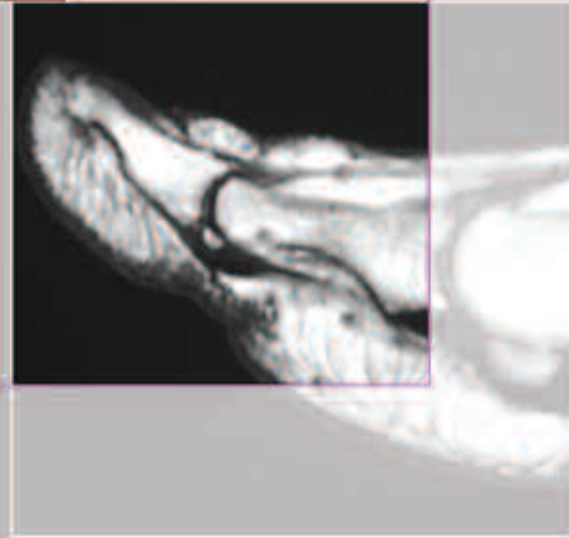


**HEEL
TO
TOE:**



**MRI
IN
PODIATRIC
MEDICINE**



Medical Arts Radiology

Imaging Excellence on Long Island for over 70 years

HEEL TO TOE: MRI IN PODIATRIC MEDICINE

MRI has revitalized the study of musculoskeletal disease in the foot and ankle due to its high soft tissue contrast resolution and its multiplanar capabilities. *MRI offers a quick and non-invasive tool for the diagnosis of injuries, which are often difficult to evaluate with alternative modalities.* It is particularly advantageous for assessment of soft tissue structures such as tendons, ligaments, nerves and fascia and for detecting occult bony injuries. At Medical Arts Radiology, MRI of the foot and ankle is performed using dedicated state of the art extremity coils, which combined with tailored protocols and detailed interpretation provide accurate depiction of soft tissue injuries and bone marrow abnormalities.

Patients With These Diagnoses May Benefit From MRI:

- Morton's Neuroma
- Diabetic Foot
- Posterior Tibial Tendon Dysfunction
- Stress Fractures
- Peroneal Tendon Tears & Instability
- Achilles Tendon Rupture
- Ligamentous Injuries
- Plantar Fasciitis

Technique

Routine ankle and foot MR imaging is obtained in the axial, oblique coronal and oblique sagittal planes. The patient is supine with the foot in about 20 degrees of plantarflexion. The lower extremity is padded to provide comfort during the exam. An extremity surface coil is utilized to enhance spatial resolution. Exquisite soft tissue resolution can be obtained at all Medical Art's offices including our Brand New Open Bore MRI in Bay Shore. This revolutionary magnet features CT-Like Comfort and 1.5T Strength.

MORTON'S NEUROMA

Morton's neuroma is a common cause of forefoot pain. The differential diagnosis includes intermetatarsal bursitis, true neuroma, inflammatory arthritis, pigmented villonodular synovitis, osteomyelitis, foreign body granuloma, stress fracture, Freiberg's infraction and metatarsophalangeal joint dislocation. In these instances, *MR imaging has proven to be valuable in establishing the underlying cause of intermetatarsal pain. The behavior of Morton's neuroma on MR imaging is very typical due to its predominantly fibrous composition.* Additionally, if surgical management is considered, MR examination can confirm the diagnosis and determine the number and exact location of the neuromas.

Indications:

- Atypical Forefoot Pain
- Preoperative Evaluation
- Concomitant Neuromas
- Recurrent Neuroma

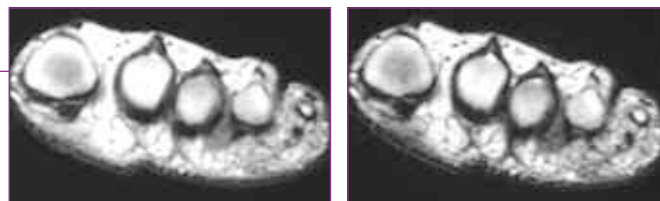


Fig 1. Morton's Neuroma.
Oblique coronal images, perpendicular to the metatarsals, demonstrate typical dark, teardrop-shaped soft tissue mass arising plantar to the intermetatarsal ligament.

