# MRI Evaluation of Foot and Ankle Injuries – Illustrative cases

Loralie D. Ma, M.D., Ph.D., FACR
Medical Director, GBMC MR-PET/CT
Advanced Radiology, PA

# Conflict of Interest

- No conflicts to disclose

# MRI and how can it be used for evaluation of musculoskeletal (MSK) injuries

- For the initial presentation of musculoskeletal injuries, conservative therapy may first be warranted.
- An X-ray will often be ordered, especially if there has been trauma, or if symptoms persist after conservative care.
- However MRI, unlike x-ray, can visualize the soft tissues and can evaluate the bone, muscles, ligaments and tendons.

# Magnetic Resonance Imaging

- MRI uses very strong magnets in order to create an image.
- These magnets can erase credit card information, stop your watch, and more importantly, interfere with implanted devices in your body.
- In the community, we do not do MRIs on patients with pacemakers or defibrillator devices.
- We screen patients so we fully know what other MRI compatible devices they may have such as cardiac stents, aneurysm clips, cardiac valves, neurostimulator devices they may have.

# Magnetic Resonance Imaging

- MRI can be performed in patients with insulin pumps. However, the pump usually has to be either removed during the MRI examination or reprogrammed after the MRI.
- Some brain shunts also have to be reprogrammed after MRI.
- MRI can be used safely in patients with joint replacements, including hip replacements.

# MRI Scanner

# MRI magnet – non MRI compatible wheelchair

# Open MRI vs. Closed MRI

# Open MRI versus Closed MRI

- Closed MRI scanning is preferred as the magnet is stronger and gives higher quality images.
- Even if a patient is claustrophobic, valium can be given for the examination, although the patient will need a driver.
- If your patent is not able to tolerate a closed MRI examination, open MRI can still be useful and has increasing quality compared to prior years, due to newer higher field strength (stronger magnet) scanners.

# Use of MRI contrast

- MRI contrast is not usually used in routine musculoskeletal examinations.
- MRI contrast may be used in spine examinations, if there has been prior spine surgery or looking for infection.
- MRI contrast may be used to evaluate masses or complex cysts.
- MRI contrast is injected into the joint only for arthrogram examinations. These are performed to look for labral tears.

# MRI of the Foot and Ankle

- MRI is excellent for evaluation of foot and ankle.
- In the past, imaging was limited due to low resolution.
- With the advent of 3T scanners, we can now get high resolution images of even the smallest joints.
- Fractures, AVN, tendon and ligament tears can now be seen.

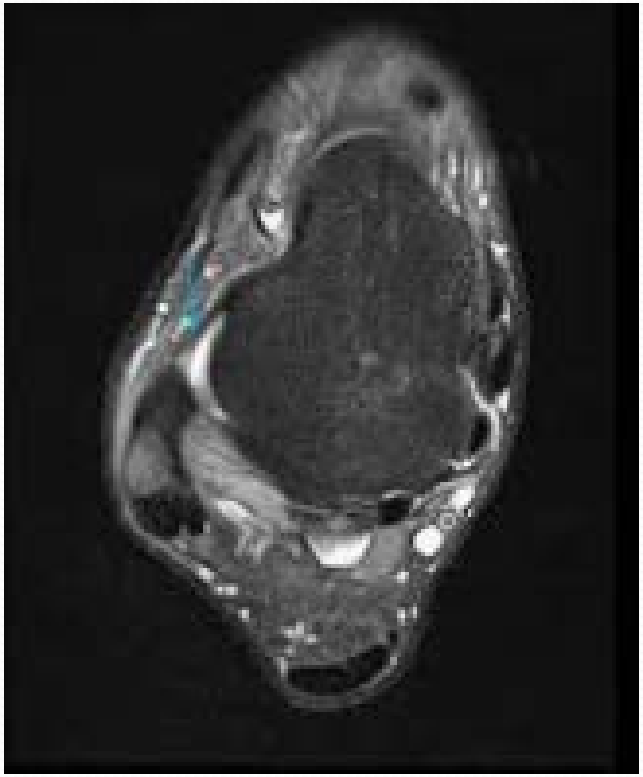
# Normal Foot and Ankle

- MRI of the foot and ankle includes T1 and T2 weighted images
- T1 weighted images are “anatomic” images – fat is bright and fluid is dark
- Tendons are dark as they have no fat and little water and ligaments are dark
- T2 weighted or “fluid-sensitive sequences” are very sensitive to fluid, either due to joint effusions or edema in bone, soft tissues or tendons and ligaments due to injury

# Normal T1 weighted image of the ankle

# Normal T2 weighted image of the ankle

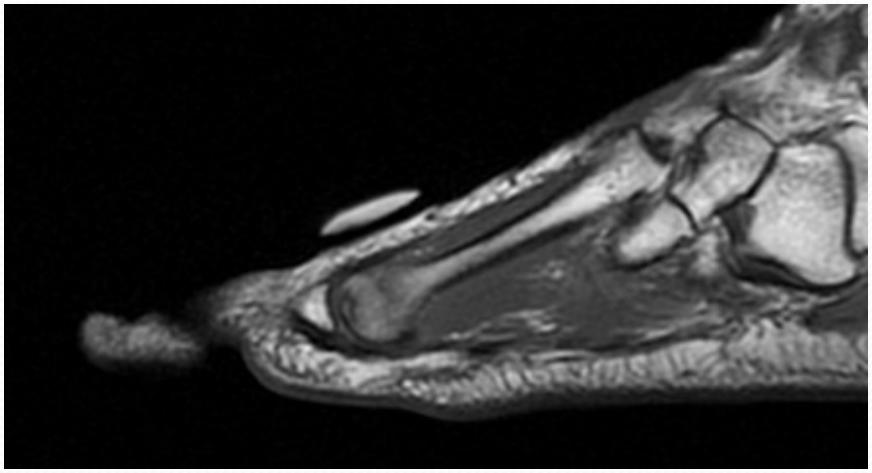
# Normal coronal and axial T2 weighted images, showing ligaments and tendons

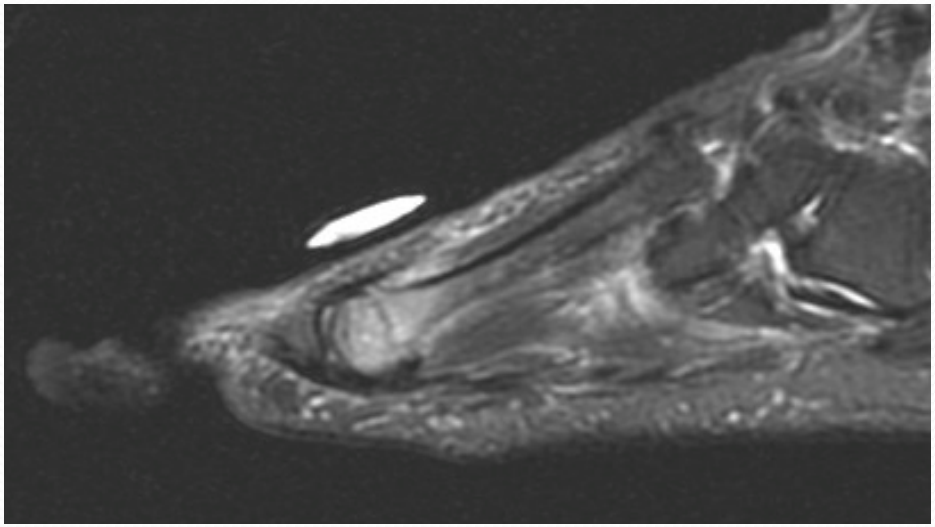



# MRI of Osseous Injuries

- Initial plain films can be negative in significant osseous injuries.
- Occult fractures, AVN and bony contusion are often occult on initial plain films, but may show up on follow up imaging.
- MRI is sensitive for bone marrow edema, and can delineate between fractures and AVN, as well as tumors and osteomyelitis.

# Pain in the second and third toes in a runner





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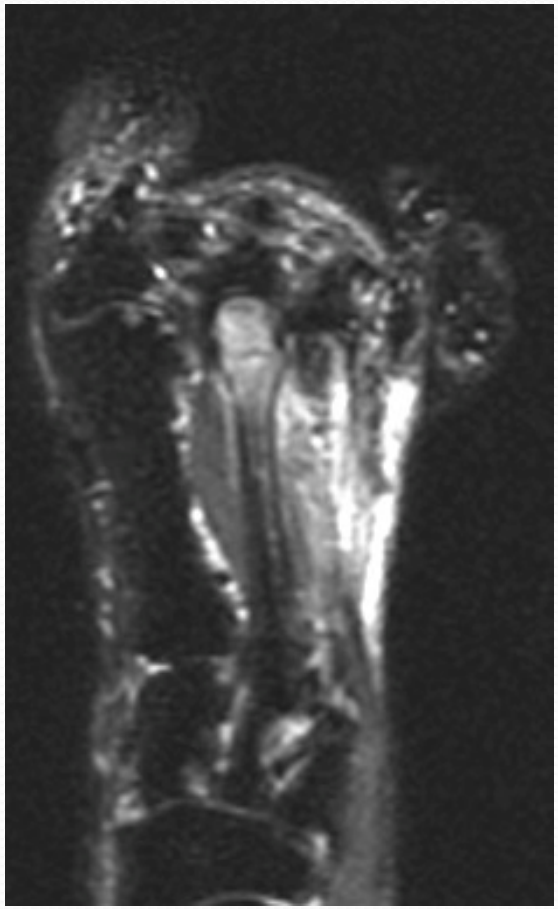
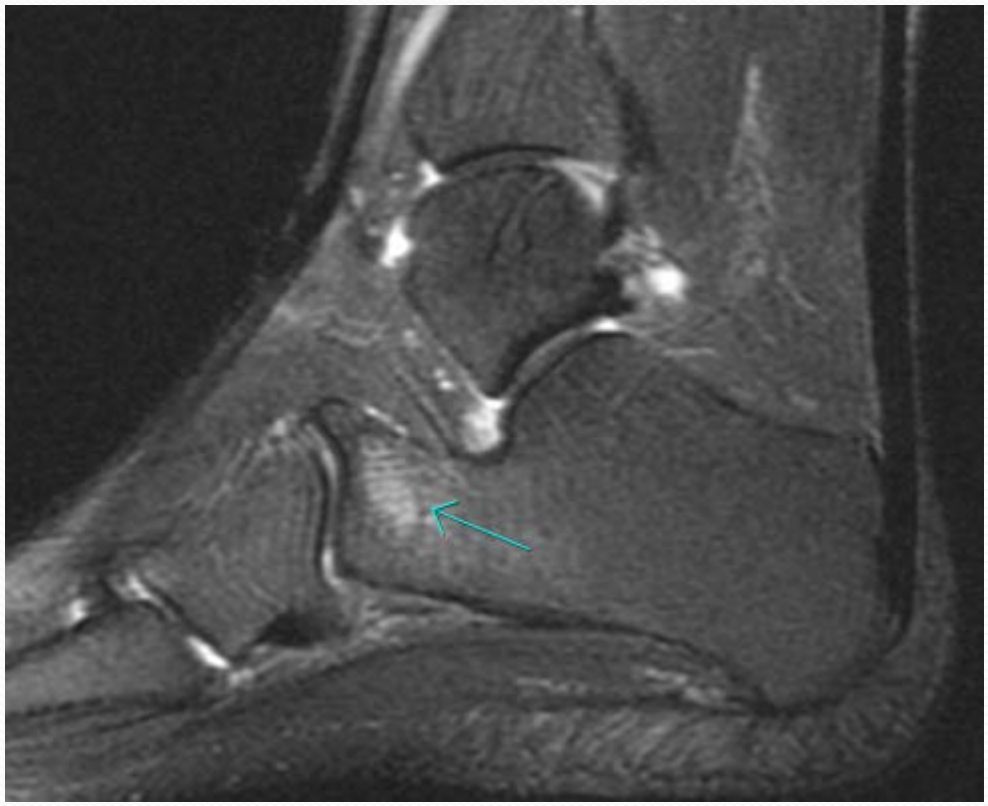


