils often unsuitable.
  - Flex coil – preferably phased array construct
  - Knee coil – esp if 8 channel phased array & pt able to position foot flat
  - Ankle coil – esp if newer ski boot 8 channel phased array

- Pulse sequences
  - Short axis PD & PD fat sat
  - Long axis PD fat sat angled to intersesamoid plane off short axis
  - Sagittal T1, PD & PD fat sat perpendicular to intersesamoid plane

- Case study

**METAL ARTEFACT REDUCTION IMAGING STRATEGY**

- Fast /turbo spin echo PD sequences with:
  - Longer echo train (12-20 L)
  - Larger receiver bandwidth
  - Shorter TE (approx 20msec)
  - Lower angle refocussing pulse

- STIR sequences

- Case study

**NEWER SEQUENCES**

- 3D PD FSE / TSE
  - Potential for isotropic data set that can be reconstructed in any plane

- IDEAL (Iterative Decomposition of water / fat using Echo Asymmetry and Least Squares estimation)
  - 3 point Dixon technique that allow use of parallel imaging
  - Homogeneous fat suppression in ankle and foot with better SNR than STIR sequencing

- UTE imaging of Achilles entheses

- Quantitative imaging of articular cartilage
  - T2 mapping
  - DGEMRIC
- T1 rho
- Fat sat T1 gradient echo for cartilage thickness / volumes