DIABETIC FOOT

MRI has been shown to be highly sensitive for detection and staging of a number of musculo-skeletal infection such as cellulitis, soft tissue abscesses and osteomyelitis. *Compared to bone scintigraphy, MRI has superior specificity, better spatial resolution, and the diagnosis can be obtained without delays.*

Acute osteomyelitis demonstrates hypointensity of the bone marrow on T1 weighted images and increased signal on T2 weighted and STIR images. *MRI is highly sensitive to the detection of periostitis and some reports indicate that it may be more sensitive than plain film radiography.* All these findings can be observed in acute osteomyelitis very early, probably within hours of the onset of the infection, whereas it may take few days to up to two weeks to be seen on plain films.

The MRI manifestations of soft tissue infection also depend on the type of infection. Soft tissue abscesses, frequent in patients with diabetic foot, demonstrate fluid-type signal intensity in different pulse sequences, surrounded by a hypointense rim presumably representing the capsule of the abscess. Cellulitis, on the other hand, demonstrates abnormal signal intensity infiltrating diffusely the subcutaneous tissues and sometimes extending into the deep fasciae, but without the capsule seen in abscesses.

Distinction between neuroarthropathy and infection may be difficult with any imaging technique. On MRI, neuroarthropathy exhibits the characteristic findings of bone fragmentation, dislocations, cortical and periosteal thickening, joint effusion and soft tissue swelling. *Post contrast imaging is always indicated* as it helps to establish the presence of associated soft tissue abscess or enhancing sinus tract adjacent to the affected bone only seen in patients with osteomyelitis.

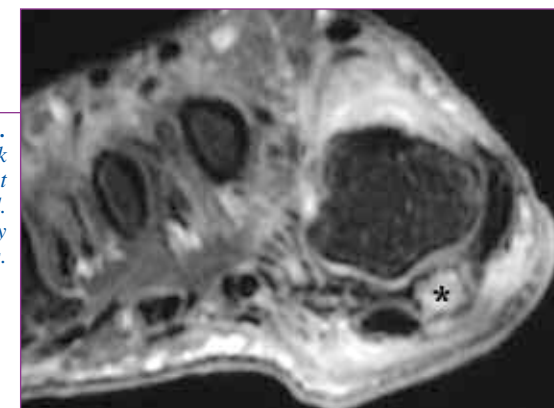
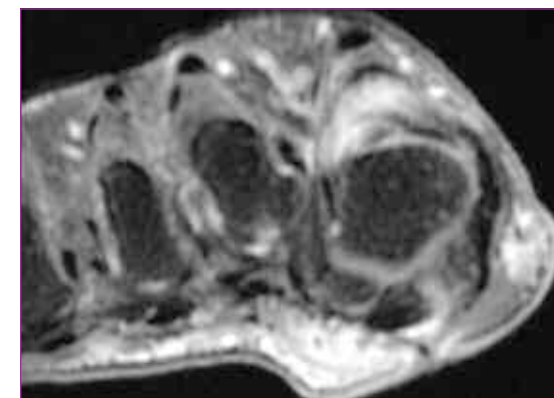


Fig 2. Sesamoid Osteomyelitis.
Post contrast MR images clearly outline a sinus track extending from a plantar ulcer underneath the first MTP joint into the medial hallucal sesamoid. Enhancement of the ossicle (asterisk) in continuity with the sinus track is highly specific for osteomyelitis.

Indications:

- Osteomyelitis vs. Neuroarthropathy
- Preoperative Assessment
- Soft Tissue Abscess

POSTERIOR TIBIAL TENDON DYSFUNCTION

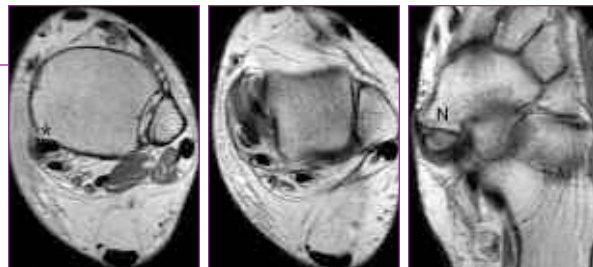
Acute or chronic dysfunction of the posterior tibial tendon encompasses a spectrum of abnormalities ranging from tenosynovitis, tendinosis to partial and complete rupture of the tendon. Acute tenosynovitis is related to overuse and is usually encountered in young athletic population. On MR imaging fluid is found within the tendon sheath. Tendinosis is depicted as mild to severe heterogeneity and thickening of the tendon. Chronic posterior tibial tendon rupture typically presents with progressive flat foot deformity. The tear is commonly noted behind the medial malleolus where the tendon is subjected to a significant amount of friction. Acute partial or complete ruptures of the posterior tibial tendon in the young athletic population are less common and are usually found at the navicular insertion of the tendon.