# Fracture of the 2nd MT neck with subsequent infarction

- AVN of the 2nd MT head alone is known as Freiberg's infraction or infarction
- A similar pattern can be seen in patients with fractures, disruption of the blood supply and subsequent AVN

# Heel pain after fall persisting for 6 weeks

# Heel pain after a fall persisting for 8 months

# Nondisplaced calcaneal fracture

- Fractures at or near the anterior process of the calcaneus are common
- Fractures in the plantar heel due to chronic repetitive stress such as walking or running are also common
- Chronic fracture non-unions can result in arthritis

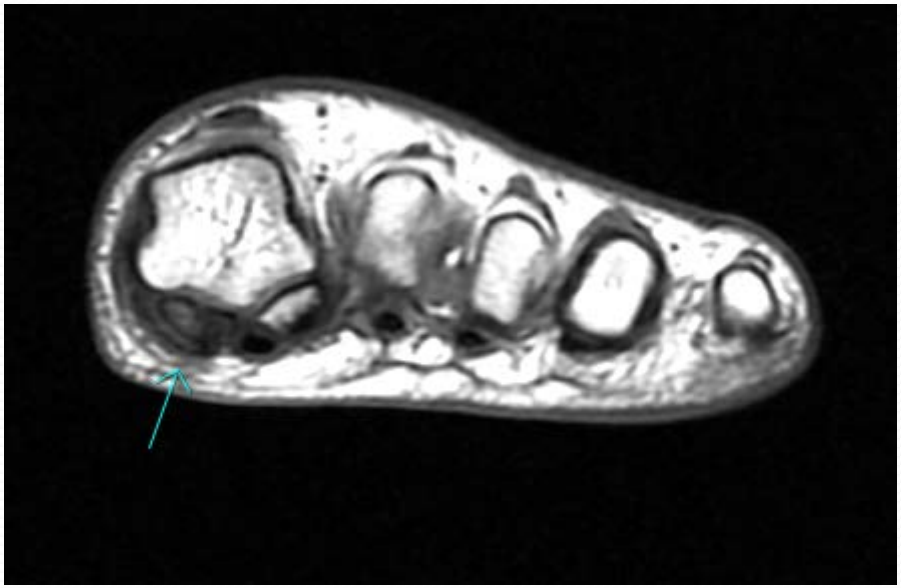
# Running injury – posterior tibial tendon tear vs. fracture

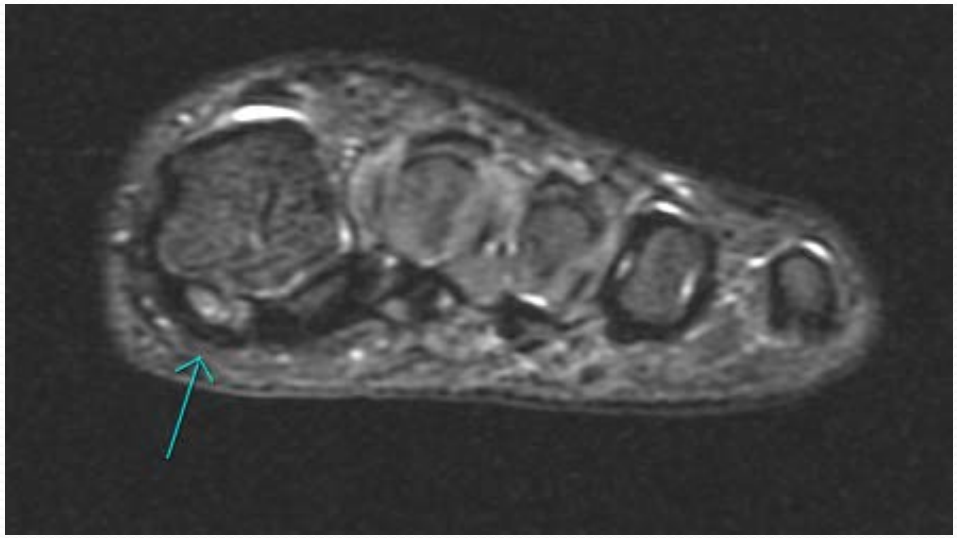
# Tibial stress fracture

# Twisted ankle – persisting pain 4 weeks after injury, avulsion lateral malleolus on plain film

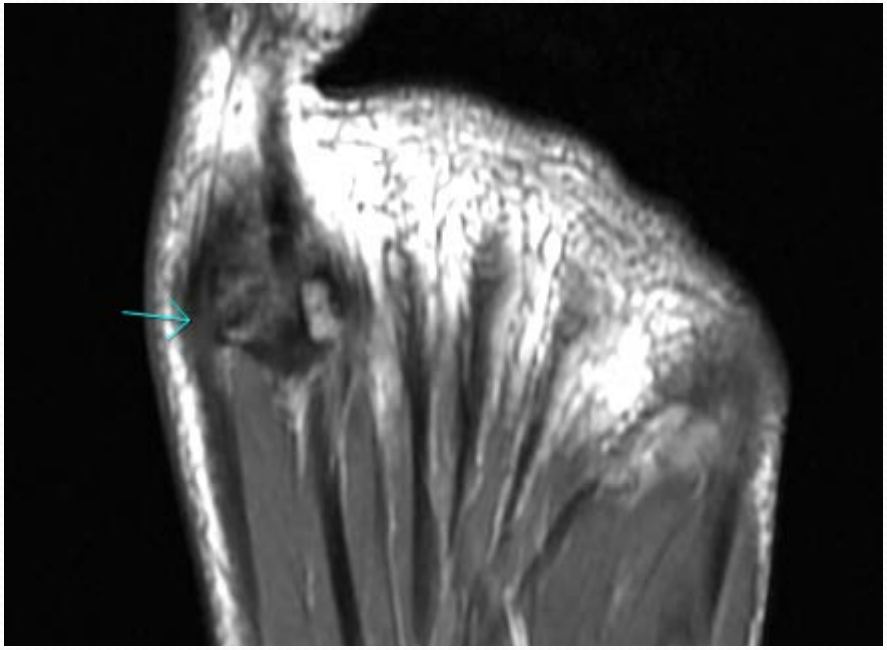
# Salter 1 injury distal fibula and calcaneal apophysitis

