

MRI foot

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Prince of Wales Hospital

MRI foot

- Flat foot
- Mid foot injury – Lisfranc's injury
- Metatarsalgia (forefoot pain)

Flat foot

Pes planovalgus

Pes planus

Flat foot

- Acquired : **PTT dysfunction, spring ligament tear**
- Congenital : **Tarsal coalition**, congenital vertical talus, Down's syndrome, cerebral palsy

- Flexible (normal in non-weight bearing)
- Rigid (abnormal in non-weight bearing) –
Congenital anomalies !

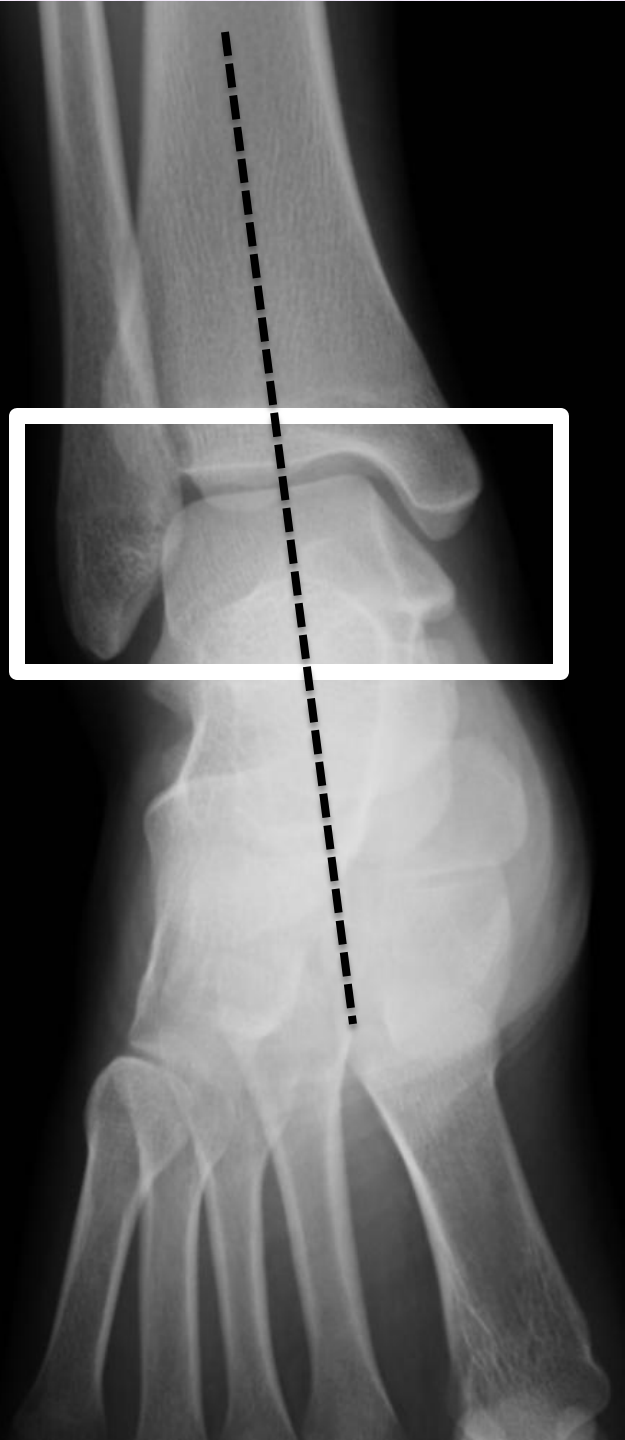
- Adult
- Childhood

Flat foot

Loss of medial plantar arch (mid foot collapse)

- Talus head rotated medially and inferiorly
- Hindfoot plantar flexion : talonavicular fault (talar tilt)
- Hindfoot valgus (heel/calcaneovalgus): tibiocalcaneal angle
- Forefoot/Midfoot (talonavicular) abduction : talonavicular unroofing / navicular lateral shifting

R

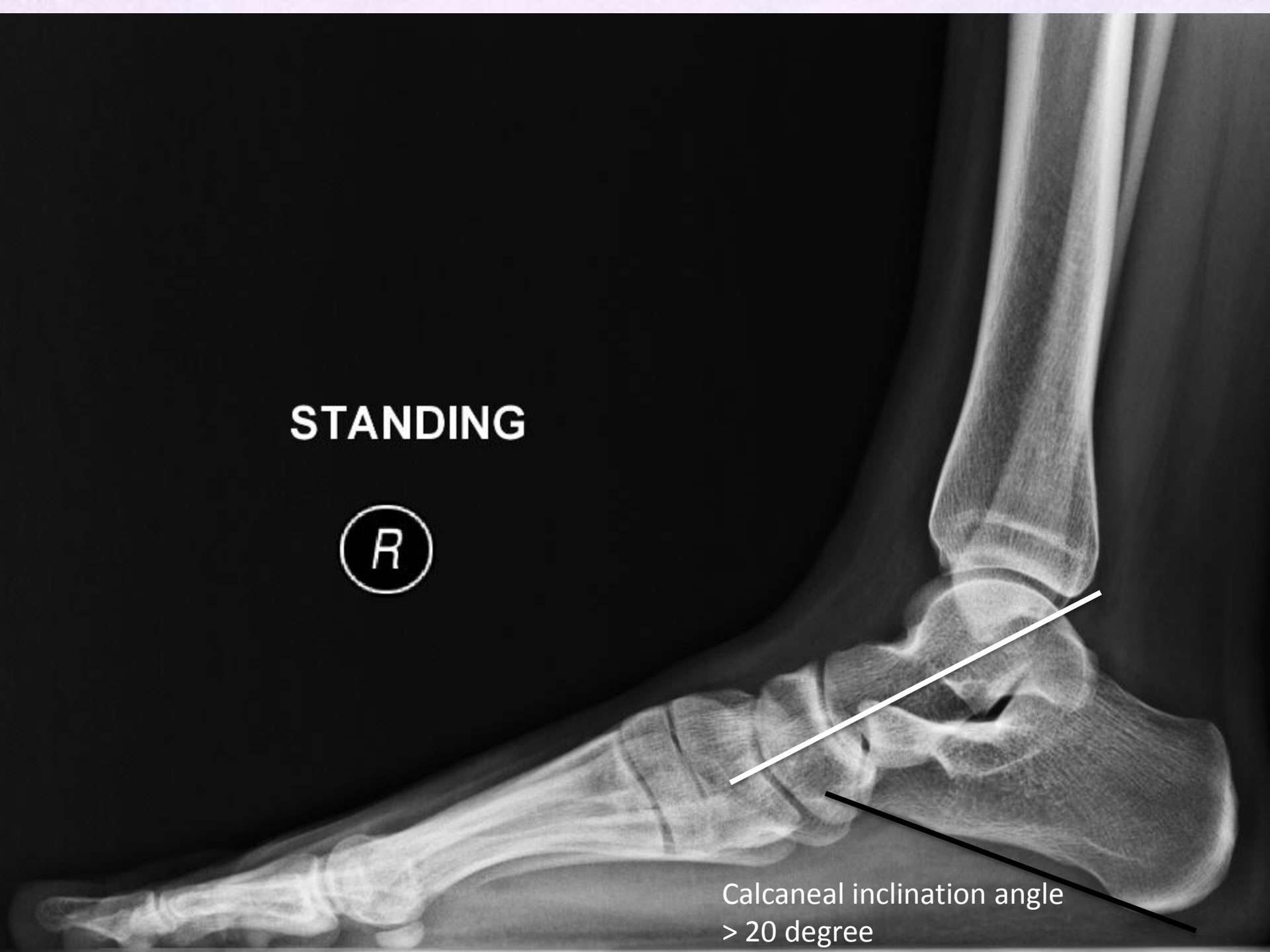




STANDING

R

Calcaneal inclination angle
> 20 degree



STANDING

511582L

CCT

P

A





STANDING





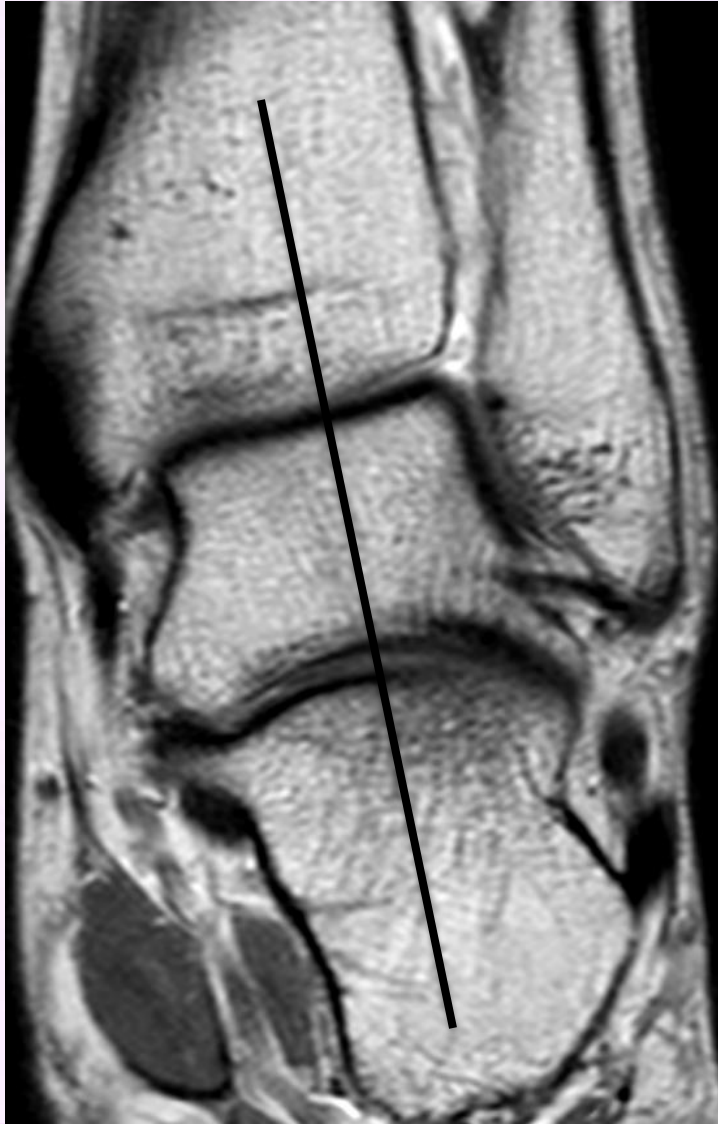
MRI of flat foot

- 1) Bony alignment
- 2) Associated soft tissue abnormalities
- 3) Secondary bony abnormalities
- 4) Underlying relevant congenital abnormalities

1) Bony alignment

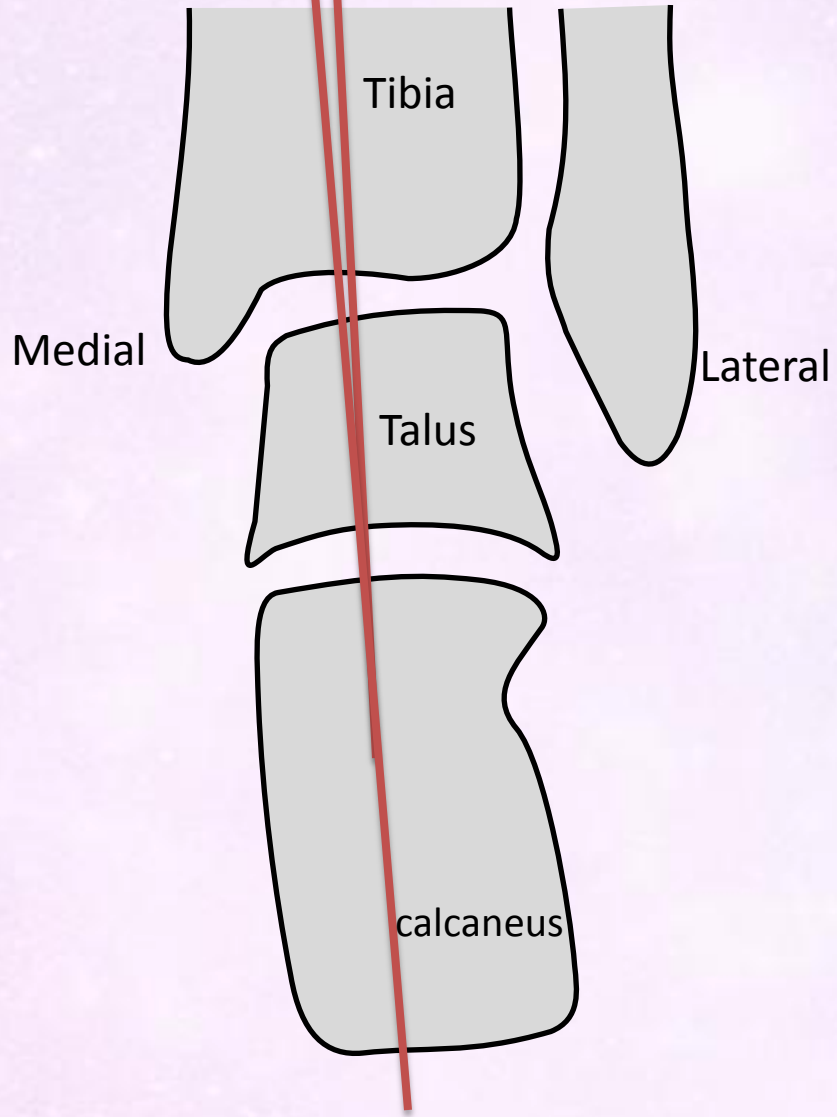
- A. Heel valgus
- B. Inferomedial migration of talus head
- C. Uncovering of talus head by navicular
- D. Talus plantar flexion : talonavicular fault