A number of soft tissue and bony abnormalities are encountered on MRI in patients with posterior tibial tendon tears. These include fluid within the tendon sheath, sinus tarsi syndrome, periostitis at the insertion of the flexor retinaculum to the tibia, hindfoot valgus, subtalar and talonavicular malalignment, and accessory navicular.

Indications:

- Acquired Flat Foot Deformity
- Preoperative Assessment
- Rheumatoid Arthritis-Sinus Tarsi Syndrome

Fig 3. Posterior Tibial Tendon Dysfunction. Split longitudinal tear of the posterior tibial tendon (white asterisk) associated with spurring of the posteromedial tibia (black asterisk) at the flexor retinaculum insertion. A type II accessory navicular is noted articulating to the medial navicular tubercle (N).



STRESS REACTION AND STRESS FRACTURES

Stress fractures and insufficiency fractures are frequent in the ankle and foot, and involve predominantly the second metatarsal, the calcaneus and less frequently the navicular bone and talus. Before a stress fracture takes place, a condition termed “stress reaction” occurs. During this period, edema, hyperemia and osteoclastic activity develops within the stressed area of the bone, translated on MR imaging as poorly defined abnormal signal intensity of the bone marrow, similar to a bone contusion.

As the stress persists and a fracture develops, MRI will show a hypointense irregular line within the area of edema and hyperemia. Periosteal callous formation begins shortly after the fracture, and it can be seen on MRI as a hypointense line parallel to the cortex, representing the elevated periosteum. *MRI has been found to be more sensitive than conventional radiography and more specific than bone scintigraphy*, for detecting occult fractures particularly in the elderly and osteoporotic patients.

Fig 4. Stress Injury. Stress reaction of the third metatarsal is noted in this long distance runner. The radiographs were negative.



Indications:

- Pain Related to Overuse
- Negative Radiographs

PERONEAL TENDON TEARS & INSTABILITY

Indications:

- Chronic Lateral Pain Following Inversion Injury
- Lateral Ankle Instability

Injuries to the peroneal tendons are frequently encountered. They include peritendinosis, tenosynovitis, tendinosis, rupture and dislocation. The MR characteristics of peritendinosis and tenosynovitis include peritendinous scarring and fluid within the common tendon sheath, respectively. Longitudinal tears of the peroneus brevis tendon often originate within the fibular groove. They may be associated with flexor retinacular tear or laxity secondary to inversion injury. Isolated tears of the peroneus longus are more frequently seen at the level of the peroneal tubercle or cuboid tunnel. Marrow edema within the lateral calcaneus or hypertrophied peroneal tubercle may be encountered.

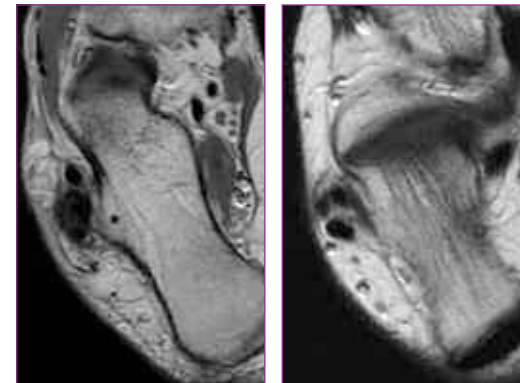


Fig 5. Tear of the Peroneal Tendons. Hypertrophy of the peroneal tubercle (asterisk) resulted in chronic attritional injury to the peroneus longus tendon, which is partially torn. The peroneus brevis tendon, in a different patient, is split into two limbs just distal to the lateral malleolus.