# Great toe pain in a runner

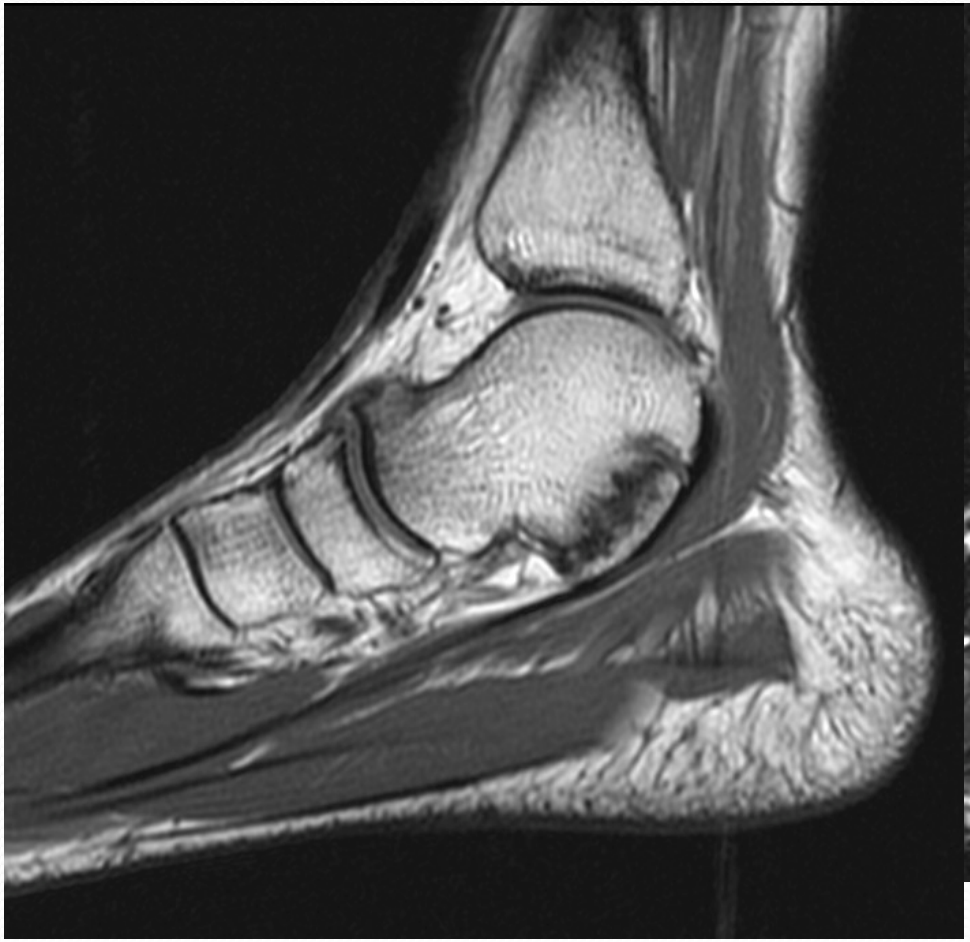


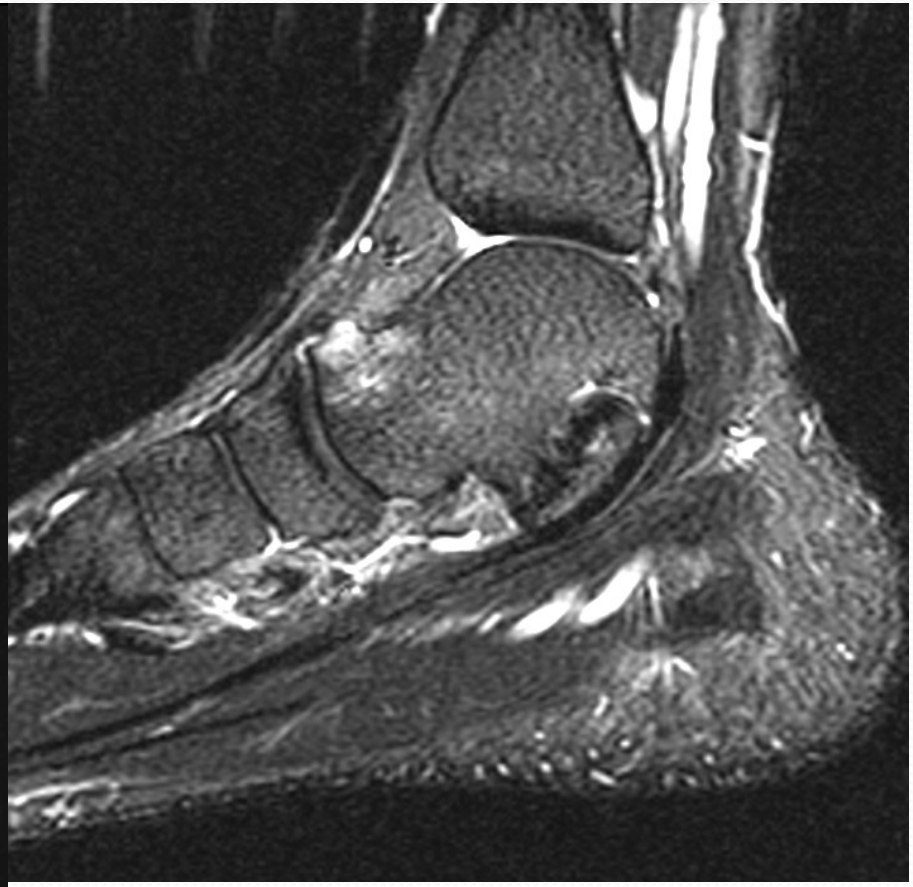


# Sesamoiditis with bipartite sesamoid



# Chronic ankle and foot pain





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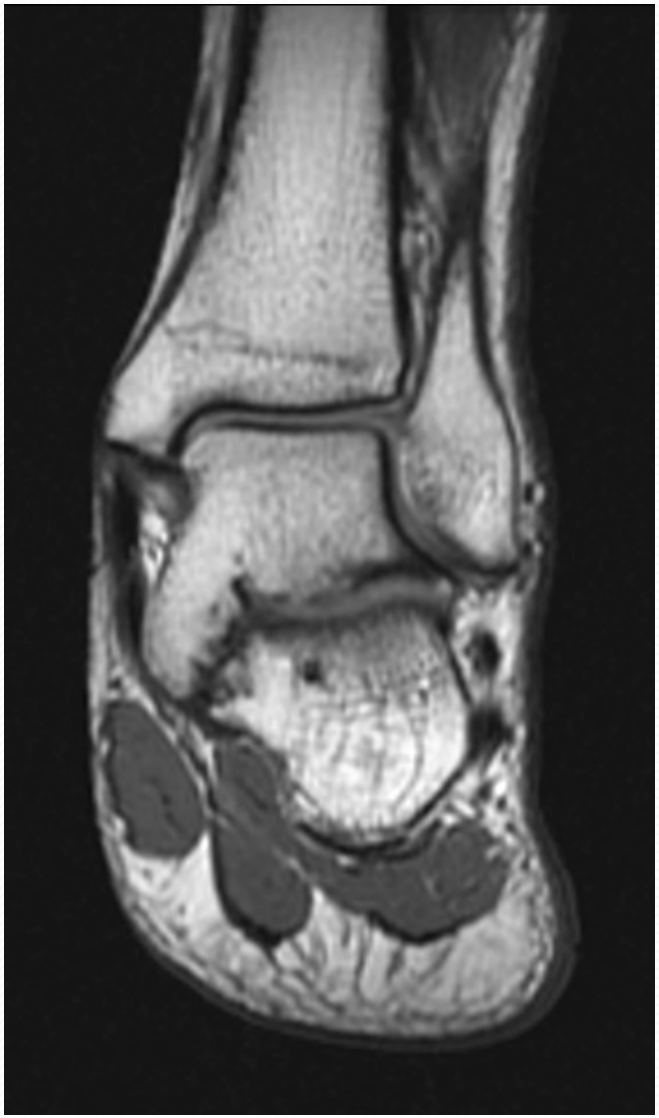


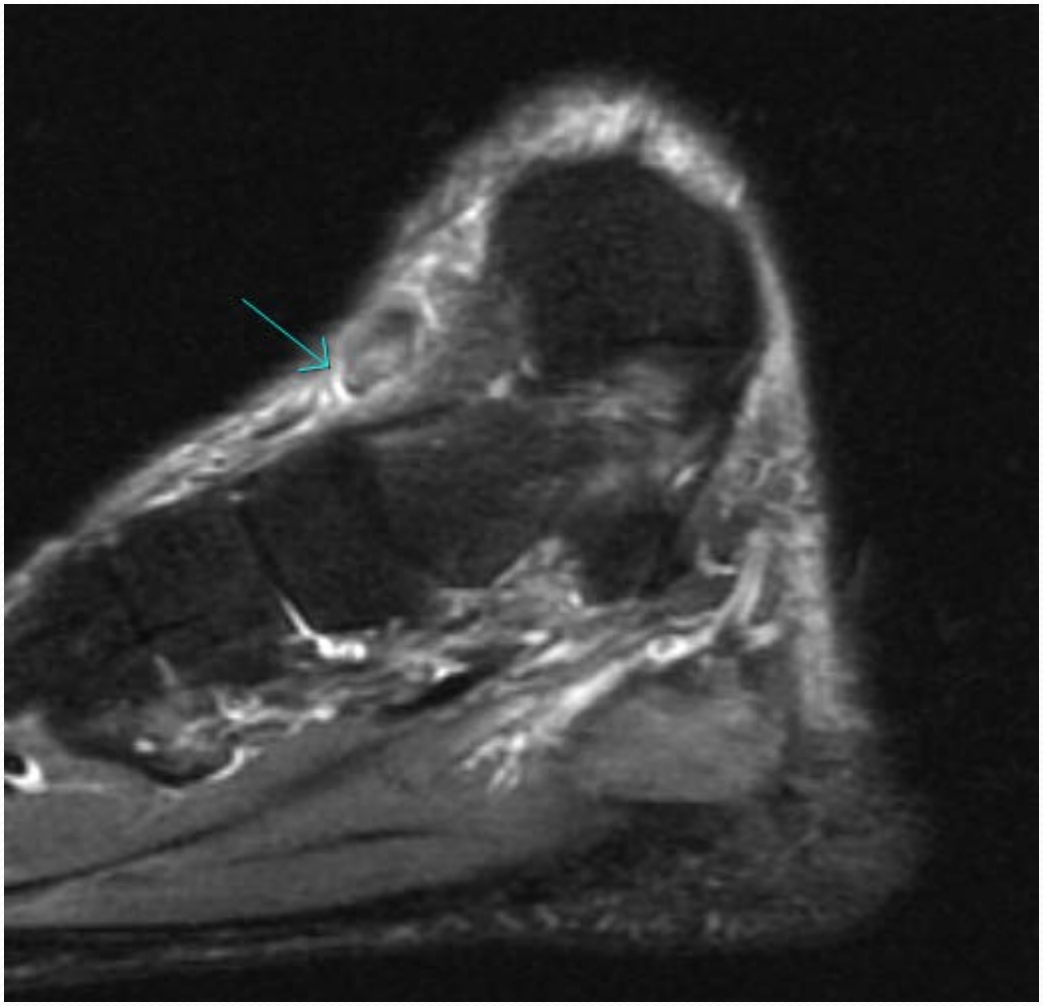
# Talocalcaneal Coalition

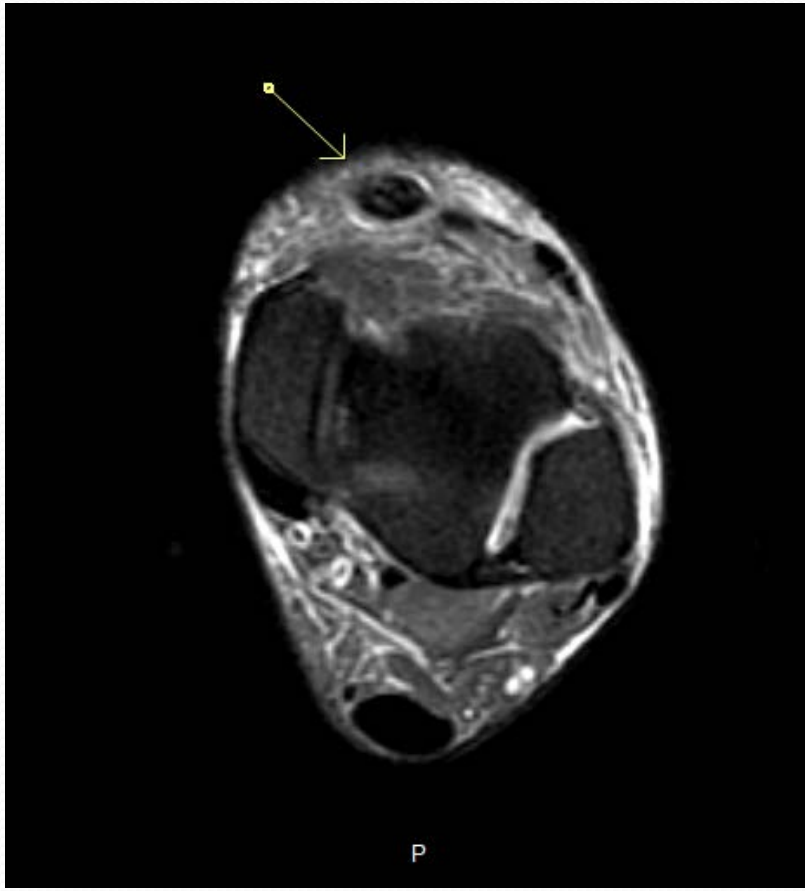
- Most common coalition
- Others include calcaneonavicular, talonavicular
- May be fibrous or osseous
- Associated with talar beaking, pes planus