A. Heel valgus (tibiocalcaneal angle : 0-6°)

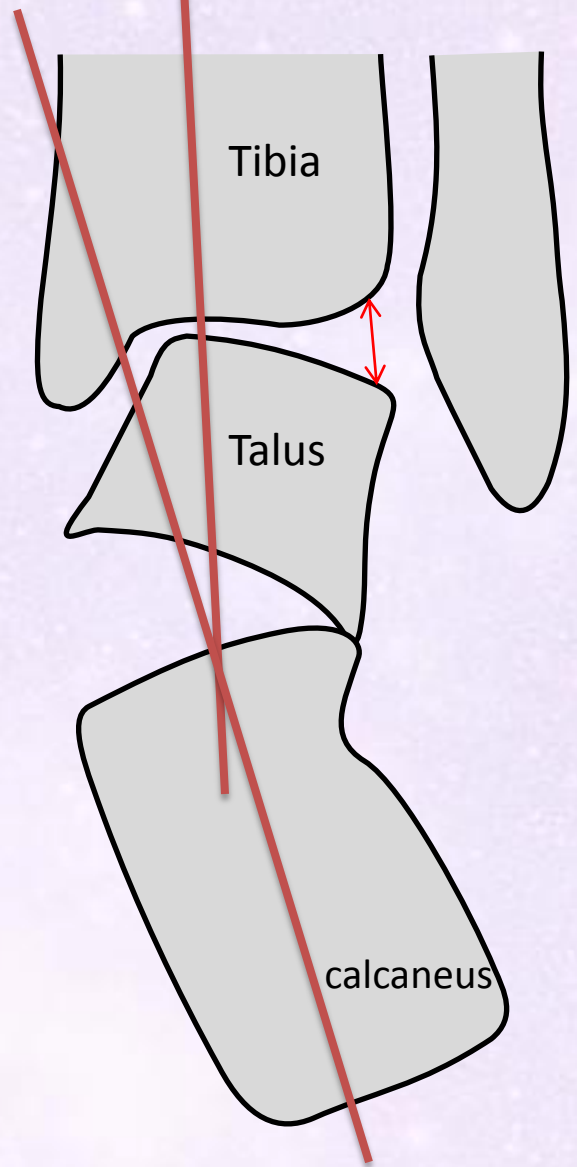


Normal

Coronal



Normal



Flat foot



Moderate flat foot



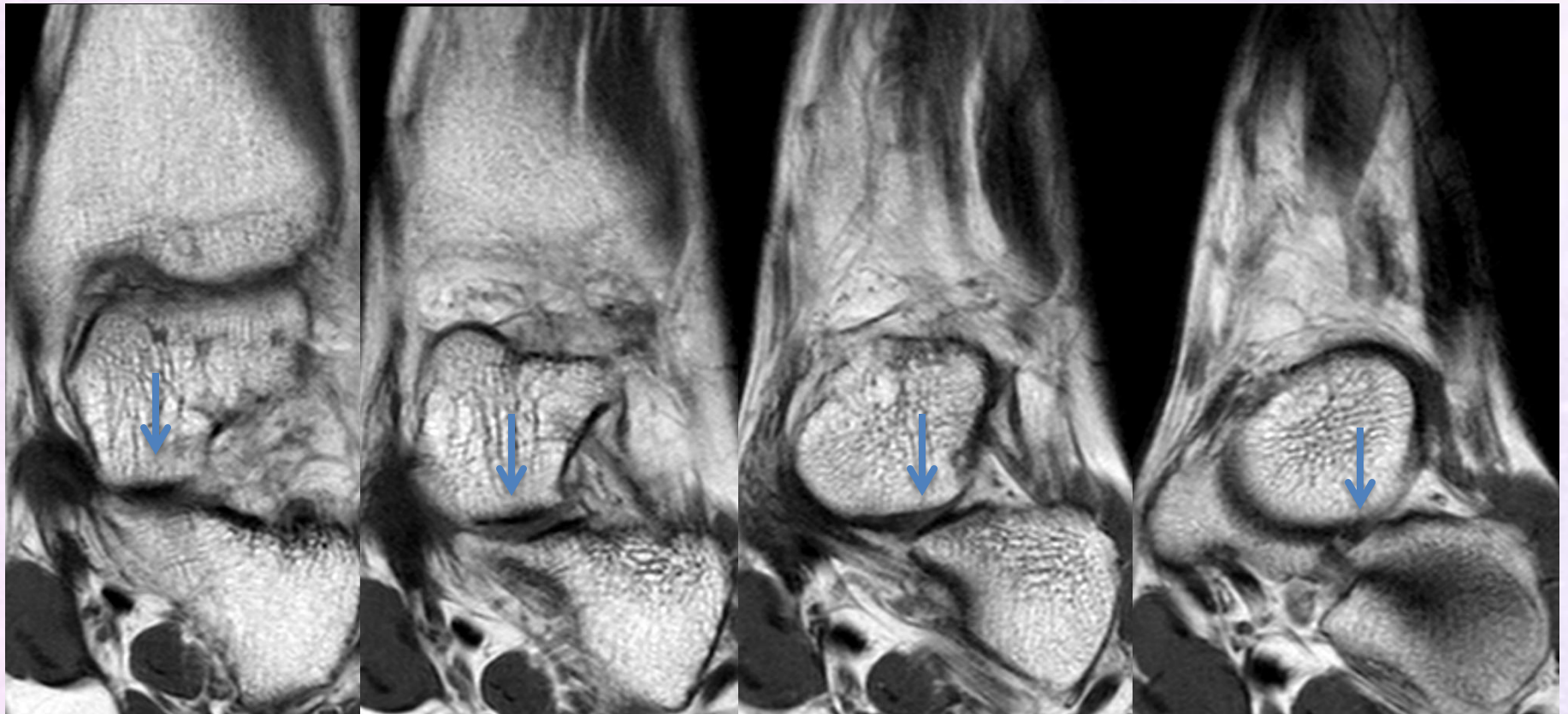
Severe flat foot



Flat foot

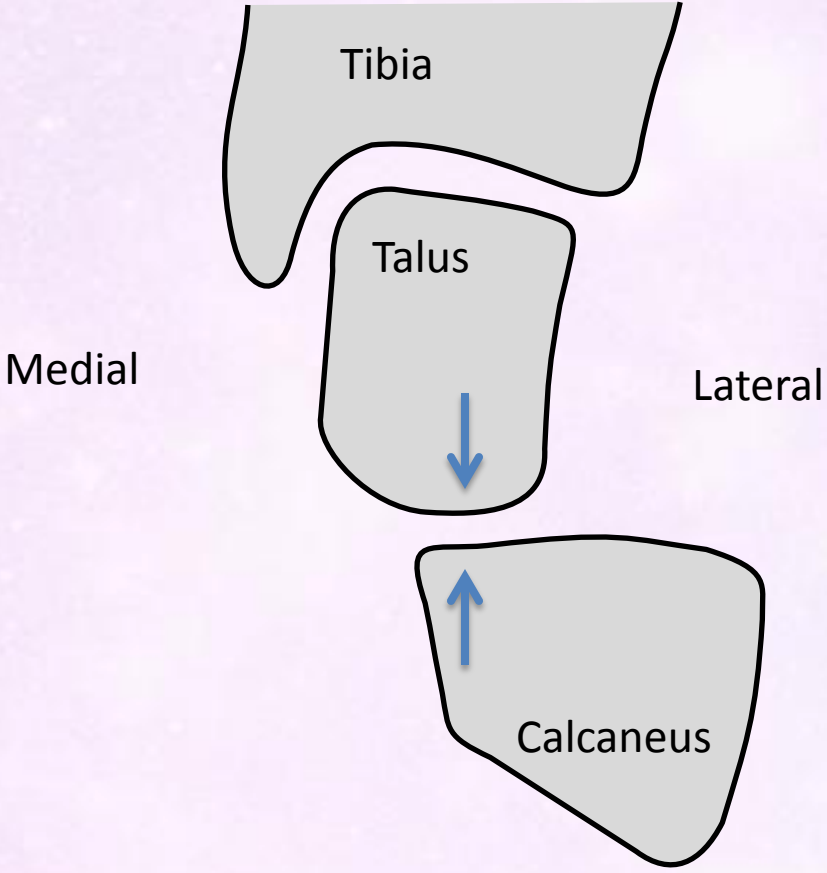
B. Inferomedial migration (rotation and adduction) of talus head