Dislocation of the peroneal tendons is often clinically misdiagnosed as an ankle sprain. *MR imaging allows direct assessment of the position of the tendons relative to the fibular retromalleolar groove.* The dislocation is best demonstrated on axial images. They are often located within a pouch, formed by a stripped off peroneal retinaculum. Associated MR findings include tenosynovitis or tears of the peroneal tendons, convex fibular groove, avulsion fracture of the distal fibula, and tear of the lateral collateral ligament.

Dislocation of the peroneal tendons is often clinically misdiagnosed as an ankle sprain. *MR imaging allows direct assessment of the position of the tendons relative to the fibular retromalleolar groove.* The dislocation is best demonstrated on axial images. They are often located within a pouch, formed by a stripped off peroneal retinaculum. Associated MR findings include tenosynovitis or tears of the peroneal tendons, convex fibular groove, avulsion fracture of the distal fibula, and tear of the lateral collateral ligament.

ACHILLES TENDON INJURIES

Non-insertional Achilles tendinosis is detected on axial MRI as loss of the anterior concave or flat surface of the Achilles tendon and fusiform thickening of the tendon on sagittal images. *Preoperative MR imaging is useful for distinguishing partial from complete rupture and assessing the extent and site of the tear.* Clinical misdiagnosis has been reported in up to 25% of patients with complete Achilles tears (false negative Thompson test). On MRI, partial Achilles tendon tears depict signal heterogeneity, and thickening of the tendon without complete interruption. Complete Achilles tendon rupture is depicted as discontinuity with fraying and retraction of the torn edges of the tendon. Approximately 2% of Achilles tendon ruptures treated surgically undergo partial rerupture. *Post-operative MR assessment includes evaluation of the extent of tendinous union and healing.* On most follow-up MR studies, the intratendinous signal intensity will decrease as the tendon heals. Insertional tendinosis is frequently associated with Haglund’s deformity. The MR findings include increased signal and thickening at the insertion of the Achilles tendon, intra substance calcifications, Haglund’s deformity, calcaneal marrow edema, and distended retrocalcaneal and Achilles bursitis.

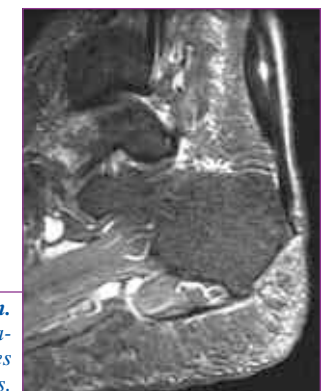


Fig 6. Partial tear of the Achilles Tendon. Sagittal fluid sensitive image shows intra-substance partial tearing of the Achilles tendon involving its non-insertional fibers.

Indications:

- Partial vs. Complete Rupture
- Preoperative Assessment
- Postoperative Complications
- Haglund’s Syndrome

LIGAMENTOUS INJURIES

Lateral ankle sprains represent 16 to 21% of all sports-related traumatic lesions. The anterior talofibular ligament is the weakest and therefore the most frequent one to tear. Acute ankle ligamentous injuries are rarely operated on. **MR assessment is useful in the evaluation of highly competitive athletes in whom primary ligamentous surgical repair is contemplated and in patients with a history of chronic ankle instability.** The MR criteria for the diagnosis of acute lateral collateral ligament tear include morphologic and signal alterations within and around the ligament. Chronic tear often exhibits thickening, thinning, elongation and wavy or irregular contour of the ligament. The accuracy for detecting acute anterior talofibular and calcaneofibular ligament tears is reported to be 94.4%. **MR arthrography was found to be 100% and 82% accurate in detecting chronic anterior talofibular and calcaneofibular ligament tears** respectively while conventional MR imaging showed an accuracy of 59% for diagnosing chronic lateral collateral ligament tears.



Fig 7. Anterior talofibular ligament injury. Extravasation of contrast material (asterisk) is noted through a fully torn anterior talar fibular ligament on this MR arthrographic image.

Indications:

- Preoperative Assessment
- Chronic Ankle Instability
- Anterolateral Impingement Syndrome

ANTEROLATERAL IMPINGEMENT SYNDROME

The anterolateral impingement syndrome is a common cause for chronic lateral ankle pain. Repetitive synovial inflammation, secondary to chronic lateral ankle instability, produces a soft tissue “mass” consisting of hypertrophied synovial tissue and fibrosis within the lateral gutter. Bony anteromedial or antero-central impingement produced by osteophytes at the anterior ankle joint can further worsen the condition.