# Ligament and Tendon Injuries

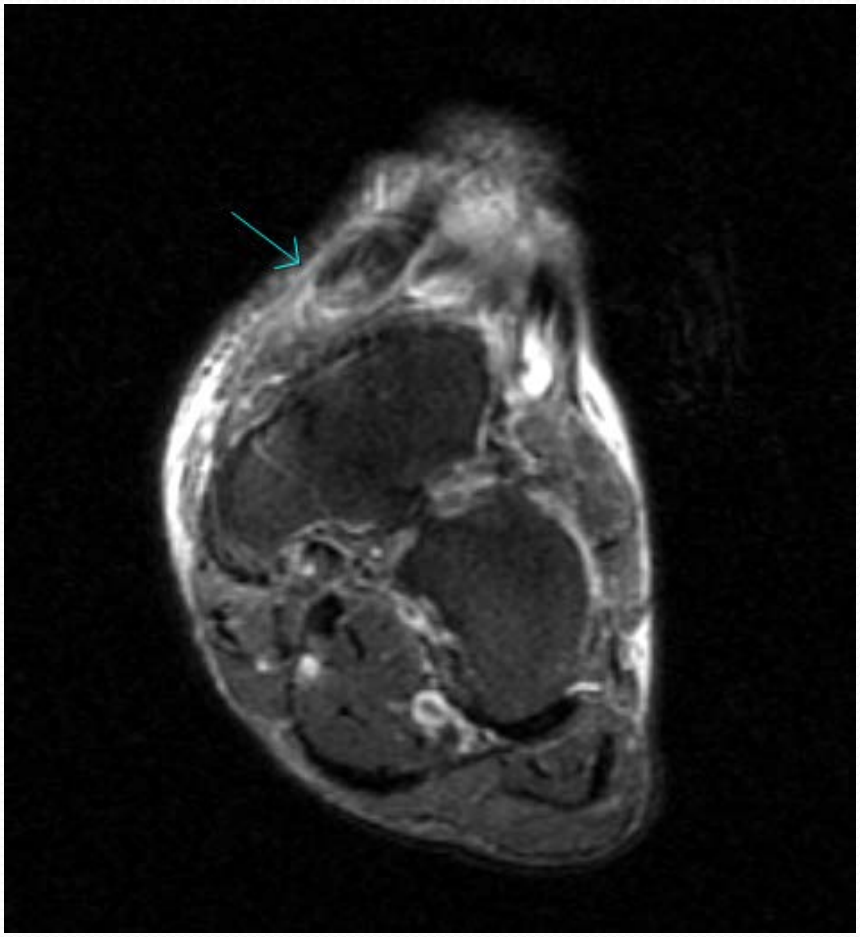
- Tendons are normally dark on T1 and T2 weighted images, due to low water content
- If partially torn the tendon can be thickened with edema, becoming high in signal
- With a full thickness tear a full thickness defect is seen
- Ligaments also have dark signal, but are thinner and can appear fan-shaped
- When ligaments are torn there is sometimes a defect but sometimes simply ill defined edema, bright on T2 weighted images