Posterior → Anterior

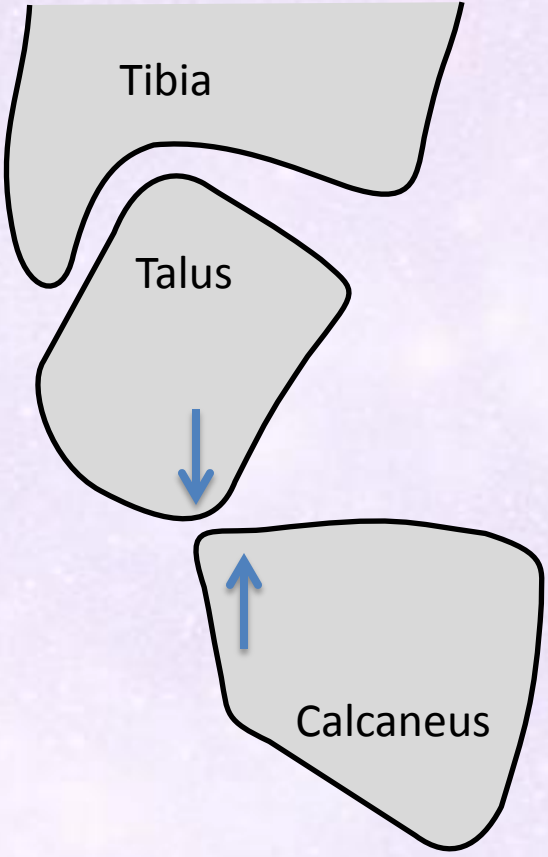


Normal

Coronal

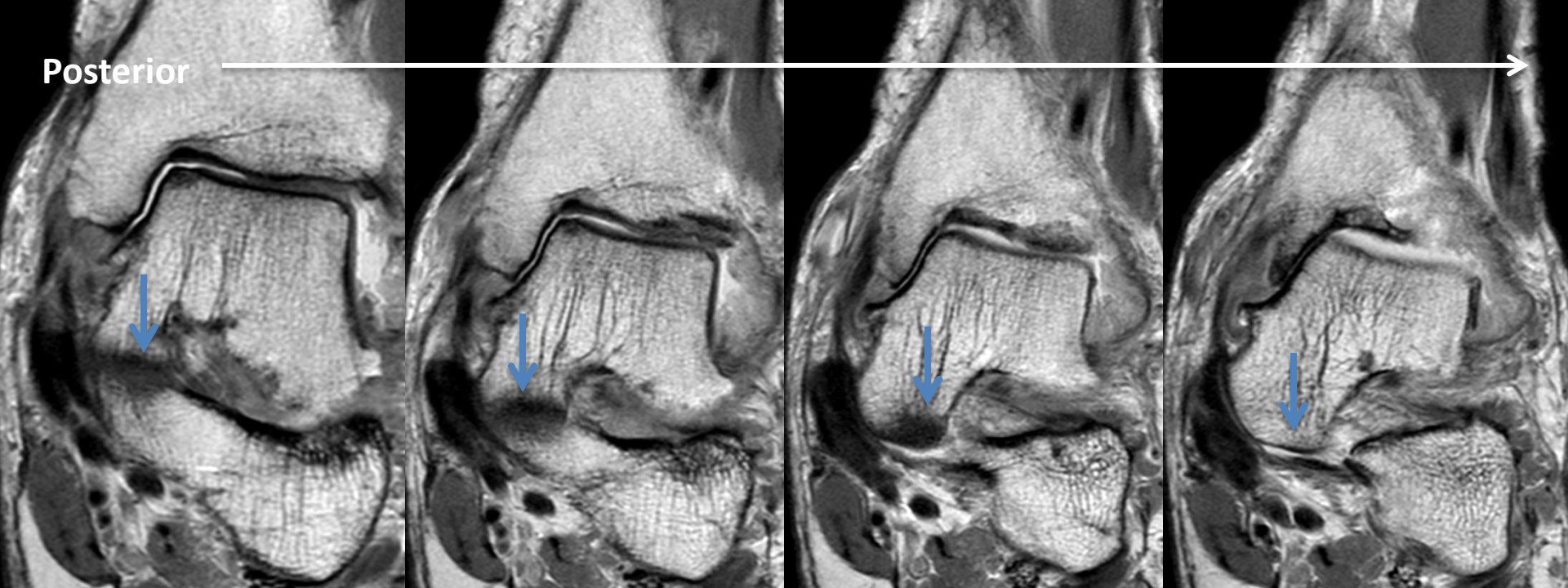


Normal

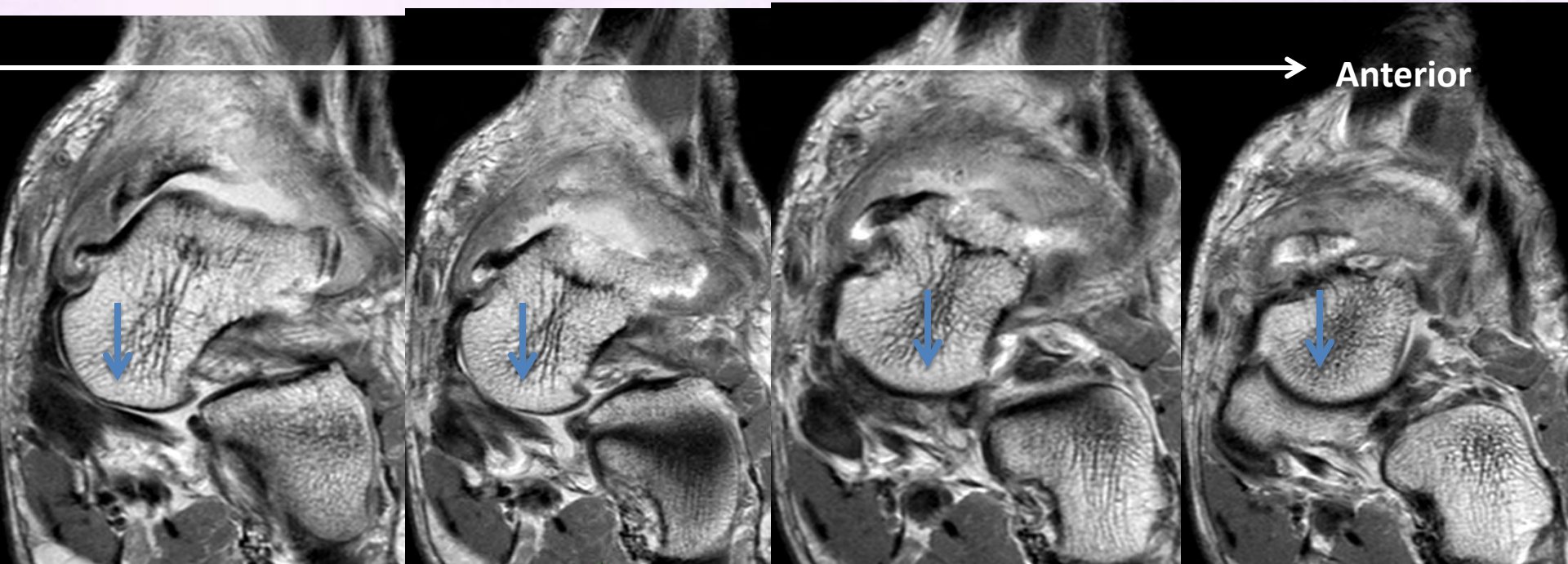


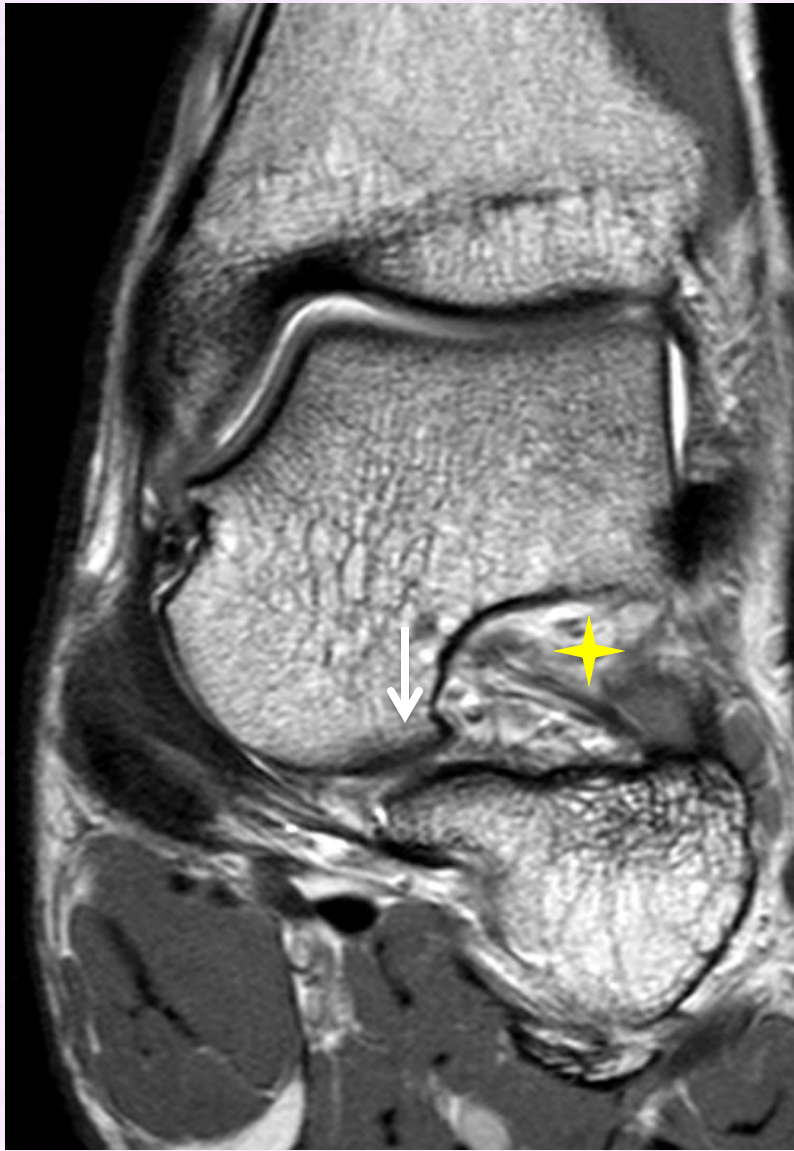
Flat foot

Posterior

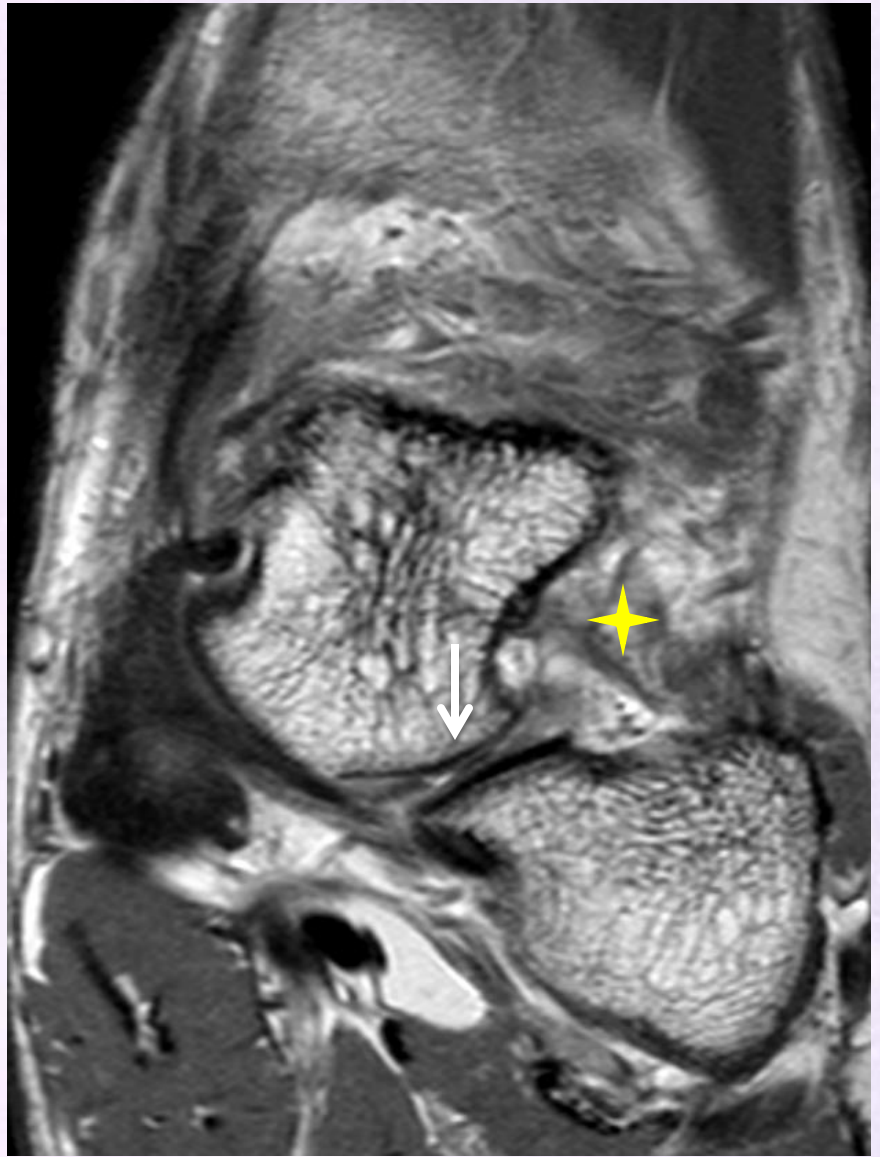


Anterior





Normal



Normal



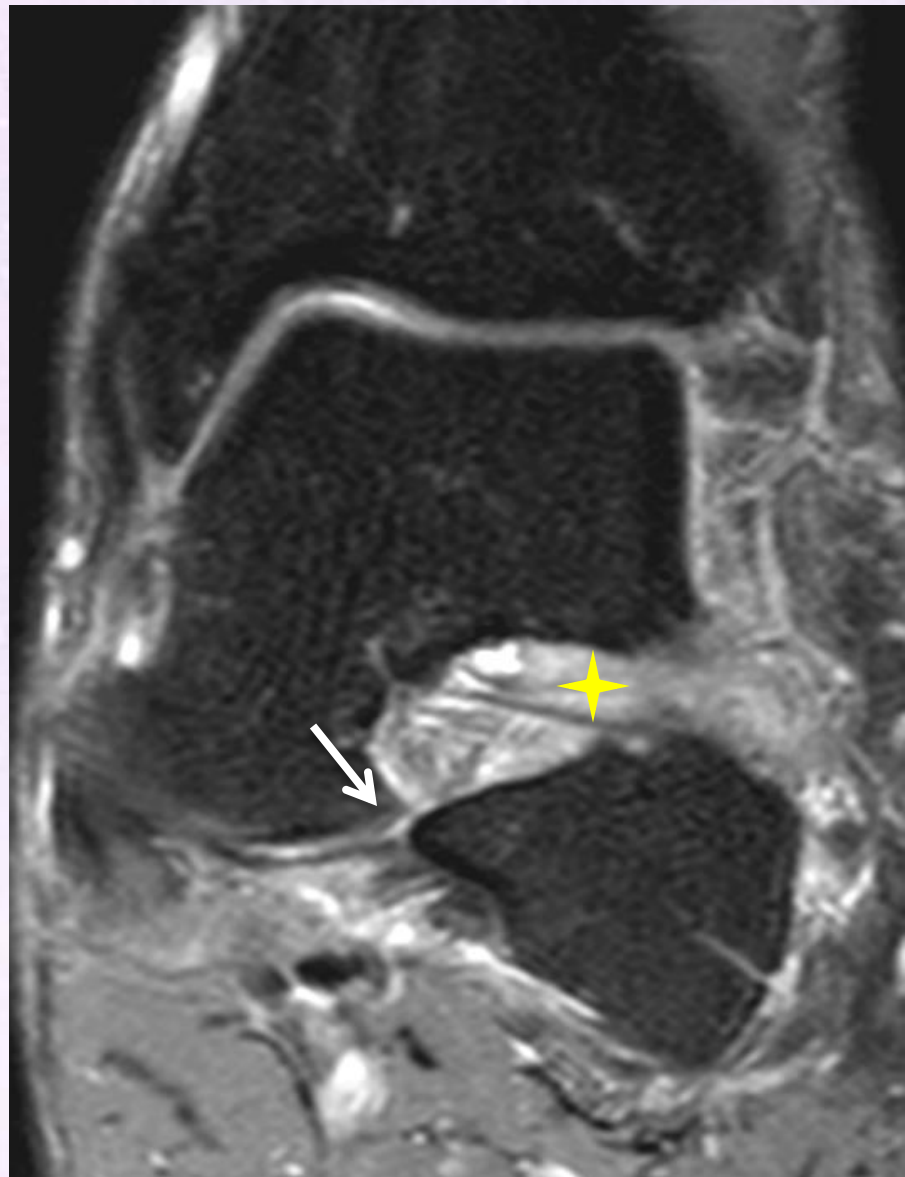
Mild