MR imaging typically depicts a “meniscoid mass” within the lateral gutter of the ankle, which demonstrates low signal intensity on all pulse sequences. Arthroscopic debridement of the soft tissue impingement shows excellent results with 84% of patients returning to their previous sport activity.



Fig 8. Anterolateral Impingement Syndrome. A meniscoid-like dark focus is identified in the anterolateral corner underlying a markedly thickened anterior talofibular ligament in this patient with chronic lateral pain following a sprain.

PLANTAR FASCIITIS

Plantar fasciitis is most likely related to repetitive trauma and mechanical stress producing micro tears and inflammation of the fascia and perifascial soft tissues. Lateral radiographs of patients with plantar fasciitis often demonstrate calcaneal spurs. However, this finding is not specific since it can be seen in about 25% of the asymptomatic population. Bone scintigraphy may demonstrate increased uptake in the region of the calcaneus, probably reflecting periosteal inflammation of the calcaneus. **MRI is useful in distinguishing plantar fasciitis from other causes of heel pain and for excluding plantar fascia tears.** When inflammatory changes take place, the plantar fascia becomes thickened. The thickening is often fusiform in contradistinction with plantar fibromatosis, which demonstrates focal, nodular thickening. Discontinuity of the fibers of the plantar fascia often with focal edema and hemorrhage is noted when a tear of the fascia is present.

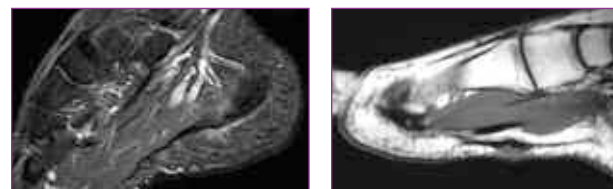
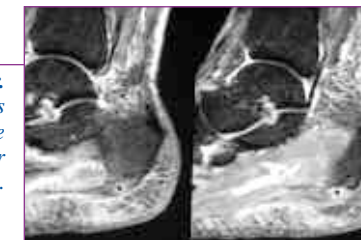


Fig 9. Plantar Fasciitis vs. Plantar Fibroma. MRI clearly depicts typical inflammatory changes associated with Plantar Fasciitis at its inferior calcaneal origin as opposed to dark, focal fusiform thickening in the mid plantar fascia consistent with Plantar Fibroma.

Indications:

- Heel Pain
- Evaluation for Fascial Tear
- Plantar Fasciitis vs. Plantar Fibroma

Fig 10. Plantar Fascia Tear. Sagittal fluid sensitive images show discontinuity of the medial cord of the plantar fascia at its origin (asterisk).



Dr. Pradeep Albert Dr. Jenny Bencardino Dr. John Parnell

Medical Arts Radiology has assembled a world-class team of musculoskeletal radiologists, including:

Dr. Jenny Bencardino, formerly director of Musculoskeletal MRI at Massachusetts General Hospital and Assistant Professor of Radiology at Harvard Medical School. Dr. Bencardino trained at the Hospital for Joint Diseases-NYU Medical Center and has authored numerous articles in the field of musculoskeletal radiology.

Dr. Pradeep Albert trained at the University of California San Diego under Donald Resnick, MD, an internationally renown expert in musculoskeletal imaging.

Dr. John Parnell acquired extensive experience in musculoskeletal radiology during fellowship training at North Shore University Medical Center.

All cases presented in this brochure were performed at Medical Arts Radiology sites.



Medical Arts Radiology

BAY SHORE

375 EAST MAIN STREET
BAY SHORE, NY 11706
PH: 631-665-2261
FX: 631-665-5535

MRI of HUNTINGTON

17 SOUTHDOWN ROAD
HUNTINGTON, NY 11743
PH: 631-427-8860
FX: 631-427-5414

COMMACK

55 VETERANS HIGHWAY
COMMACK, NY 11725
PH: 631-462-0525
FX: 631-462-0529

PATCHOGUE

240 PATCHOGUE/YAPHANK RD.
PATCHOGUE, NY 11772
PH: 631-475-5300
FX: 631-475-3369