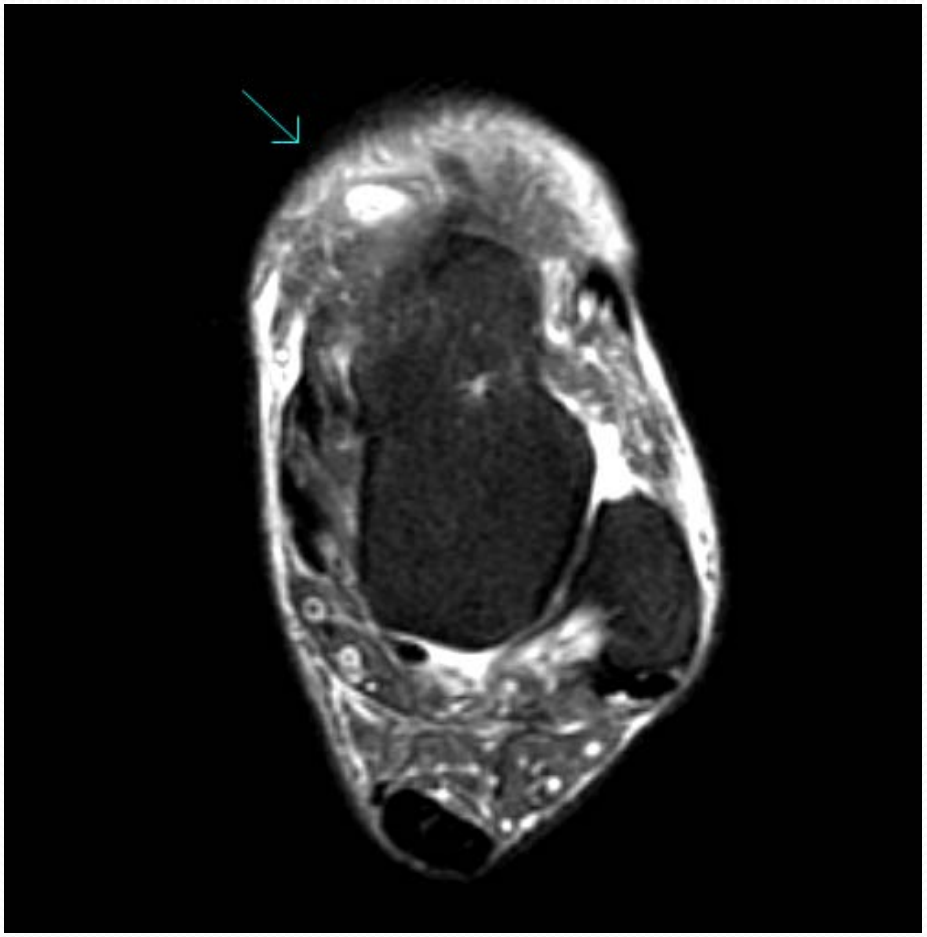
# Caught his toe while kicking a ball





# Full thickness anterior tibial tendon tear

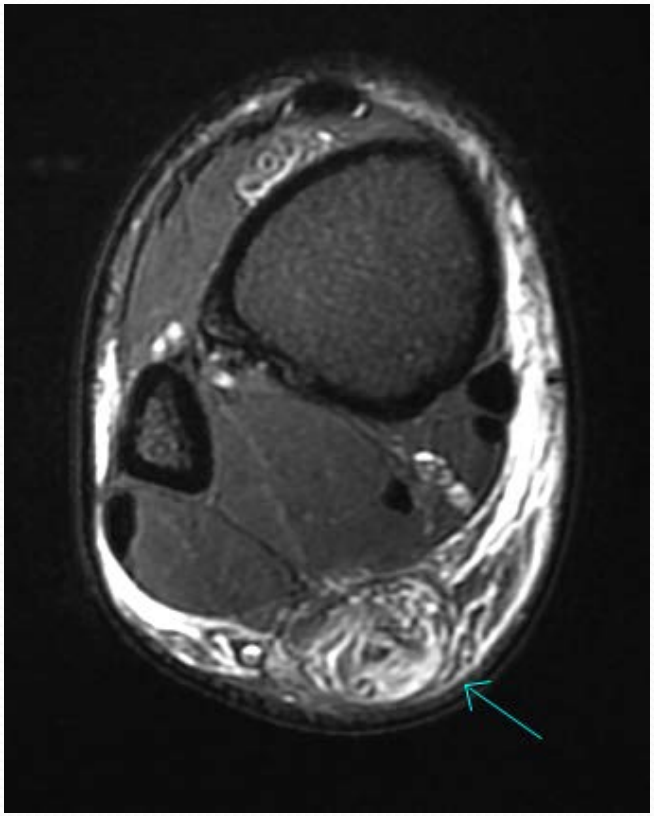


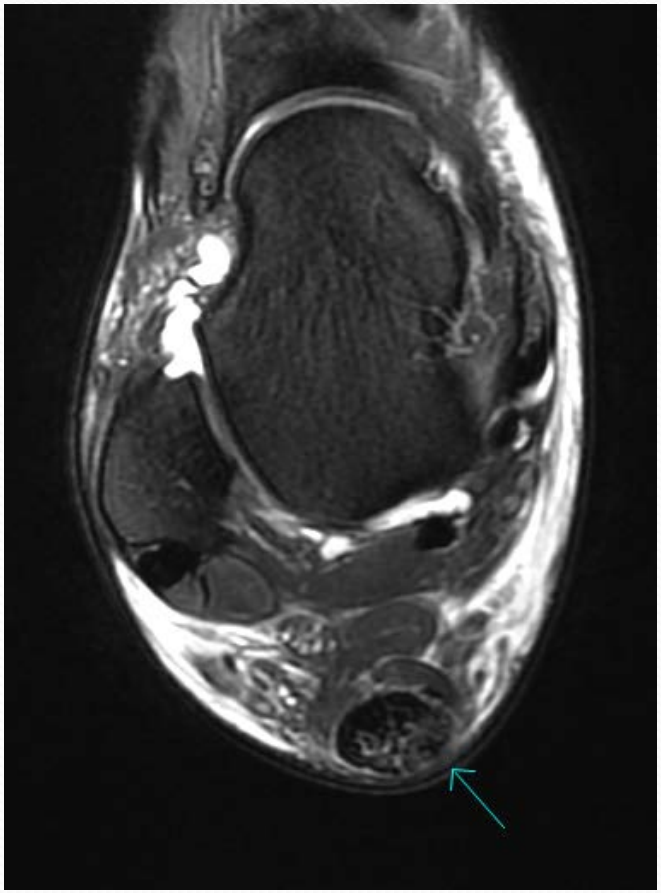


# Basketball injury 5 days ago

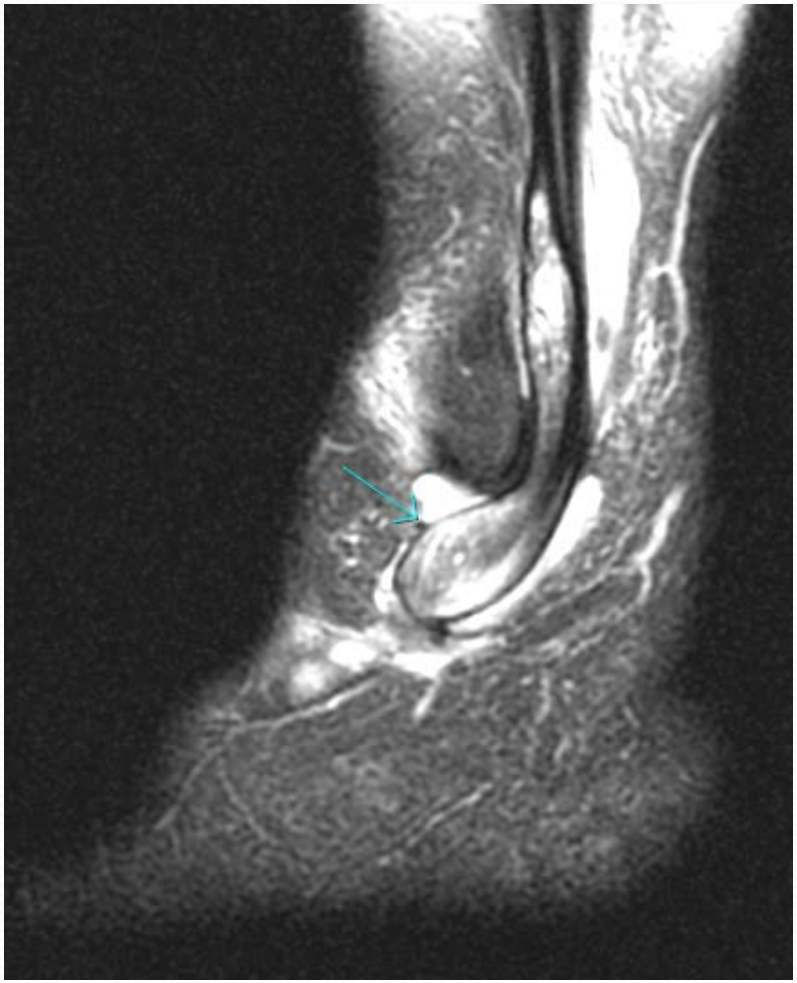
# Full thickness Achilles tendon tear

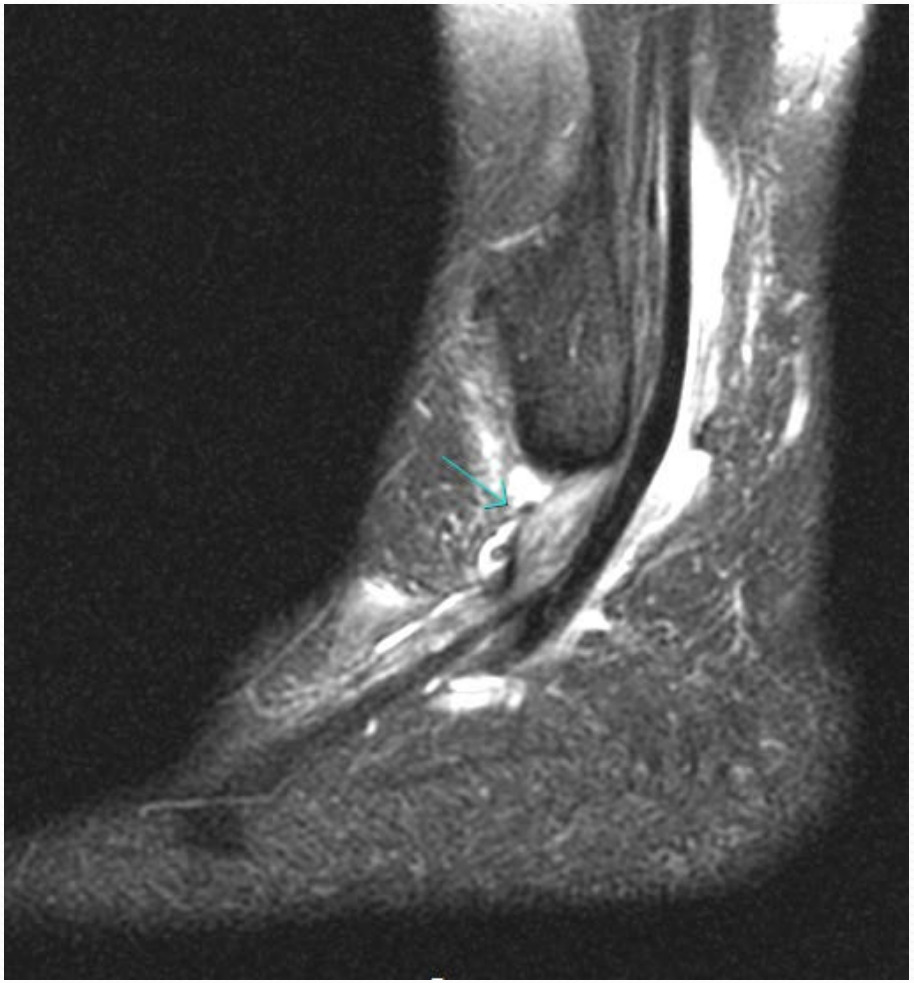
- Important to differentiate full versus partial thickness
- Important to describe site of tear, proximal or distal for surgical planning





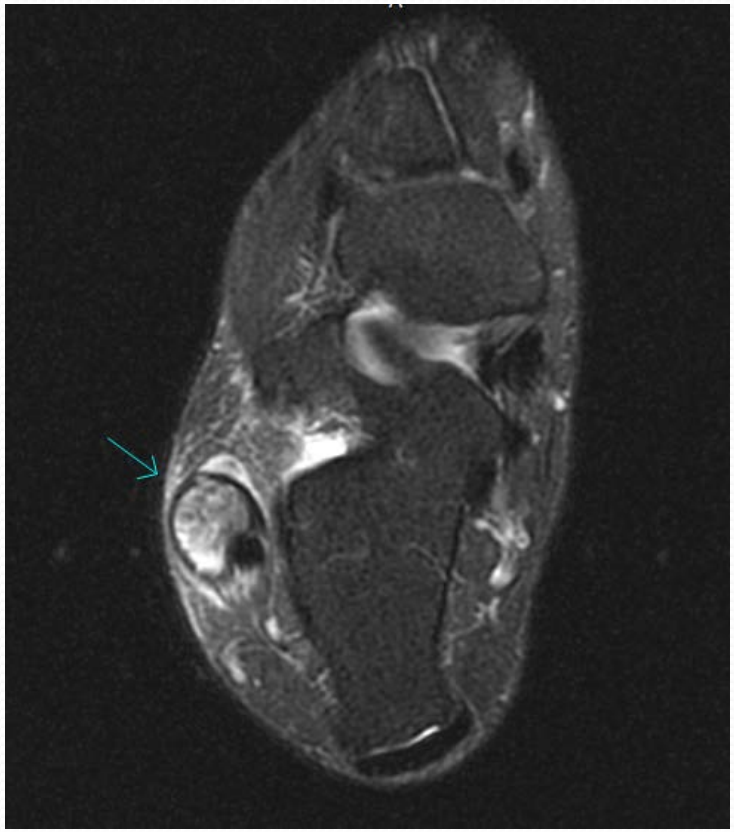
# Sprain 2 years ago with chronic lateral pain and swelling





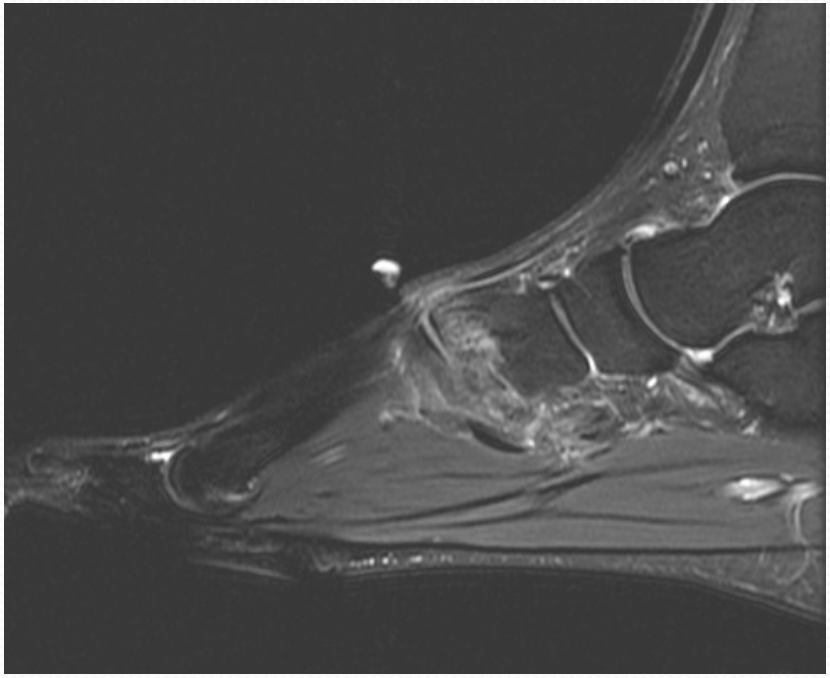
# Peroneal tendonitis/partial tear

- Mild split or “boomerang” configuration common
- Full thickness tears are less common
- Peroneal tenosynovitis can also be quite symptomatic