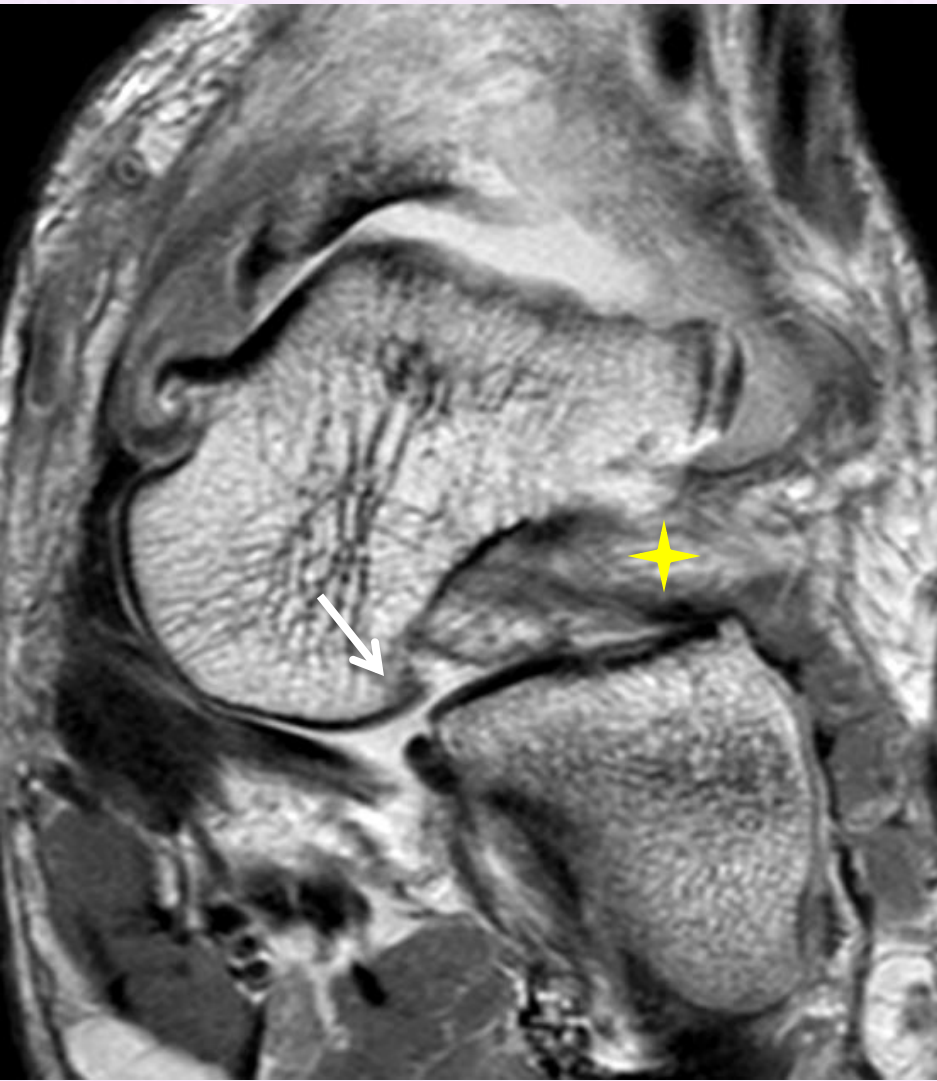
Mild to moderate



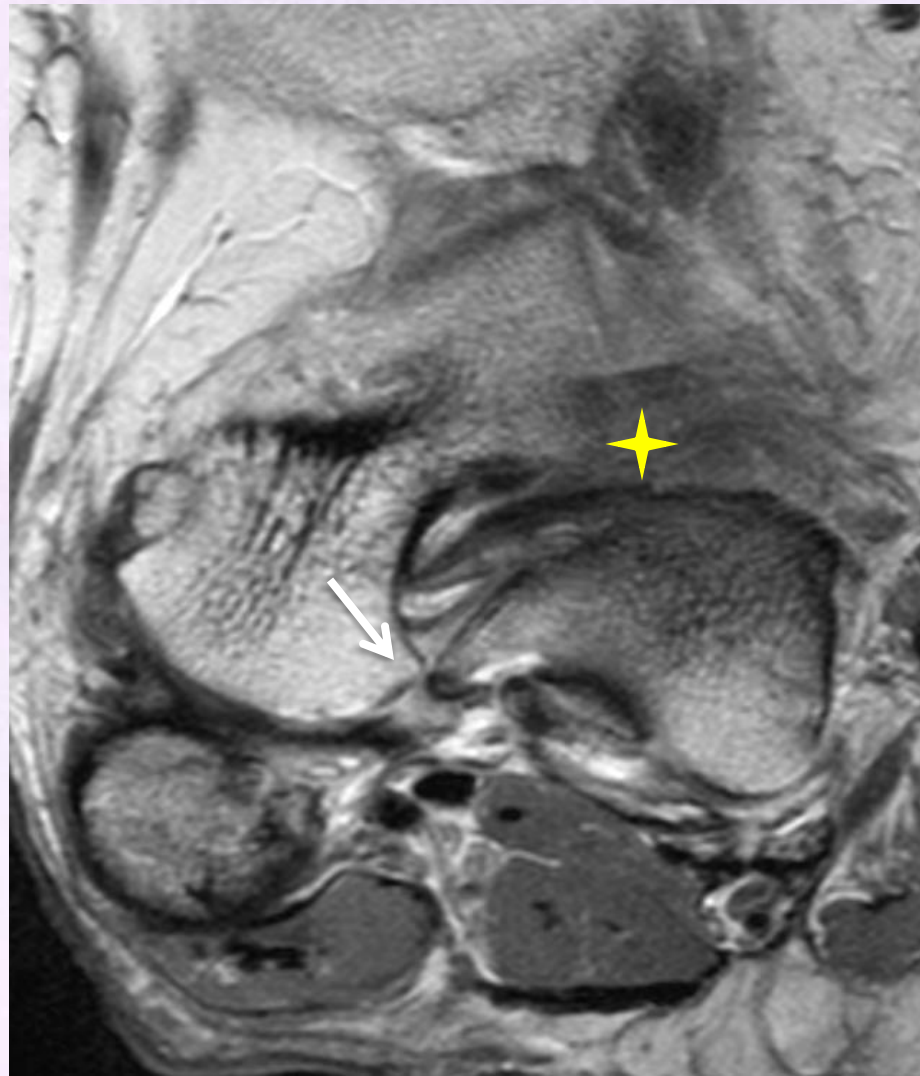
Moderate



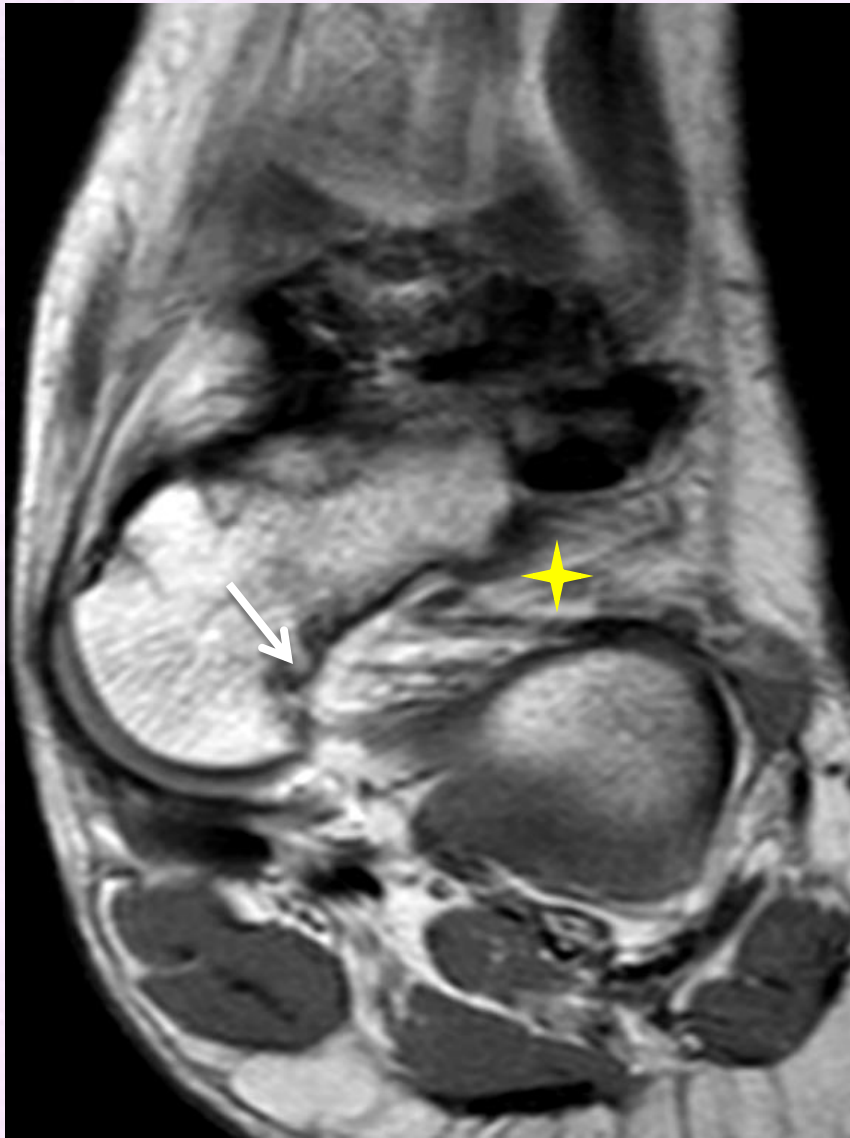
Moderate to severe



Severe



Severe to very severe

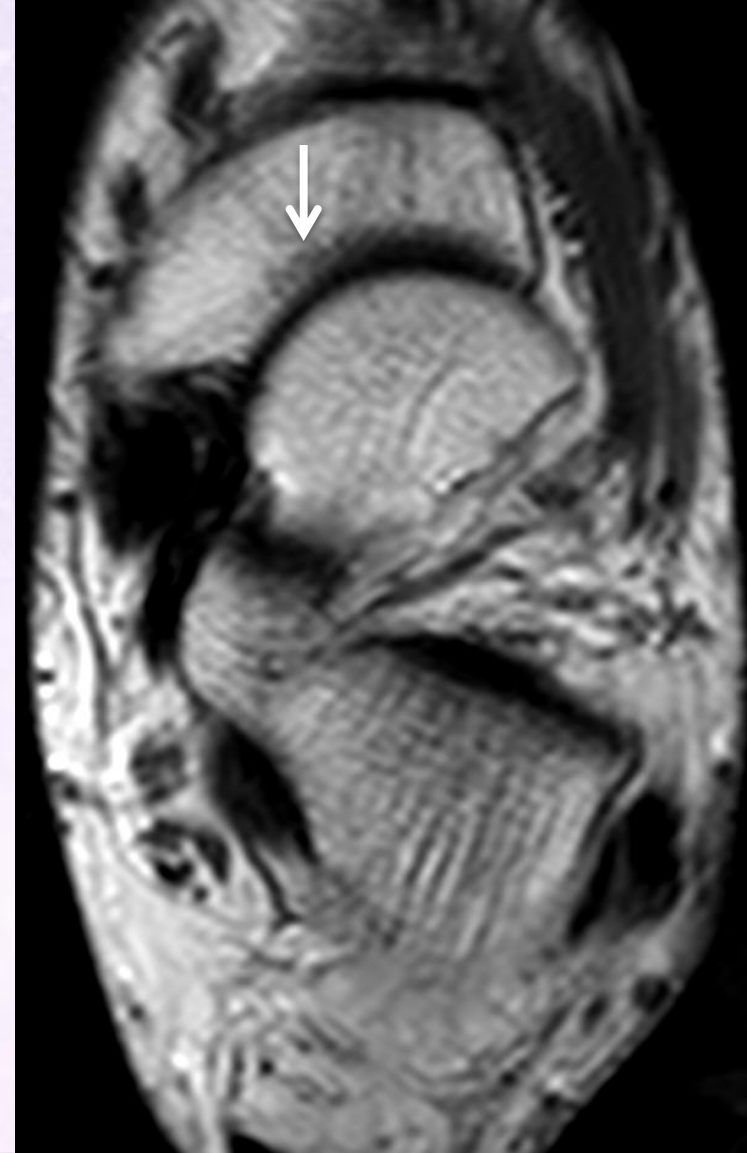


Very severe



Very severe

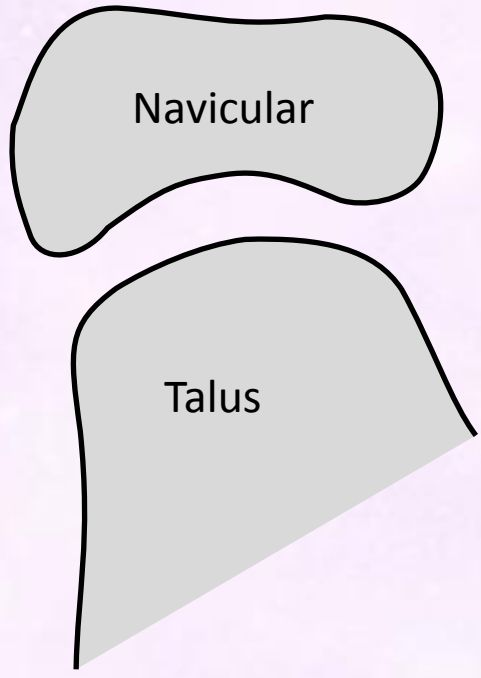
C. Navicular coverage of talus head (normal >85%)