# Recent trauma

# Additional Image

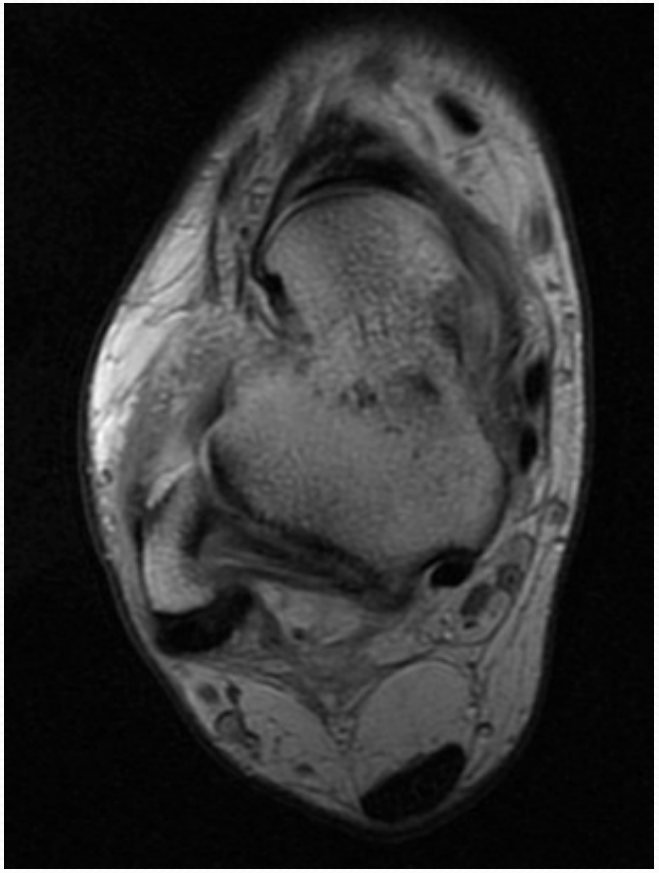


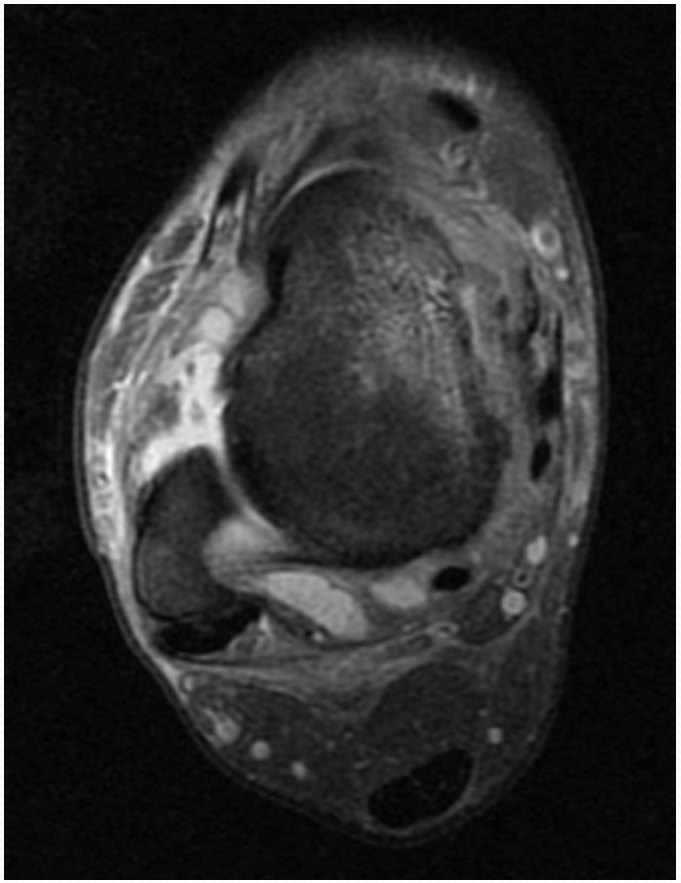
# Different patient same mechanism of injury

# Lisfranc Injury – midfoot sprain

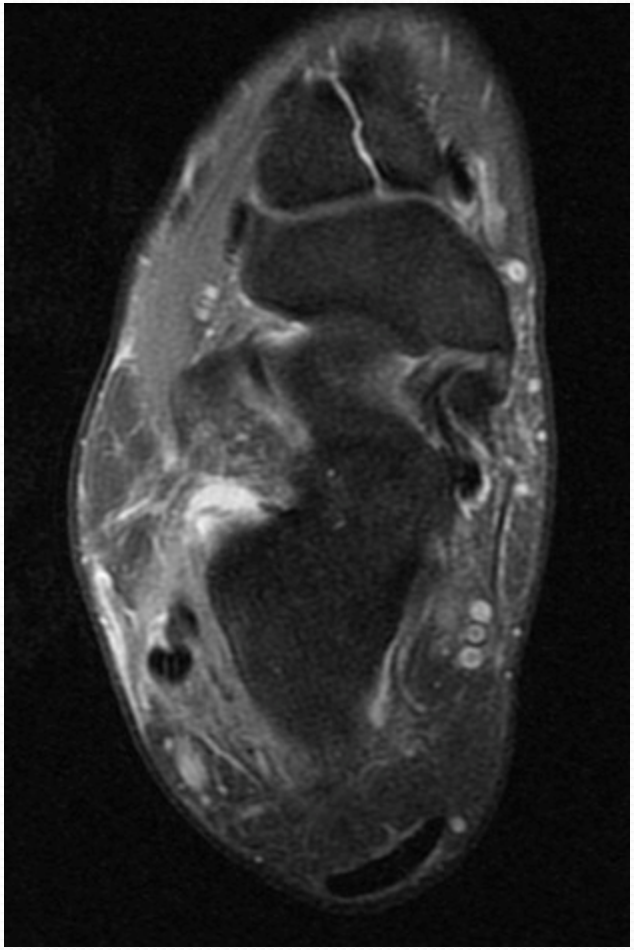
- Lisfranc Injury is uncommon, mostly seen after significant trauma or in athletes
- Lisfranc ligamentous complex has dorsal, interosseous and plantar components, between the medial cuneiform and second metatarsal base
- Unlike the other metatarsals, there is no intermetatarsal ligament between the 1st and 2nd metatarsals
- Midfoot sprain is the least severe of the lisfranc injuries

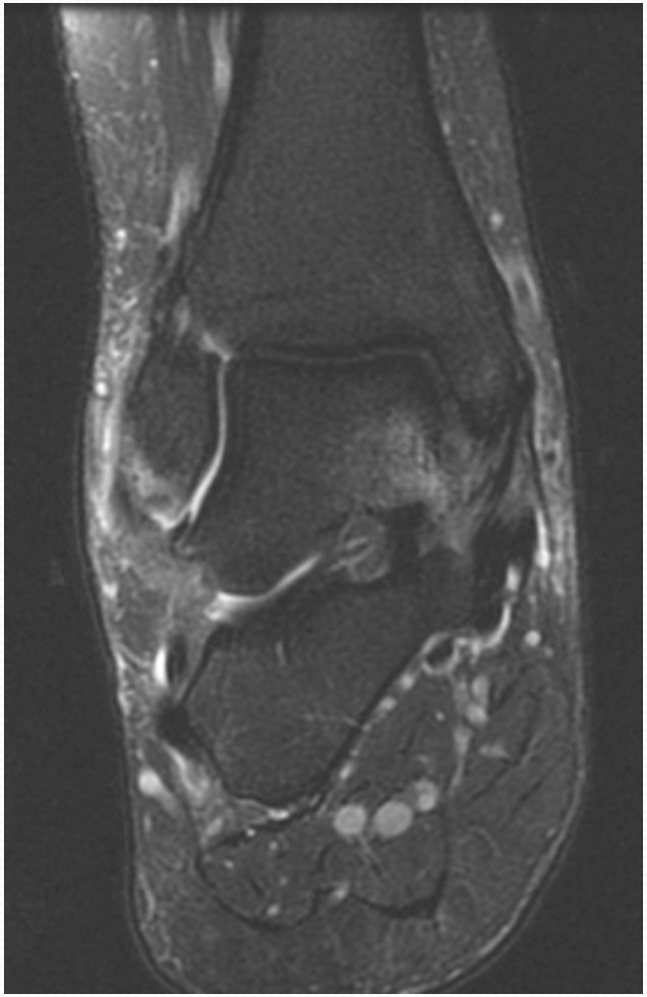
# Recent injury with medial and lateral pain





# Recent injury with medial and lateral pain

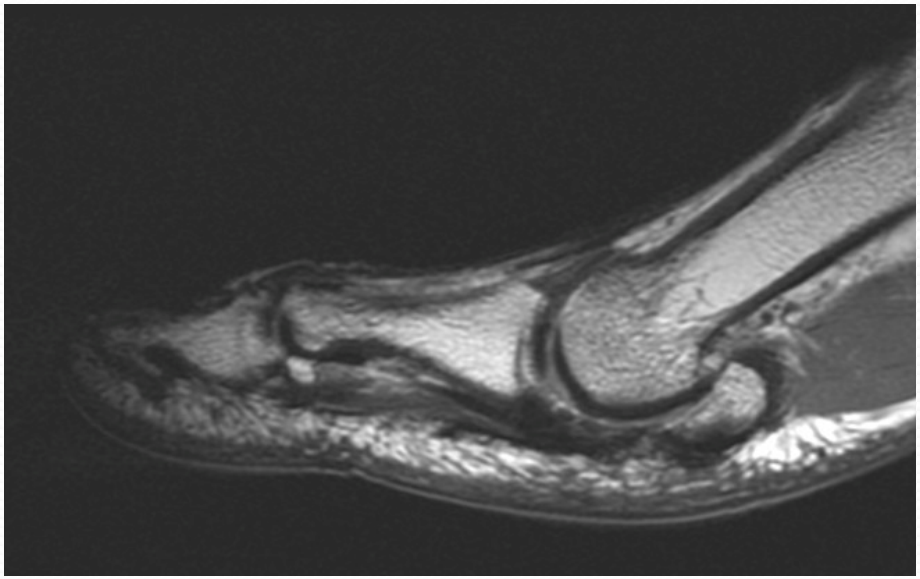




# Tears of the anterior talofibular ligament, calcaneofibular ligament and deltoid ligament

- Usually associated with inversion injury
- ATFL most commonly sprained ankle ligament
- Deltoid ligament less commonly sprained, although increasingly recognized with better imaging on 3T magnets