Normal

Axial

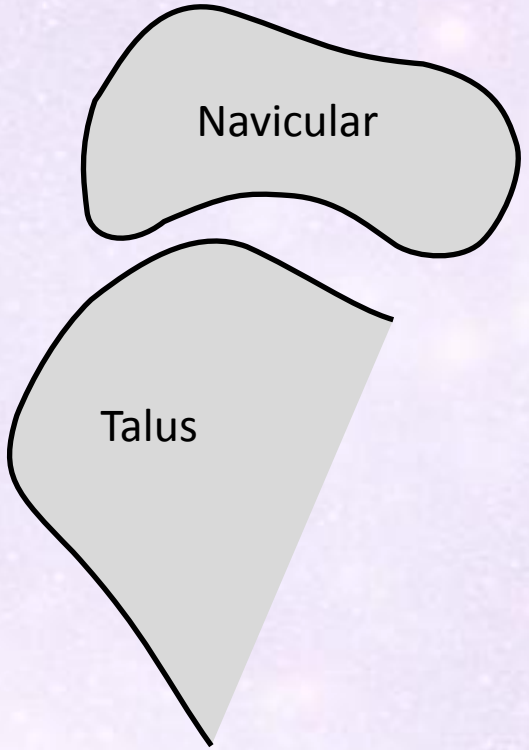
Medial



>85% coverage

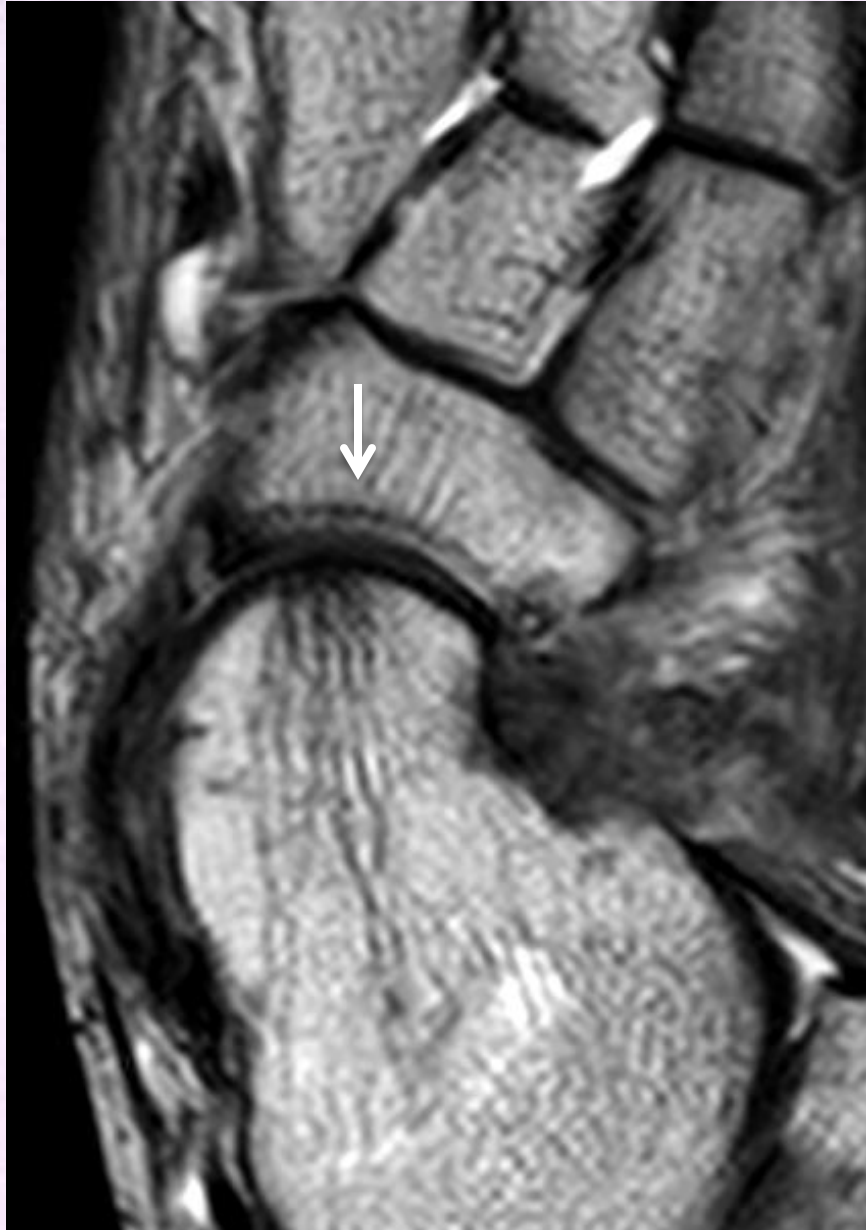
Normal

Lateral

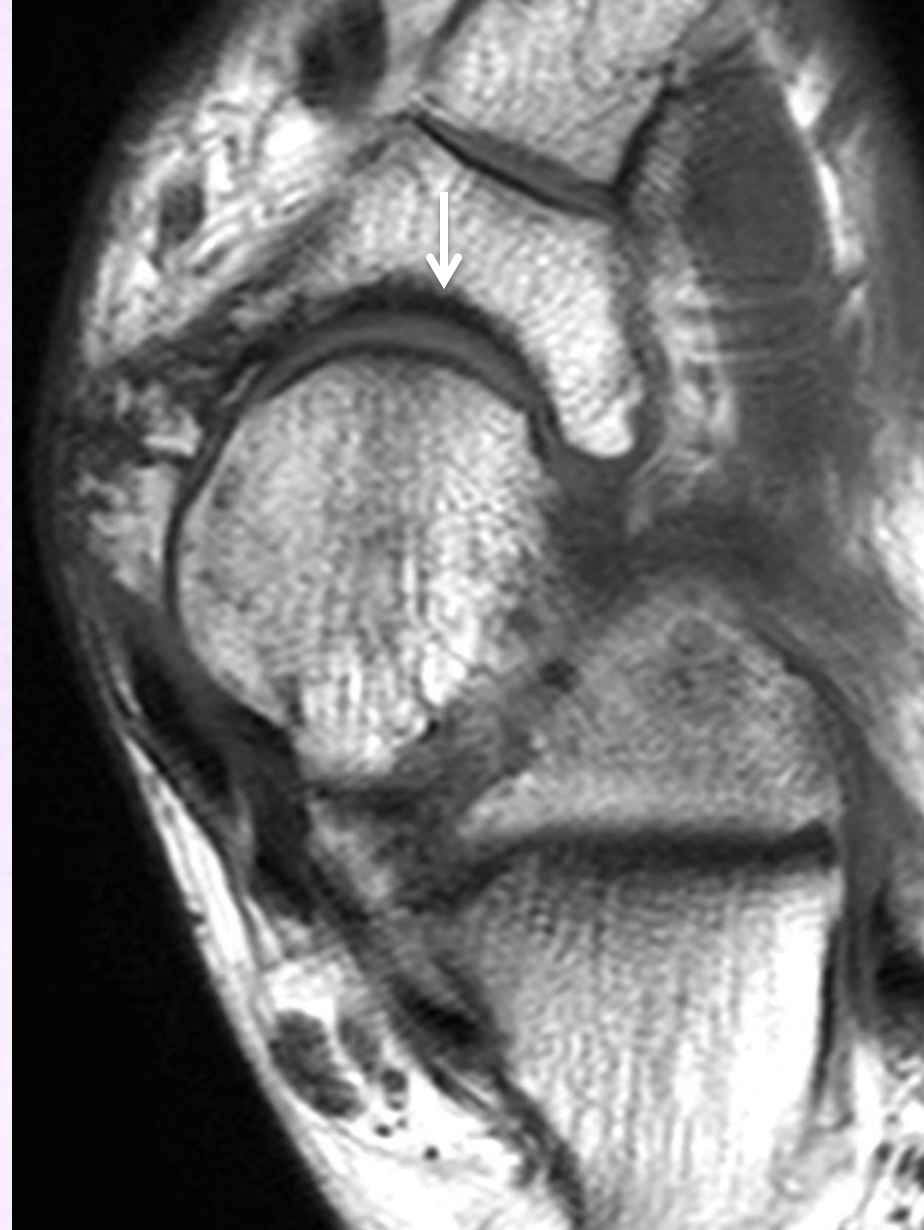


<85% coverage

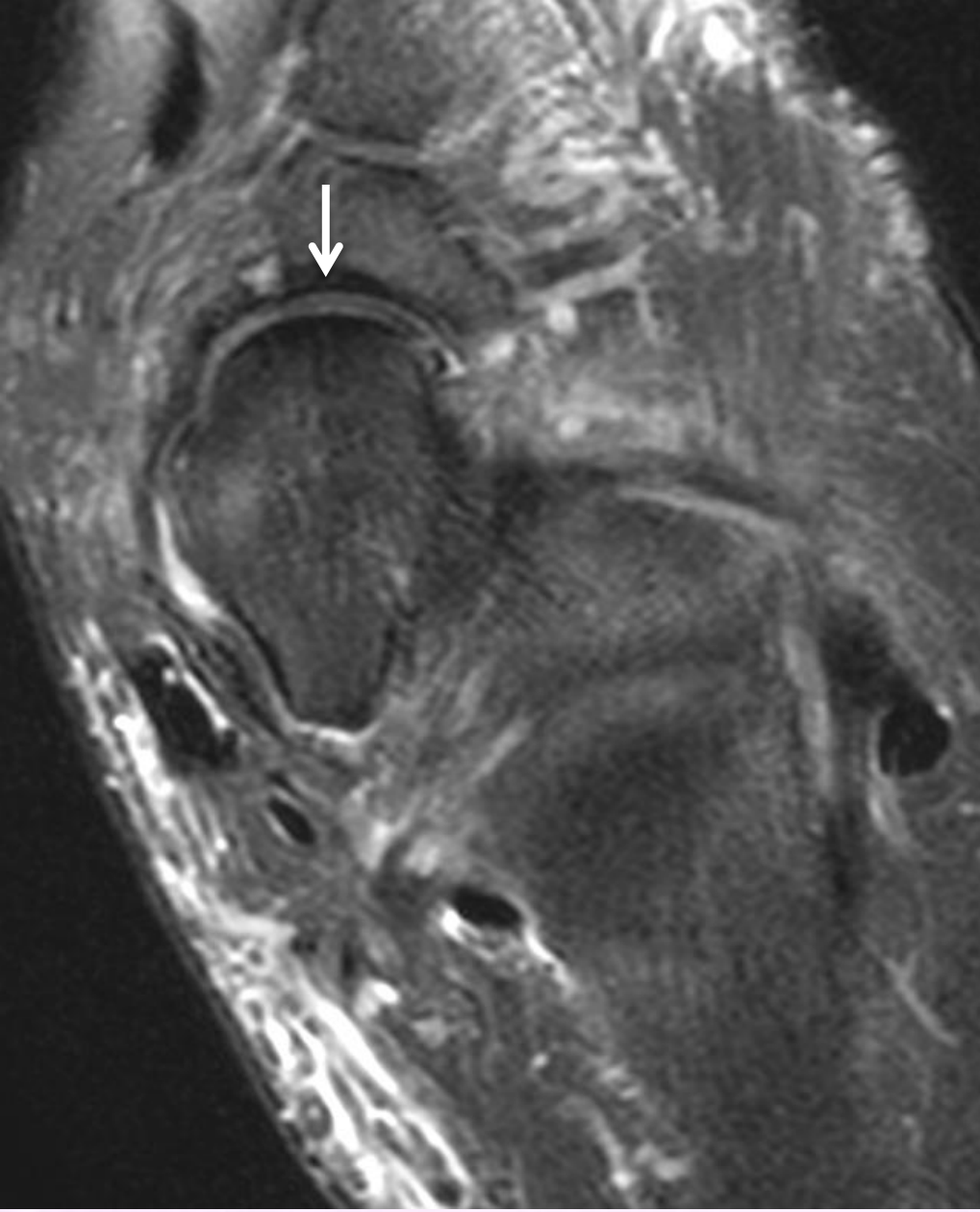
Flat foot



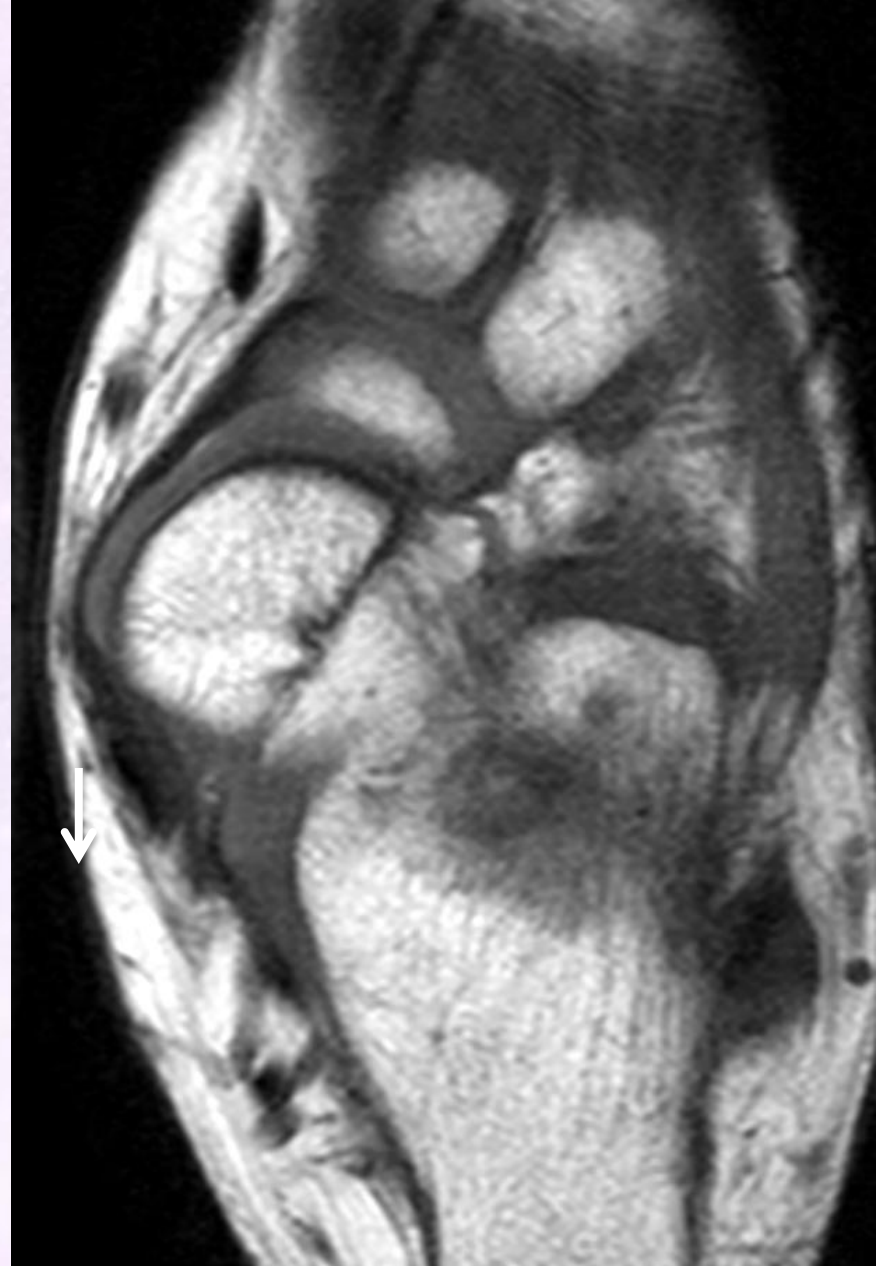
Mild



Moderate

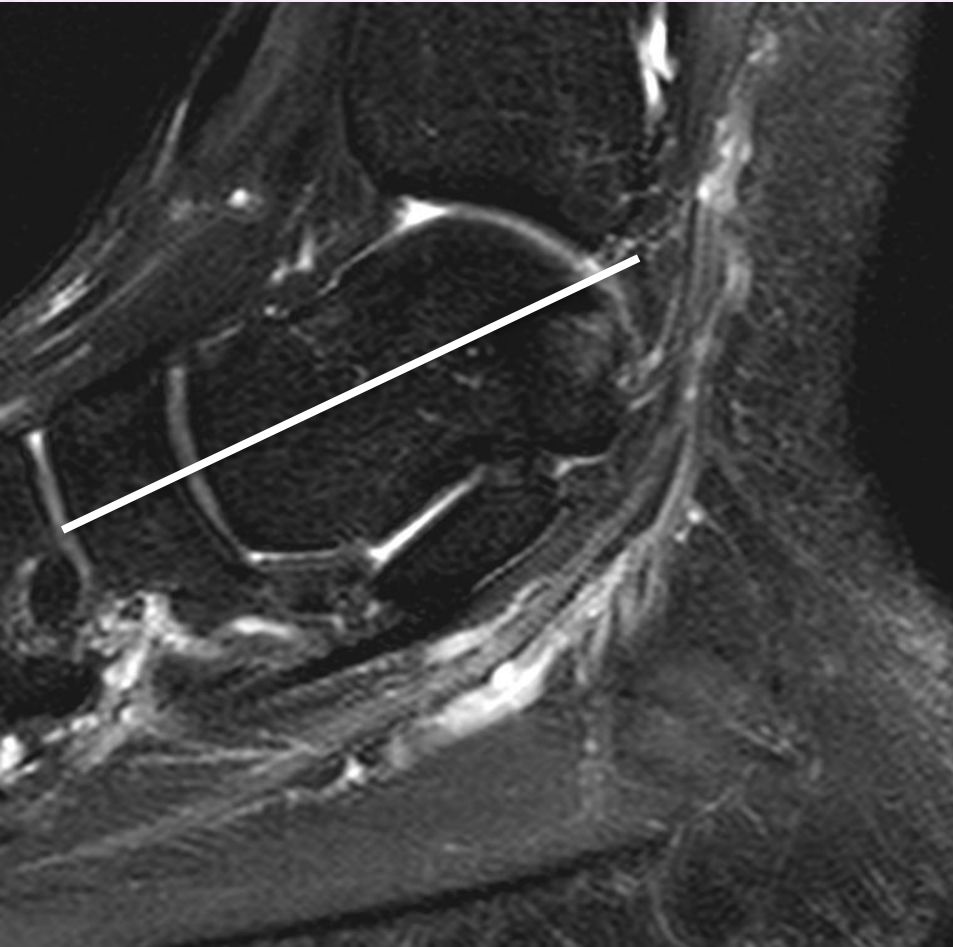


Moderate

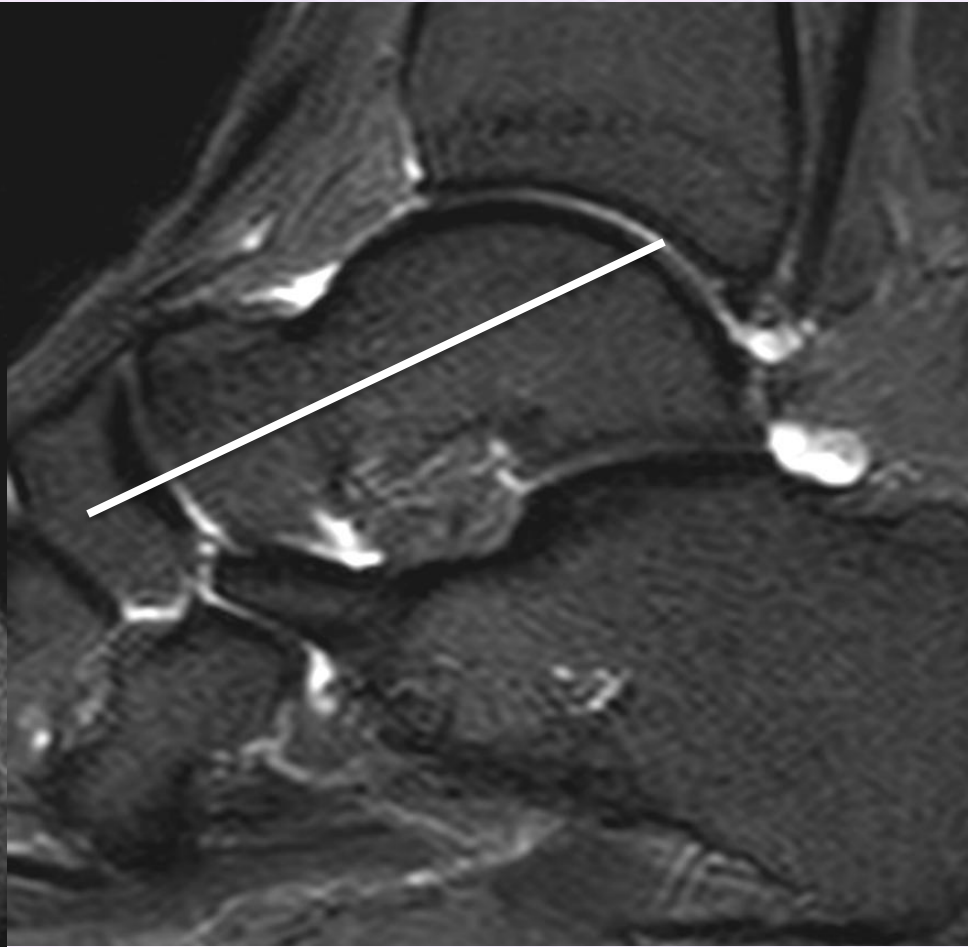


Severe

D. Talus plantar flexion

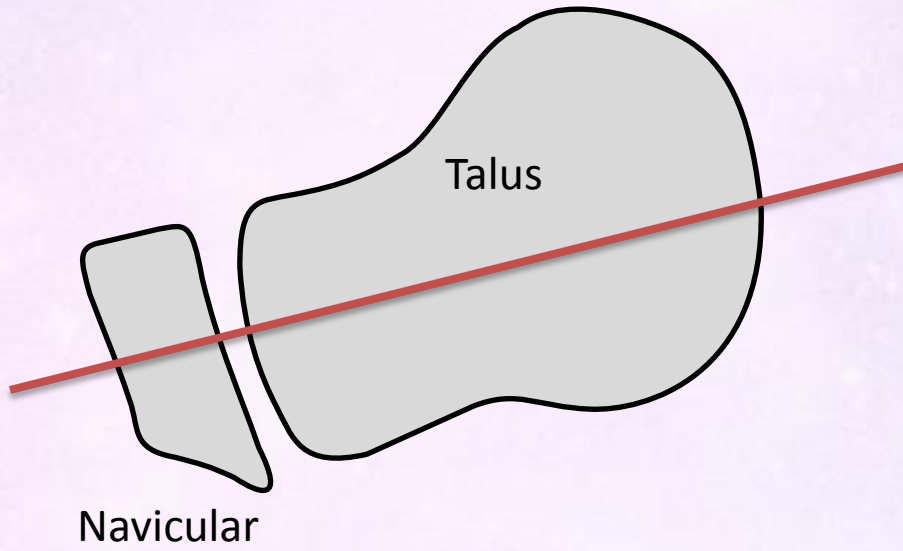


Normal

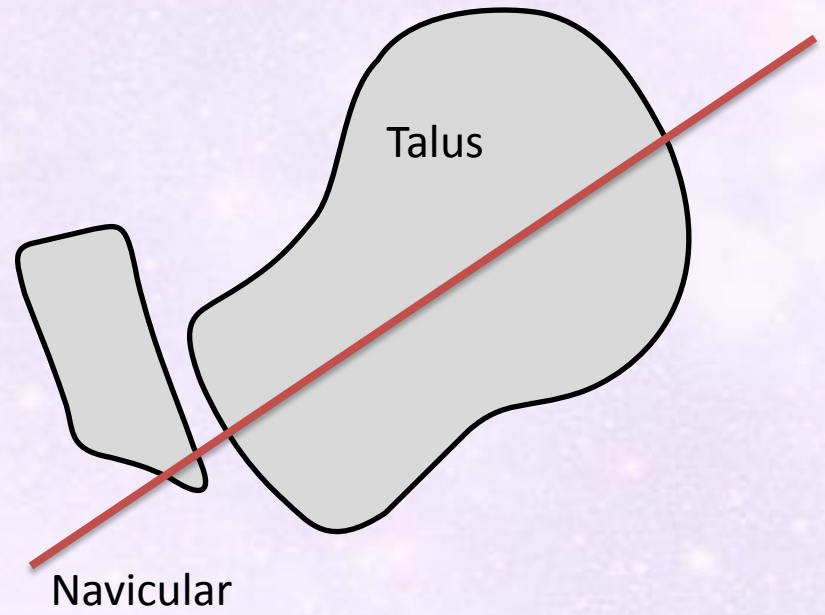


At the cut of base of 1st metatarsal bone

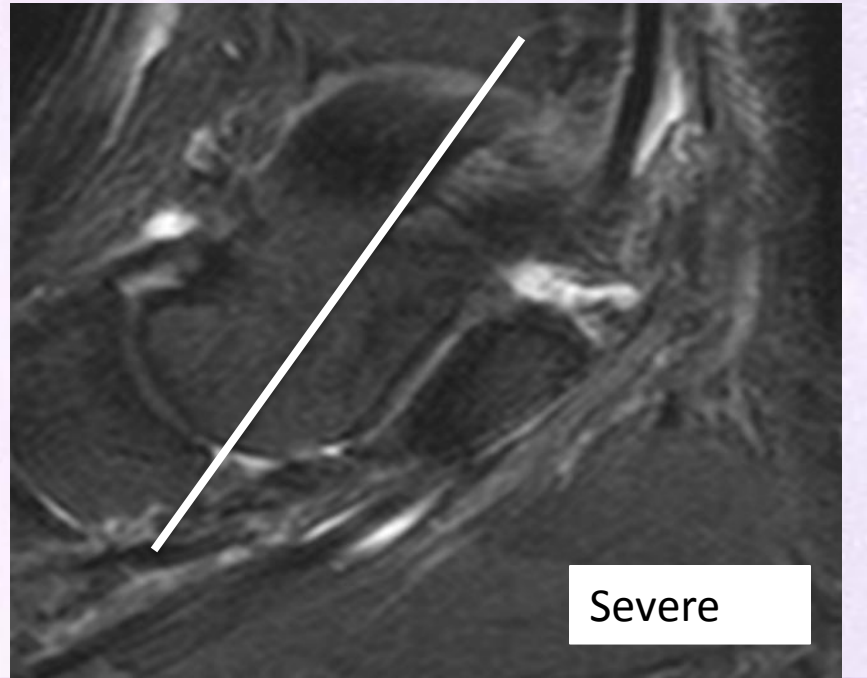
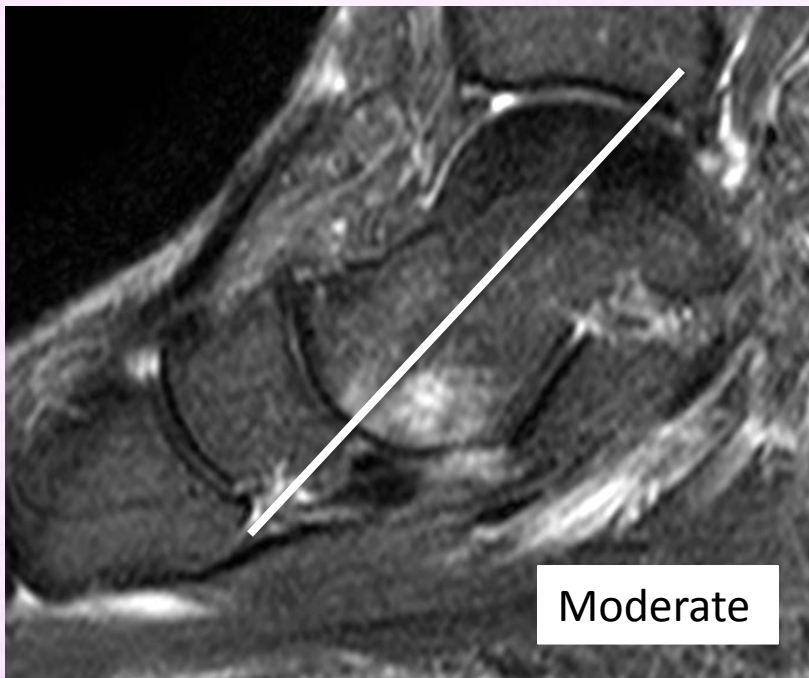
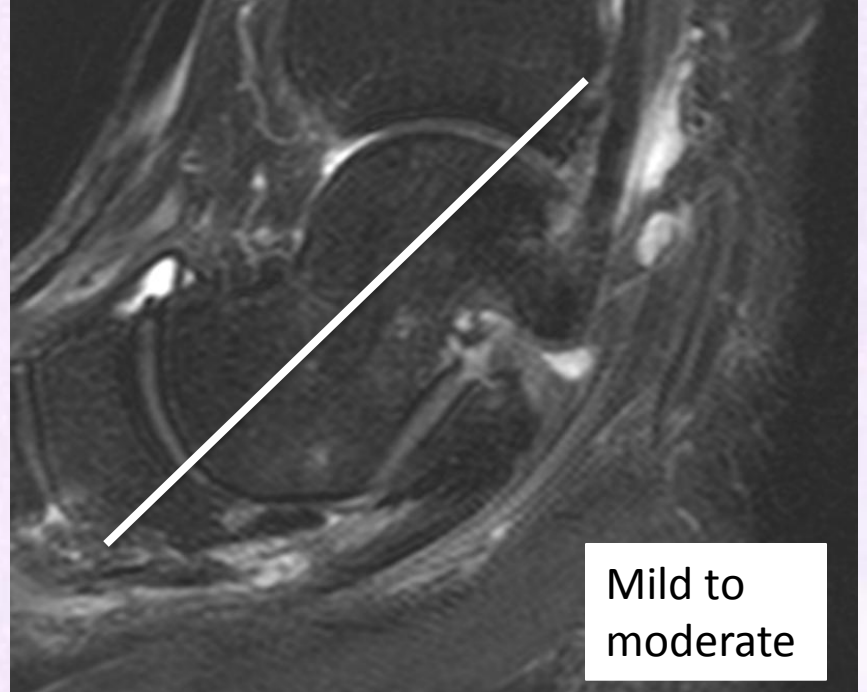
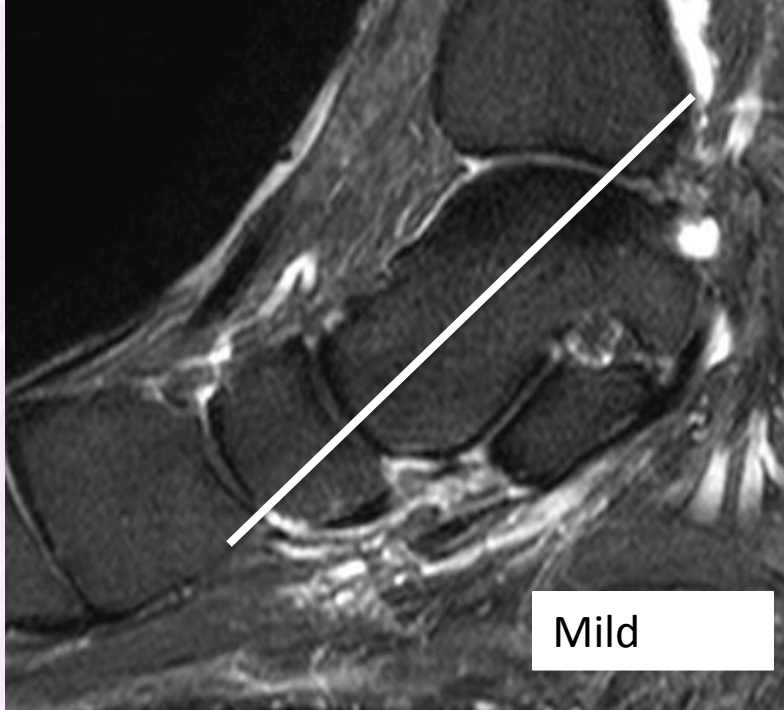
Sagittal



Normal



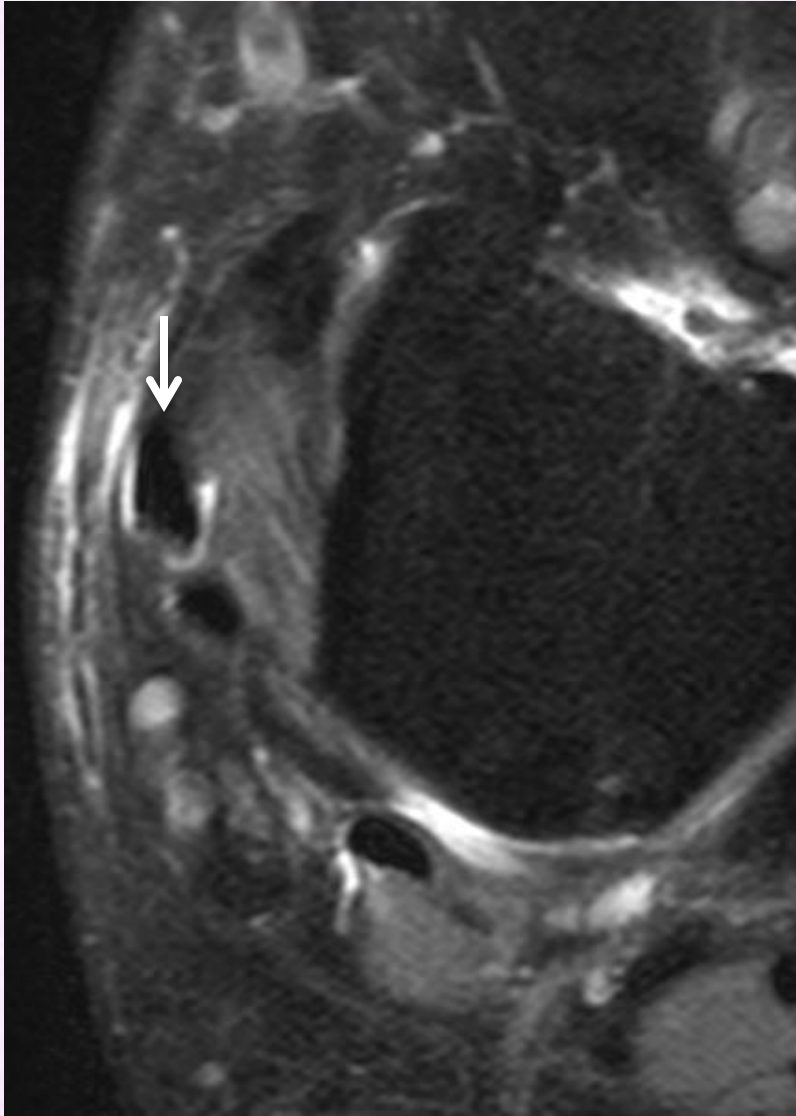
Flat foot



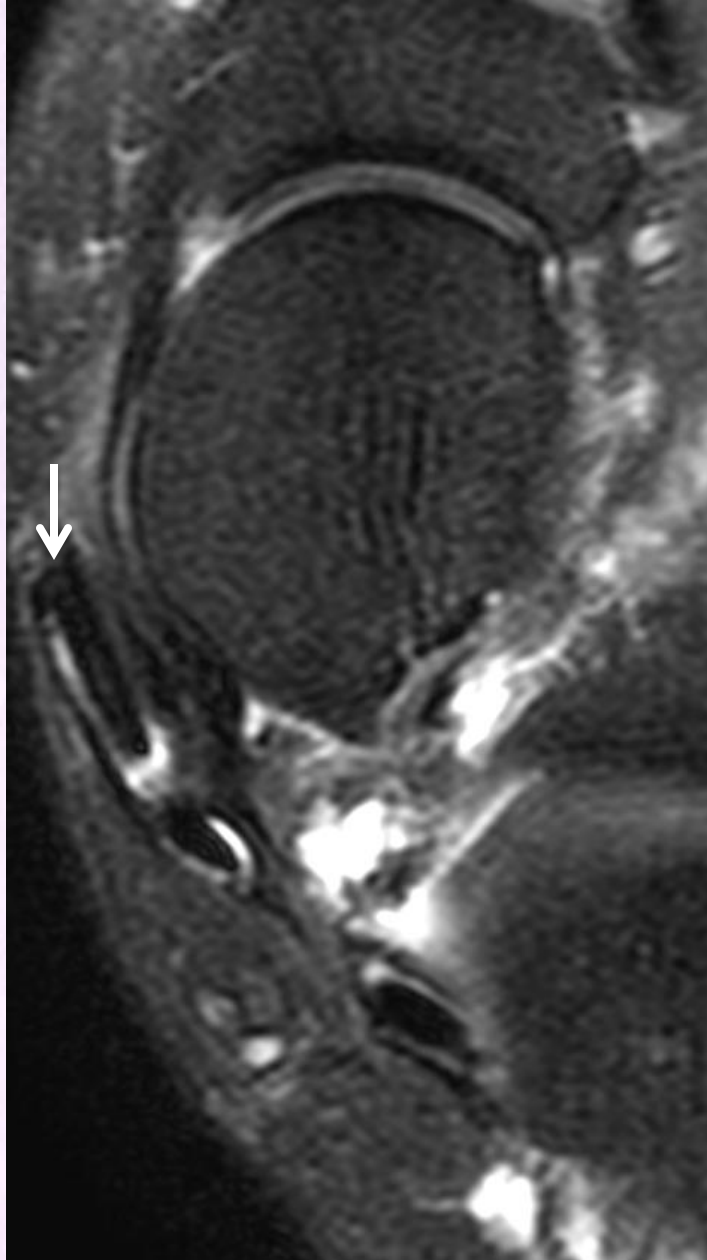
2. Associated soft tissue abnormalities

- **Posterior tibialis tendon**
 - **Spring ligament**
 - **Sinus tarsi ligaments**
 - Plantar fascia
 - Deltoid ligaments
 - Short & long plantar ligaments
 - Other plantar ligaments (naviculocuneiform and tarsometarsal ligaments)
- Triad of key structures
-