# Athlete with pain in the great toe



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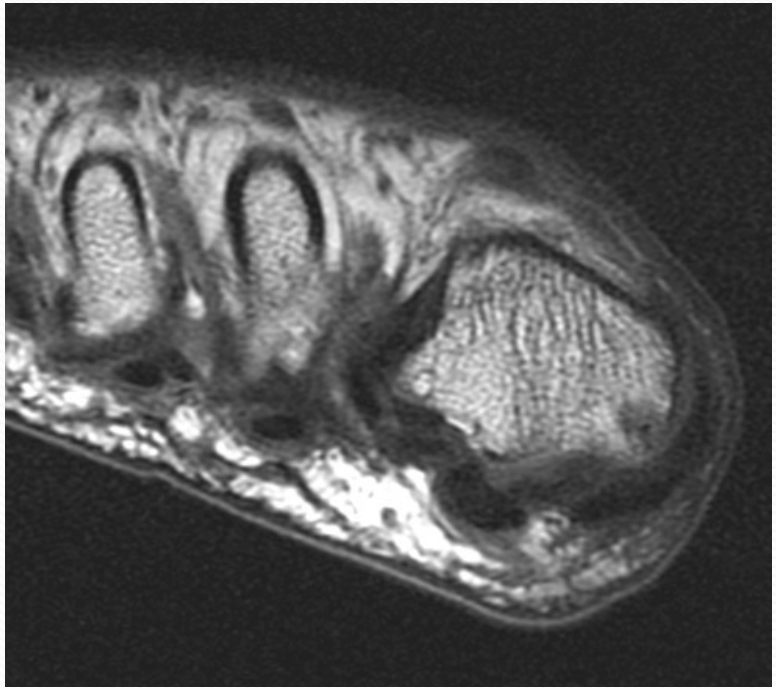
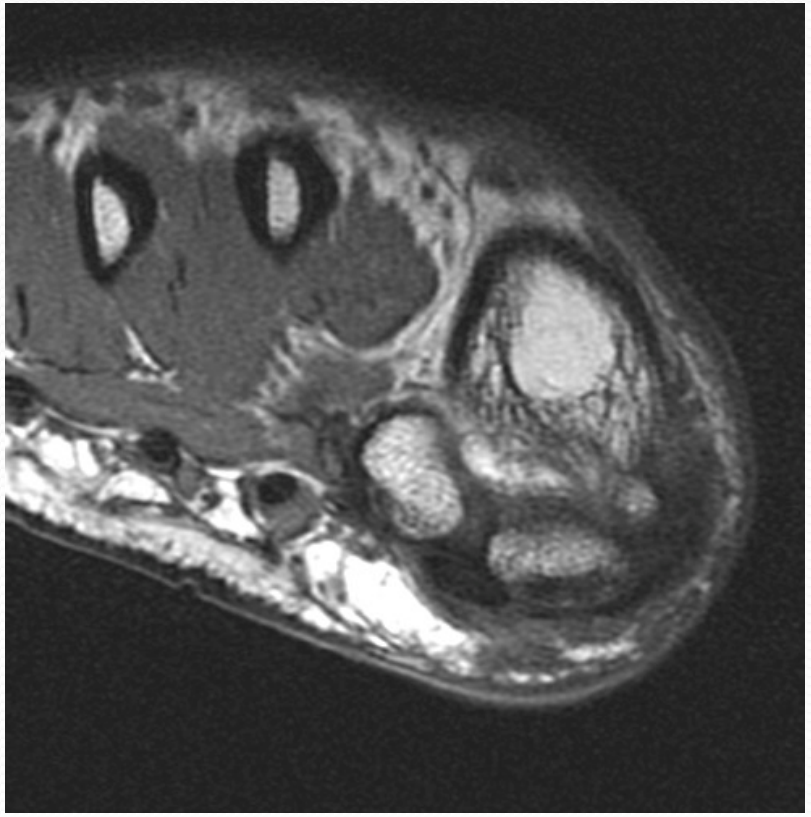


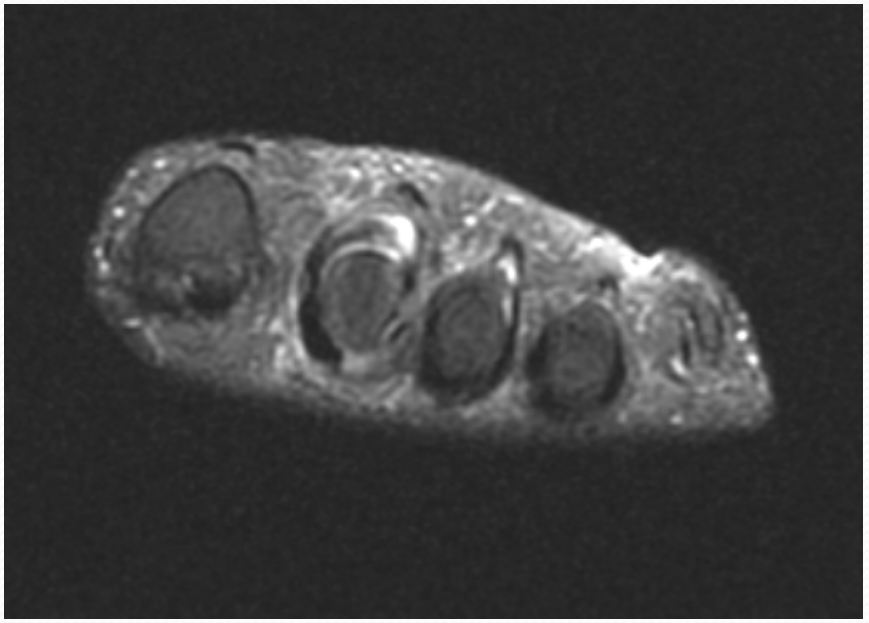


# Additional Images

# Turf Toe – Chronic Plantar Plate Rupture

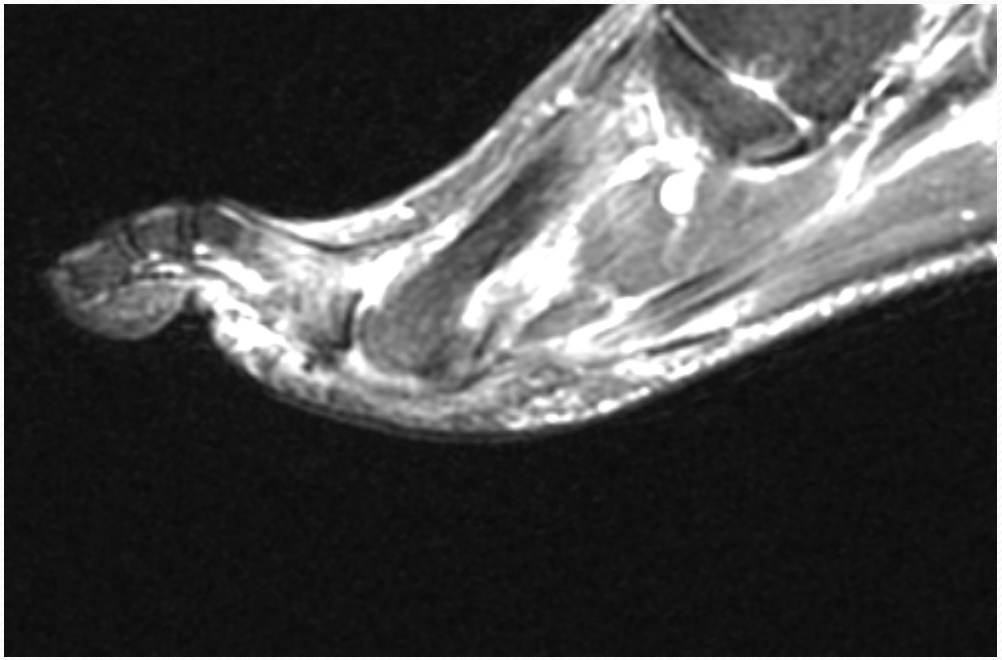
- Plantar Plate rupture in a football kicker
- Chronic rupture of the plantar plate with retraction of the sesamoids
- In acute setting a fluid filled defect is seen
- In chronic cases, scarring obscures the defect

# Foot pain in a runner

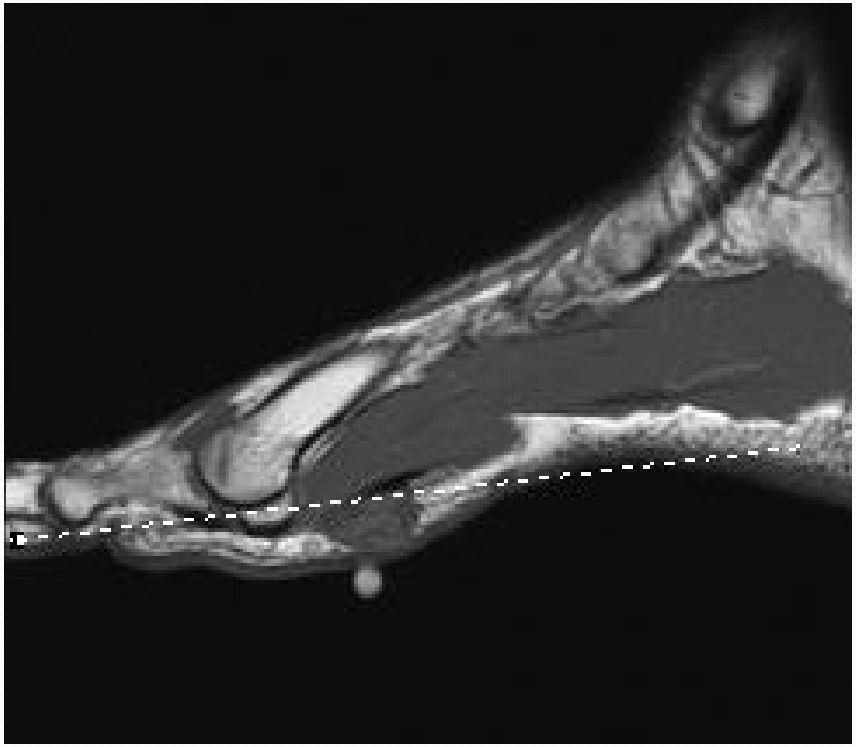


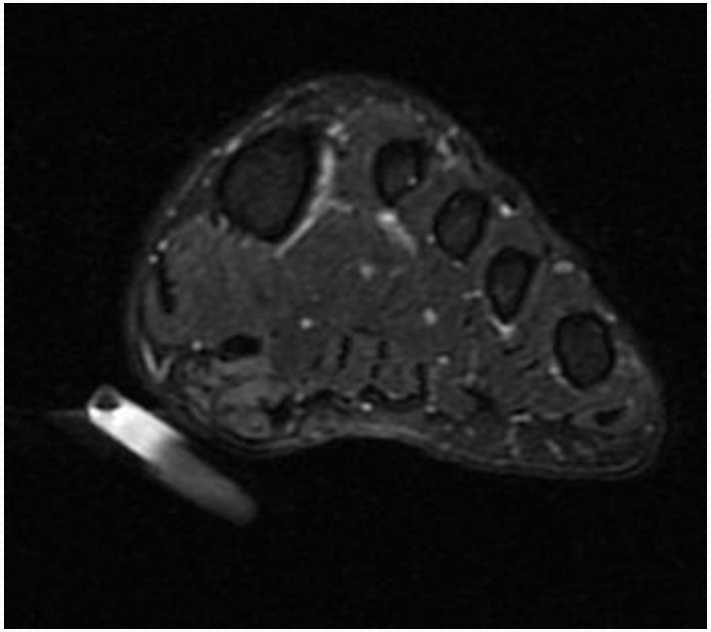
# Acute plantar plate rupture

- In the acute setting a fluid filled defect may be seen
- Subluxation of the flexor tendon is an associated finding