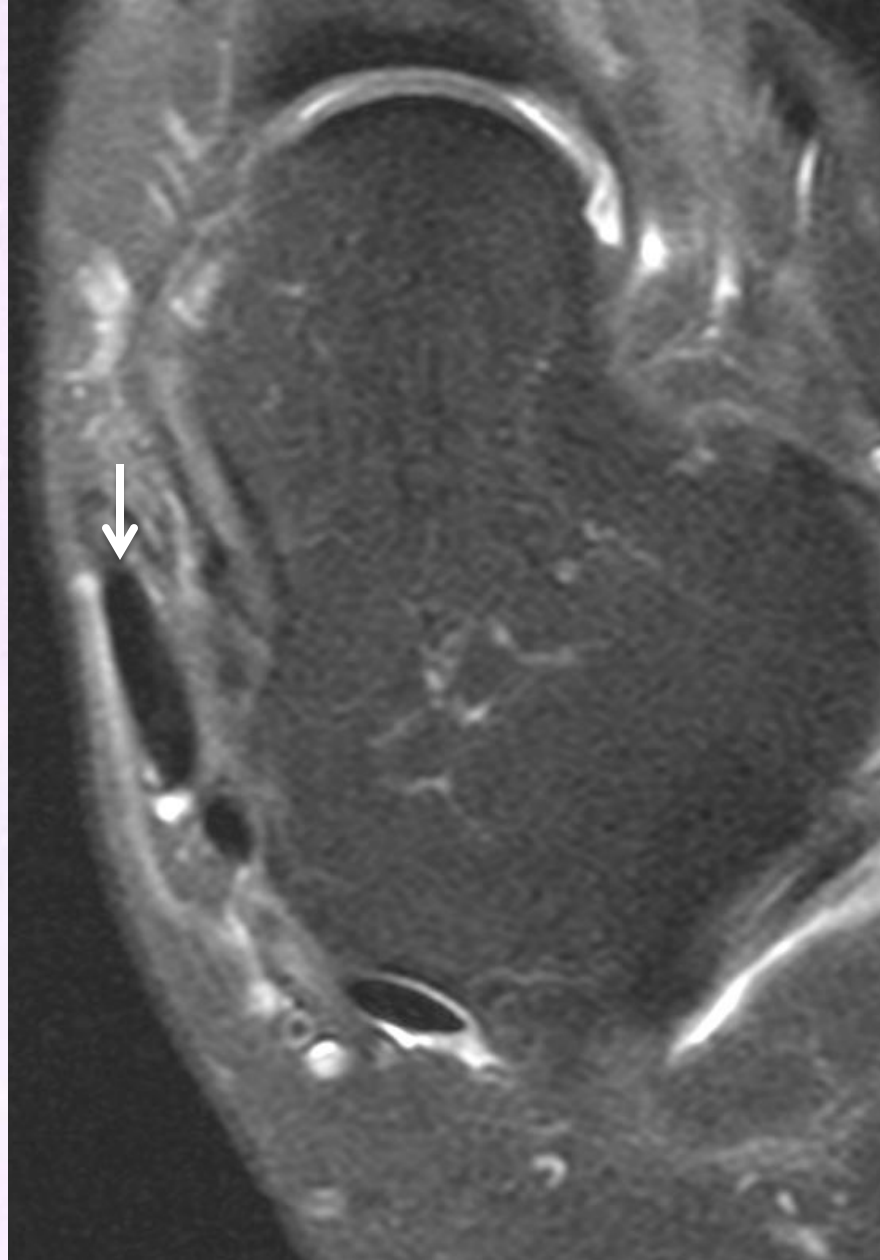
A. Posterior tibial tendon



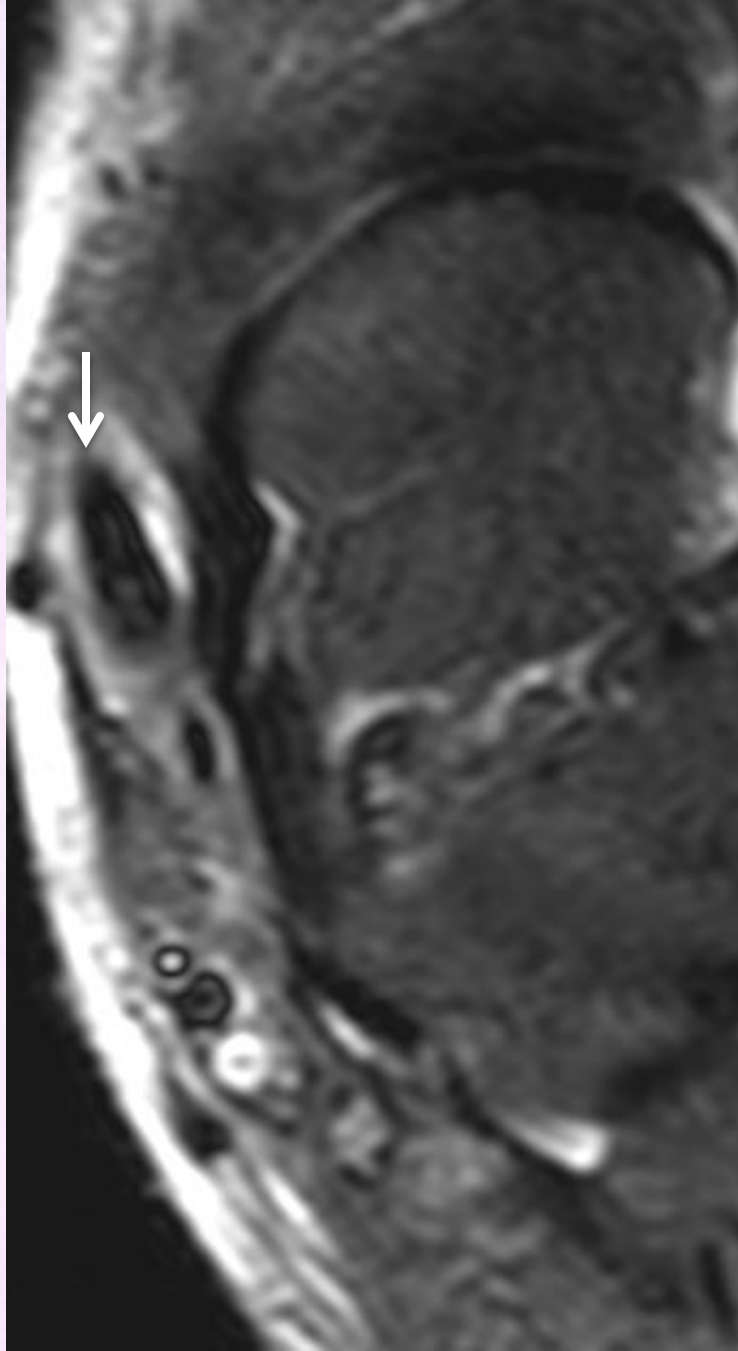
Normal



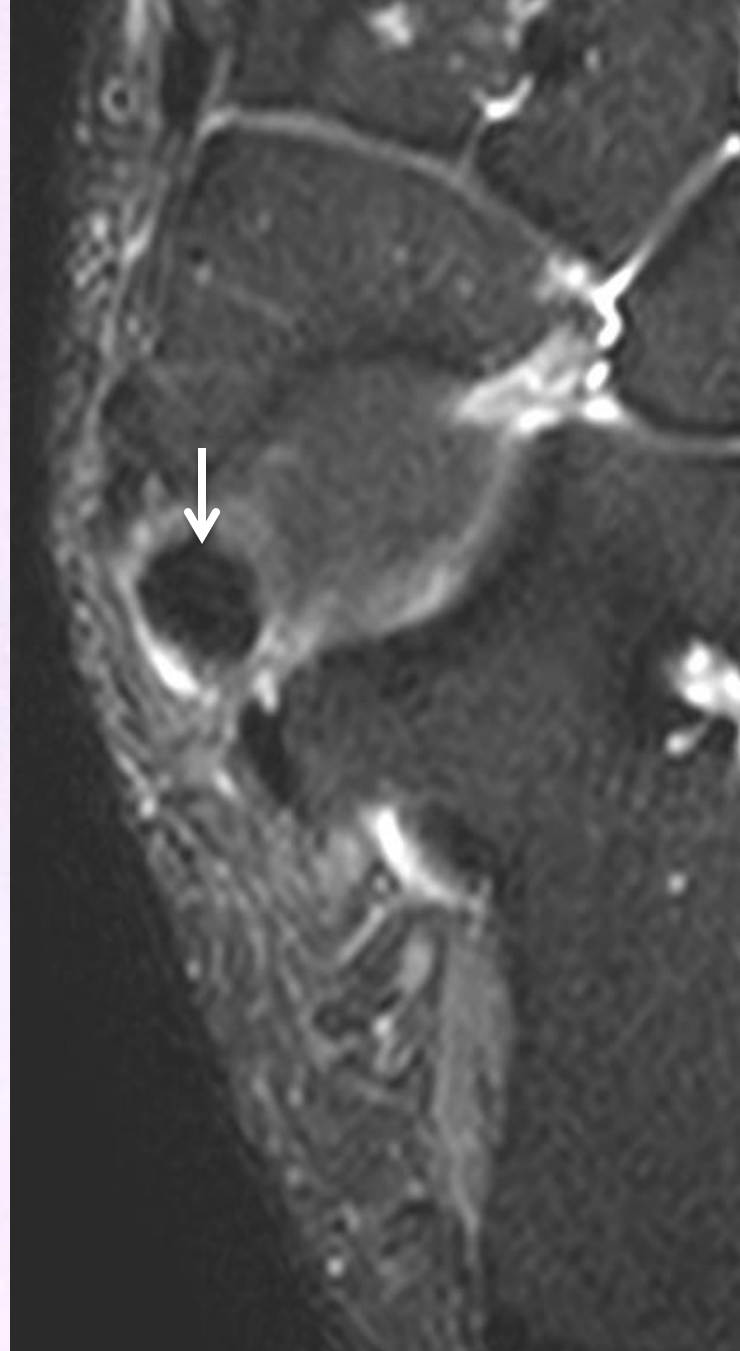
Mild tendinosis



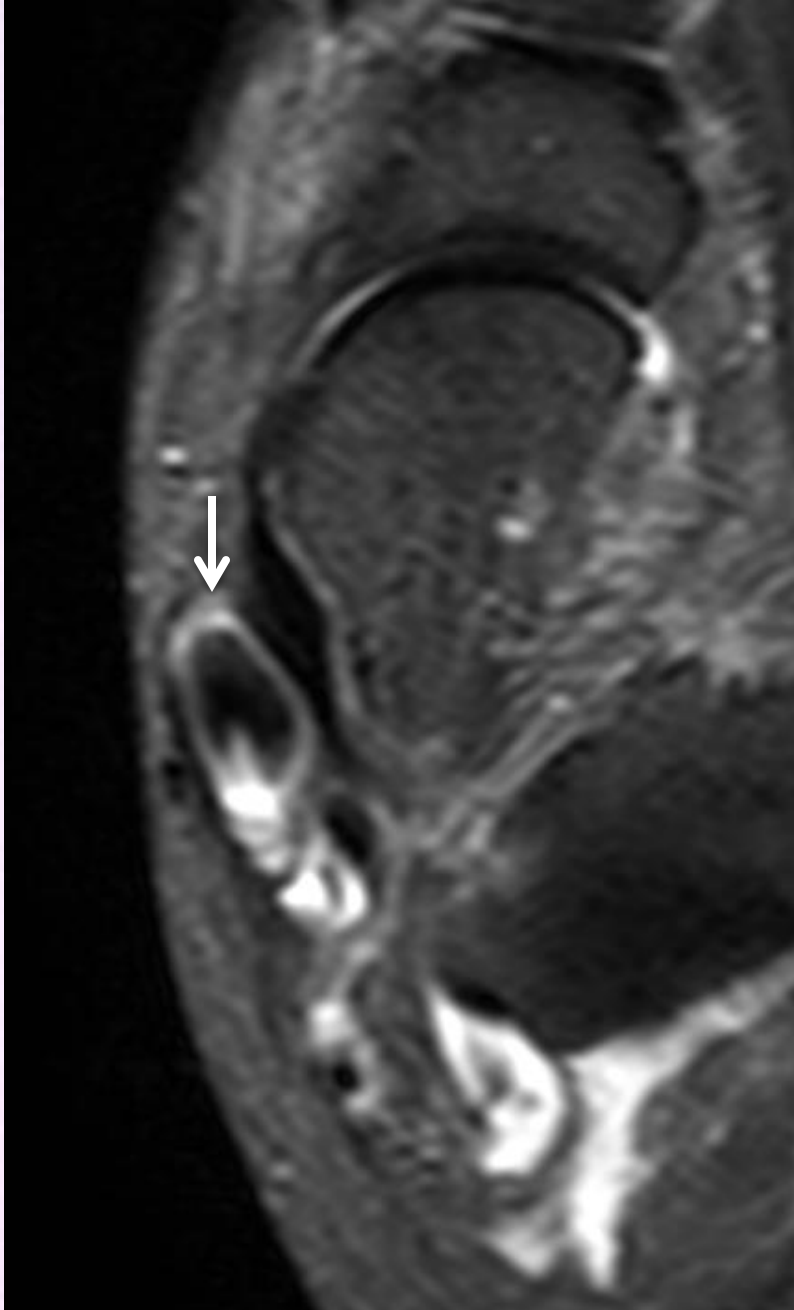
Mild tendinosis



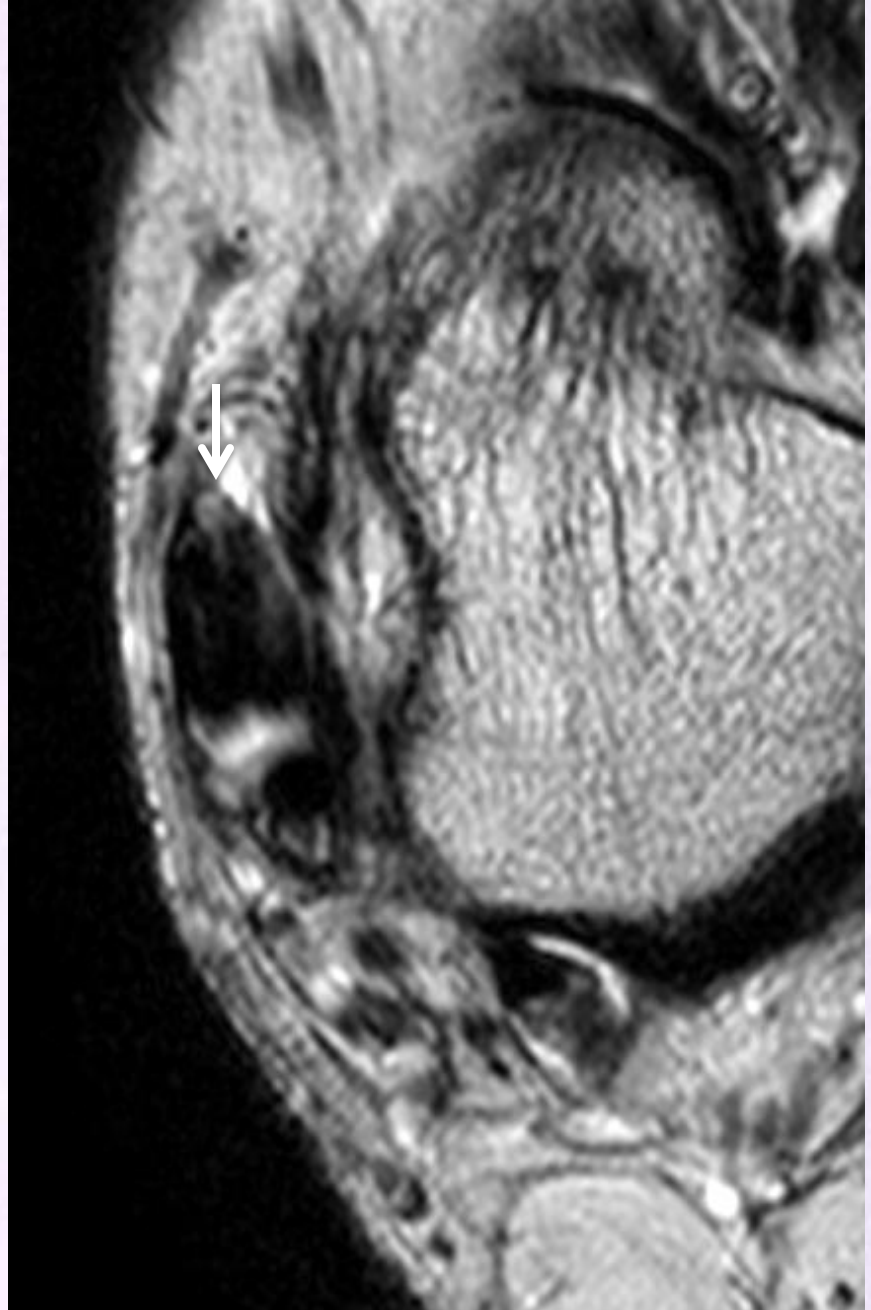
Mild to moderate tendinosis



Mild to moderate tendinosis



Moderate tendinosis



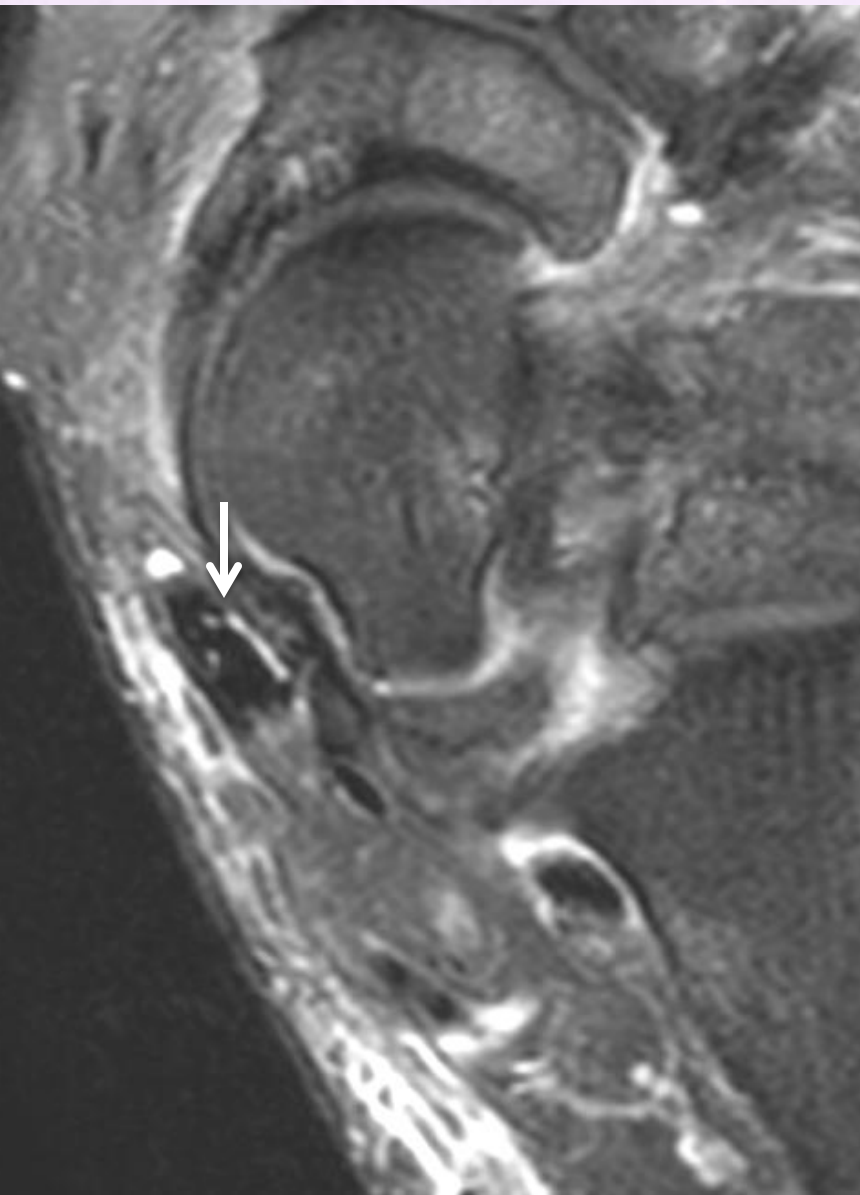
Moderate tendinosis