# Palpable abnormality





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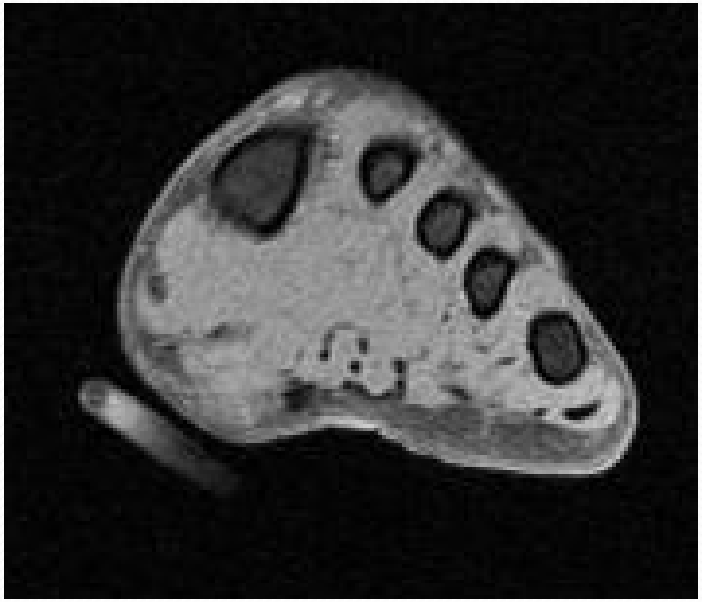
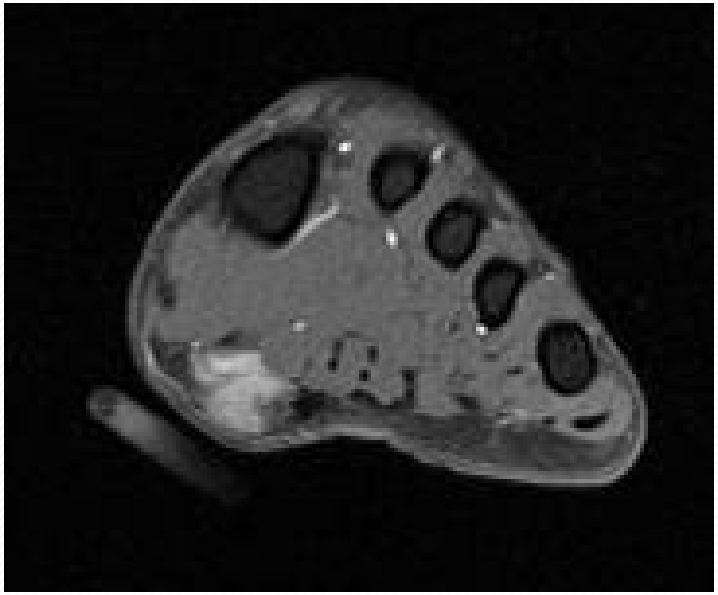
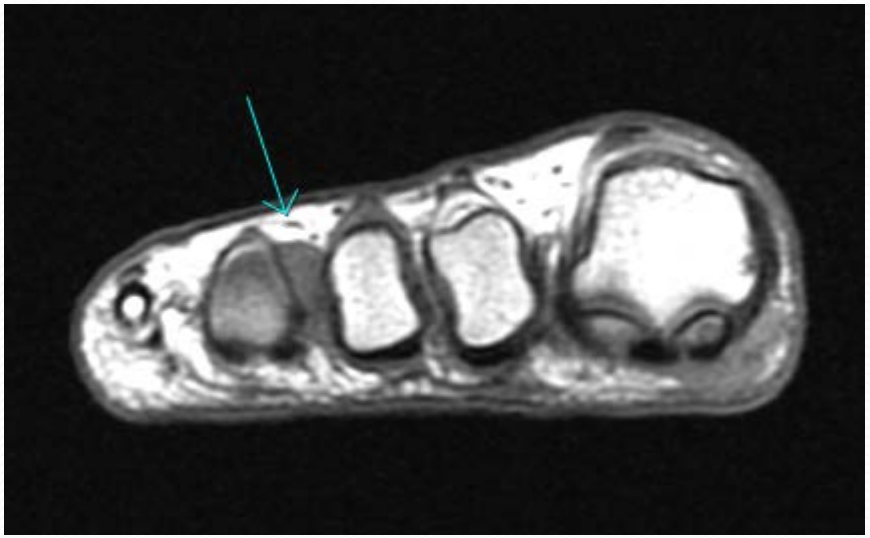




# Plantar fibroma/fibromatosis

- Benign entity involving the plantar fascia
- May be single or multiple
- No malignant potential
- DDx includes malignant mass

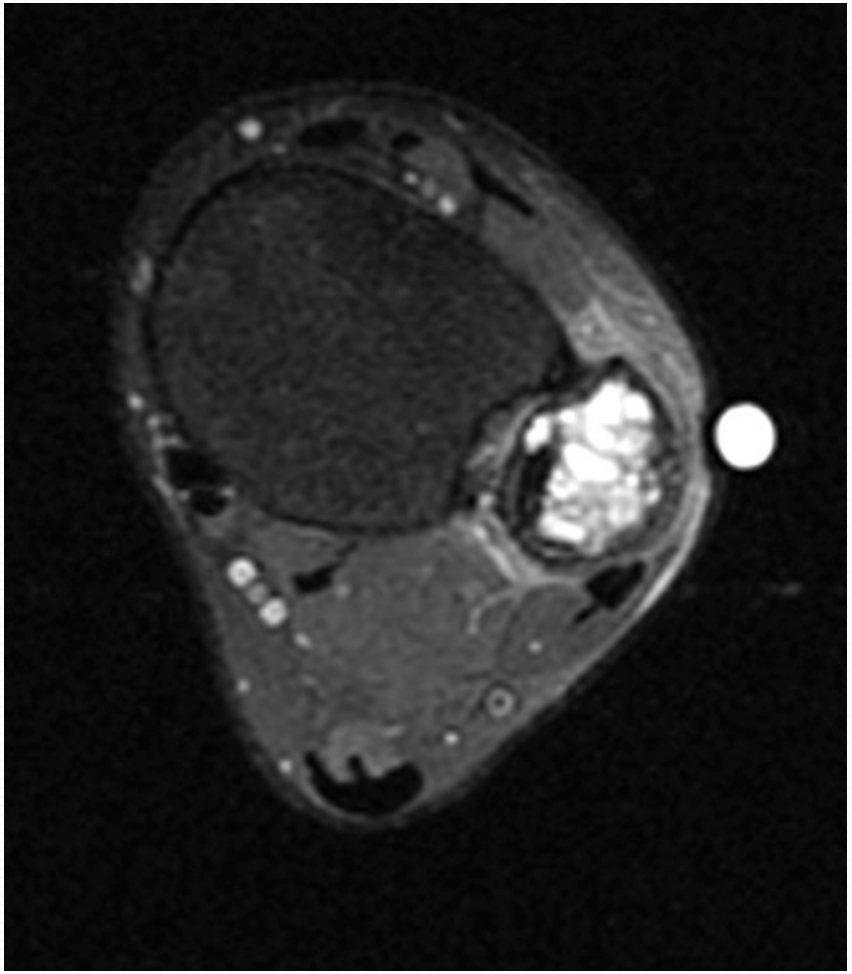
# Increasing pain between the 3rd and 4th toes for one year



# Morton's Neuroma

- Morton's neuroma are not true tumors
- Morton's neuroma are due to chronic inflammatory changes and perineural fibrosis around a plantar digital nerve of the foot
- 3rd interspace most often involved followed by the 2nd interspace
- Can be treated with steroid or anesthetic injection or surgically excised

# Teenager with lateral ankle swelling and pain



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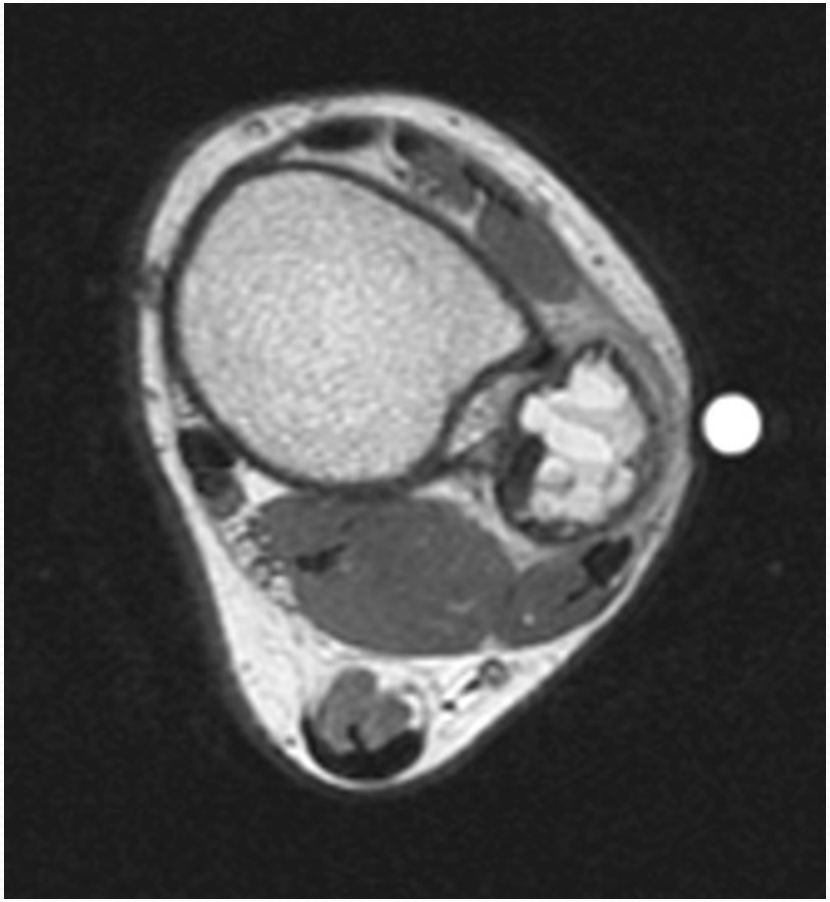

# Aneurysmal Bone Cyst

- Benign active lesion
- Often seen in the 2nd decade
- Can be seen alone or superimposed on other bone lesions
- Usually operated upon and filled with cement due to active nature and symptoms
- DDx: Telangiectatic osteosarcoma if there is an associated soft tissue component

# Conclusions

- While not the first imaging modality used in ankle and foot injuries, MRI can be very helpful in detecting occult bone injures
- Ligament and tendon tears are optimally evaluated by MRI
- Questions?

Please feel free to contact me!

dldma8@gmail.com