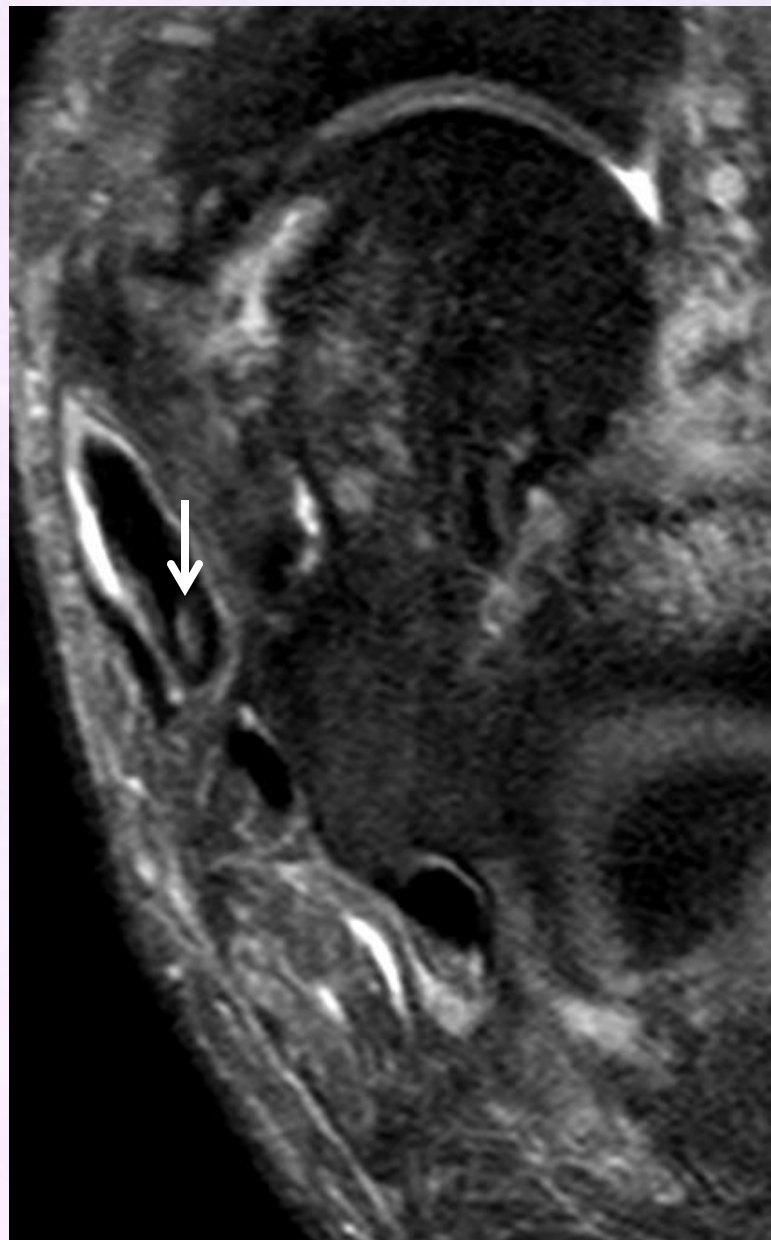
Severe tendinosis



Severe tendinosis with tears



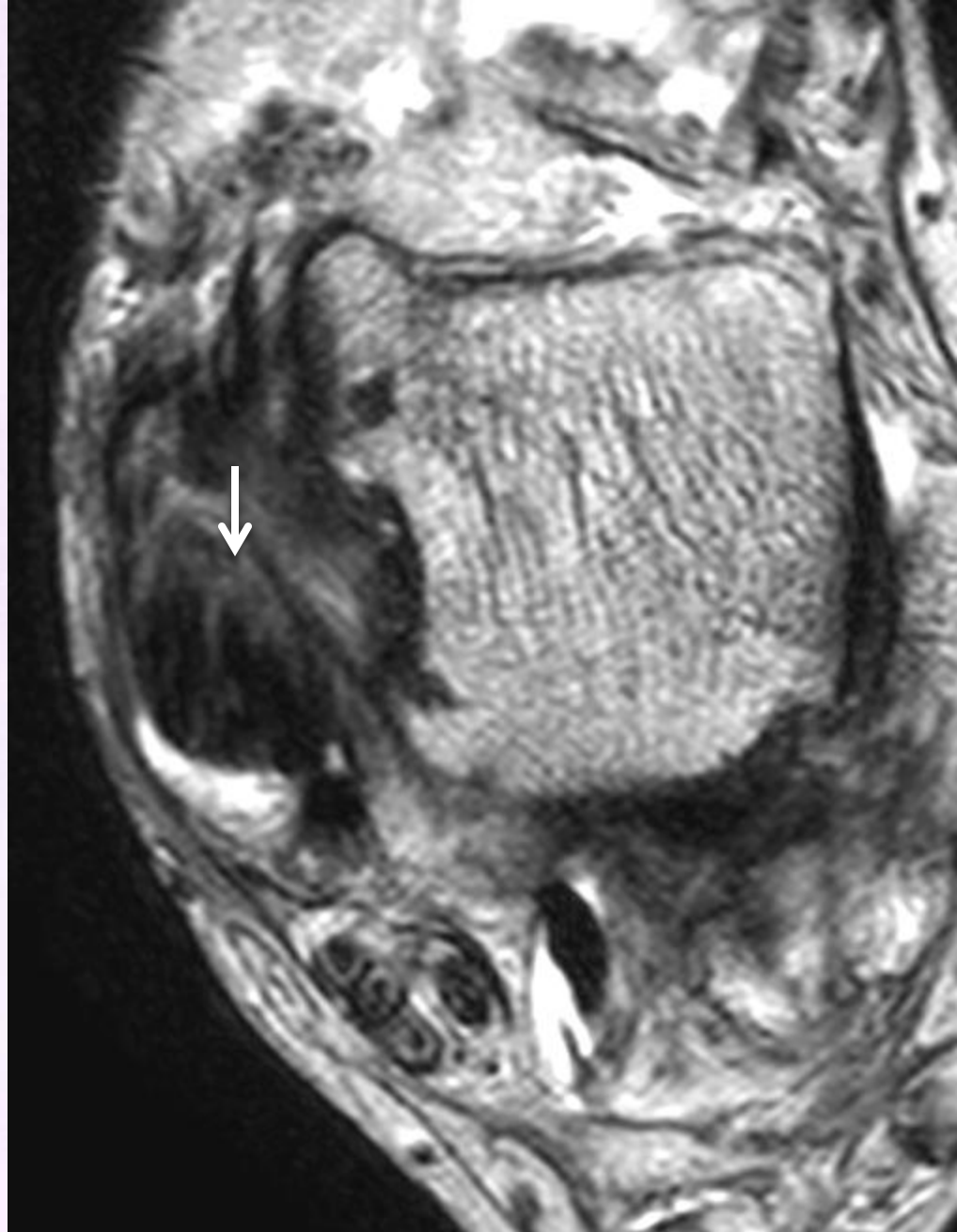
Mild tendinosis with tears



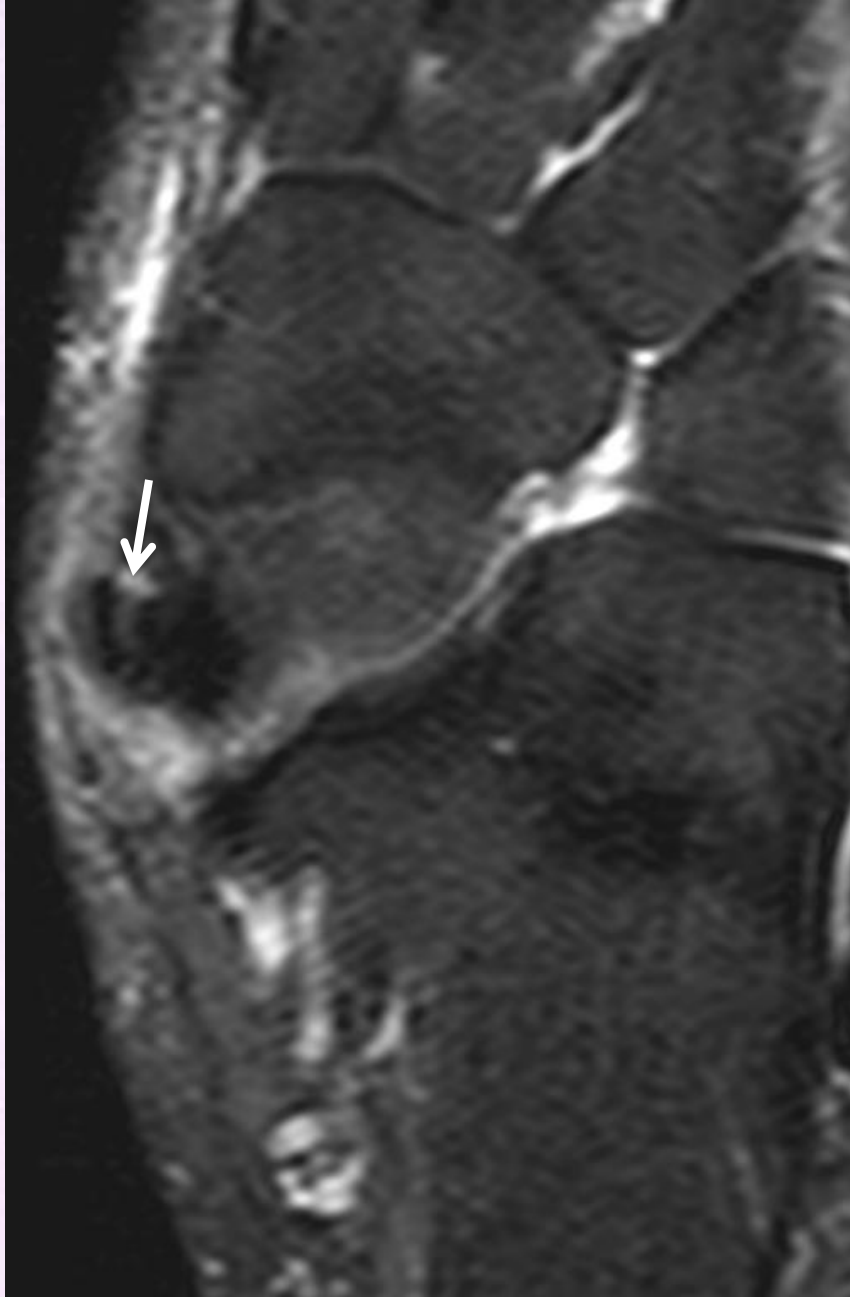
Moderate tendinosis with tears



Moderate tendinosis with tears



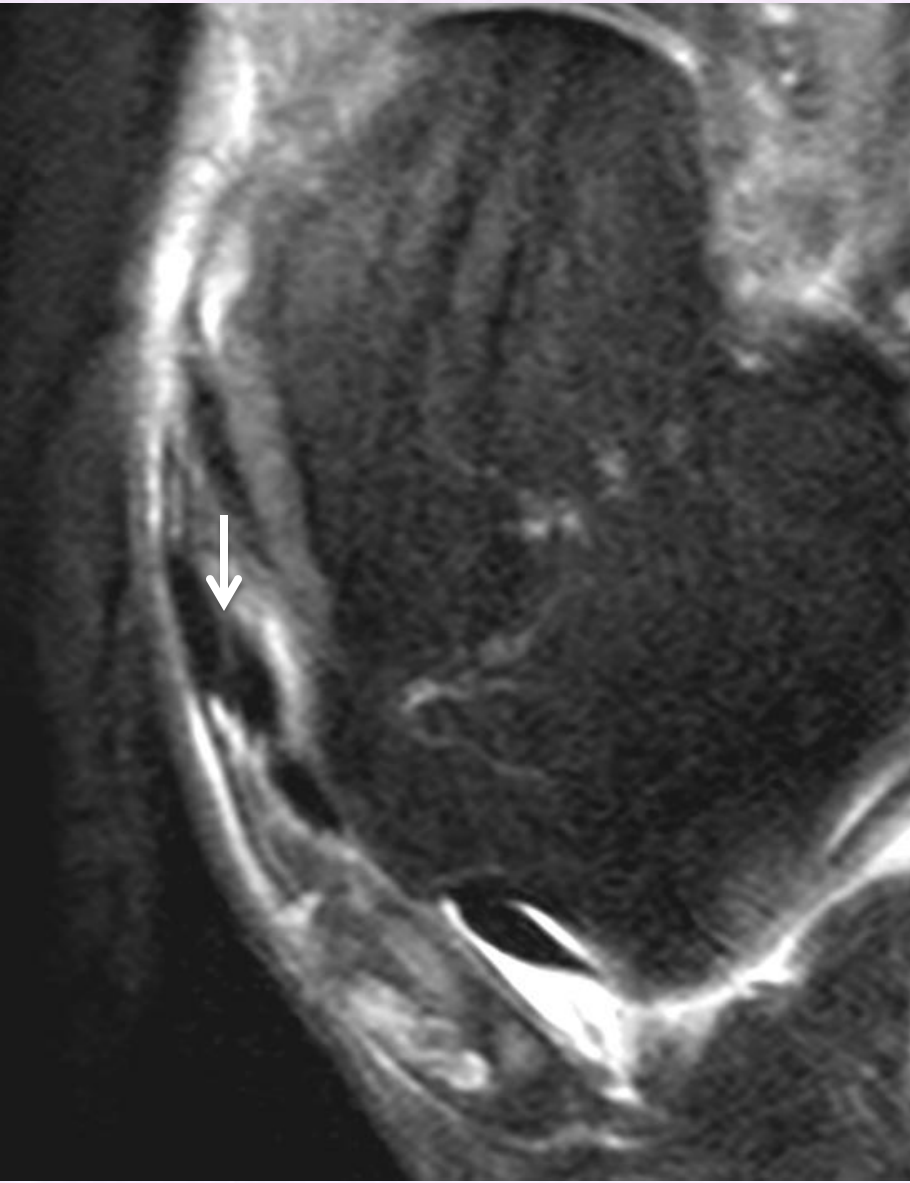
Severe tendinosis with tears



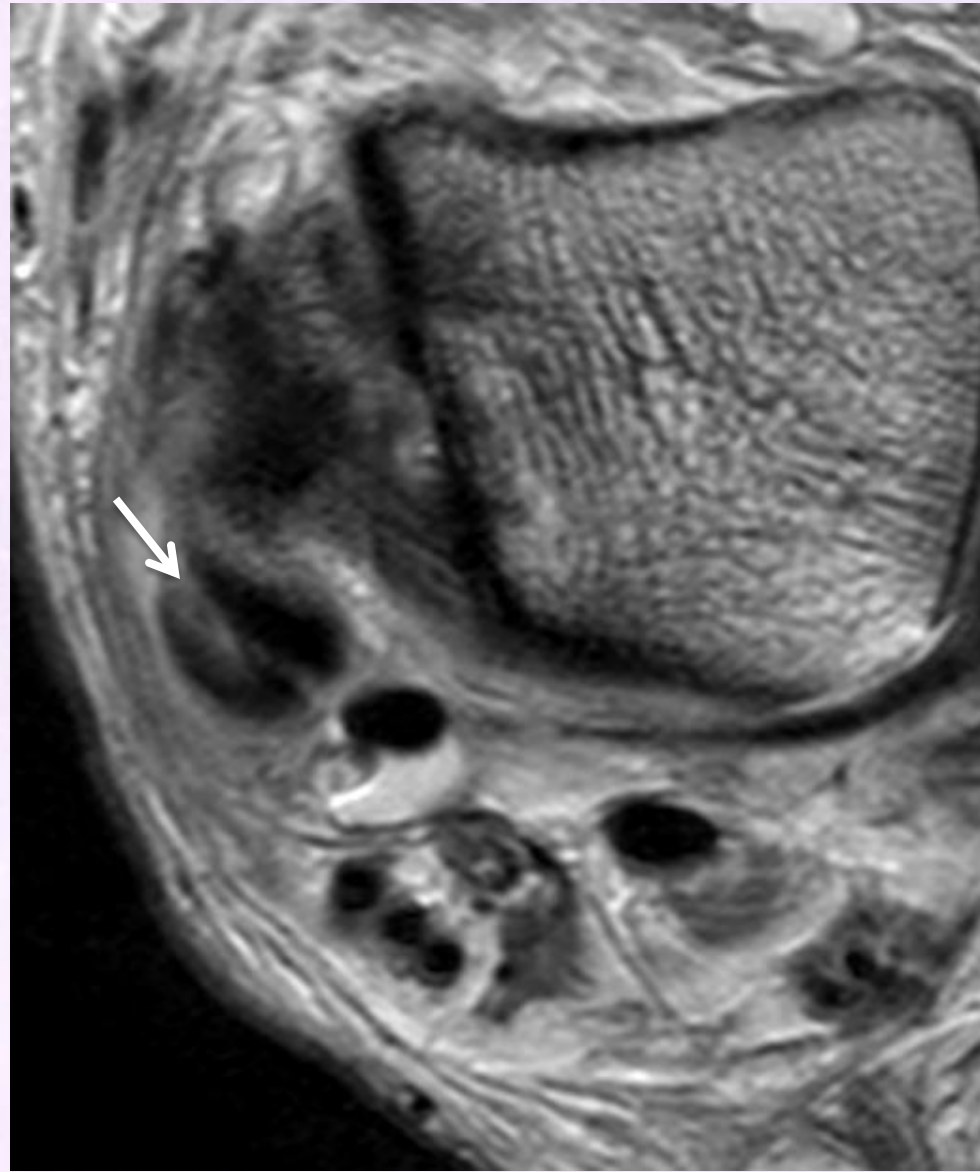
PTT partial thickness tear



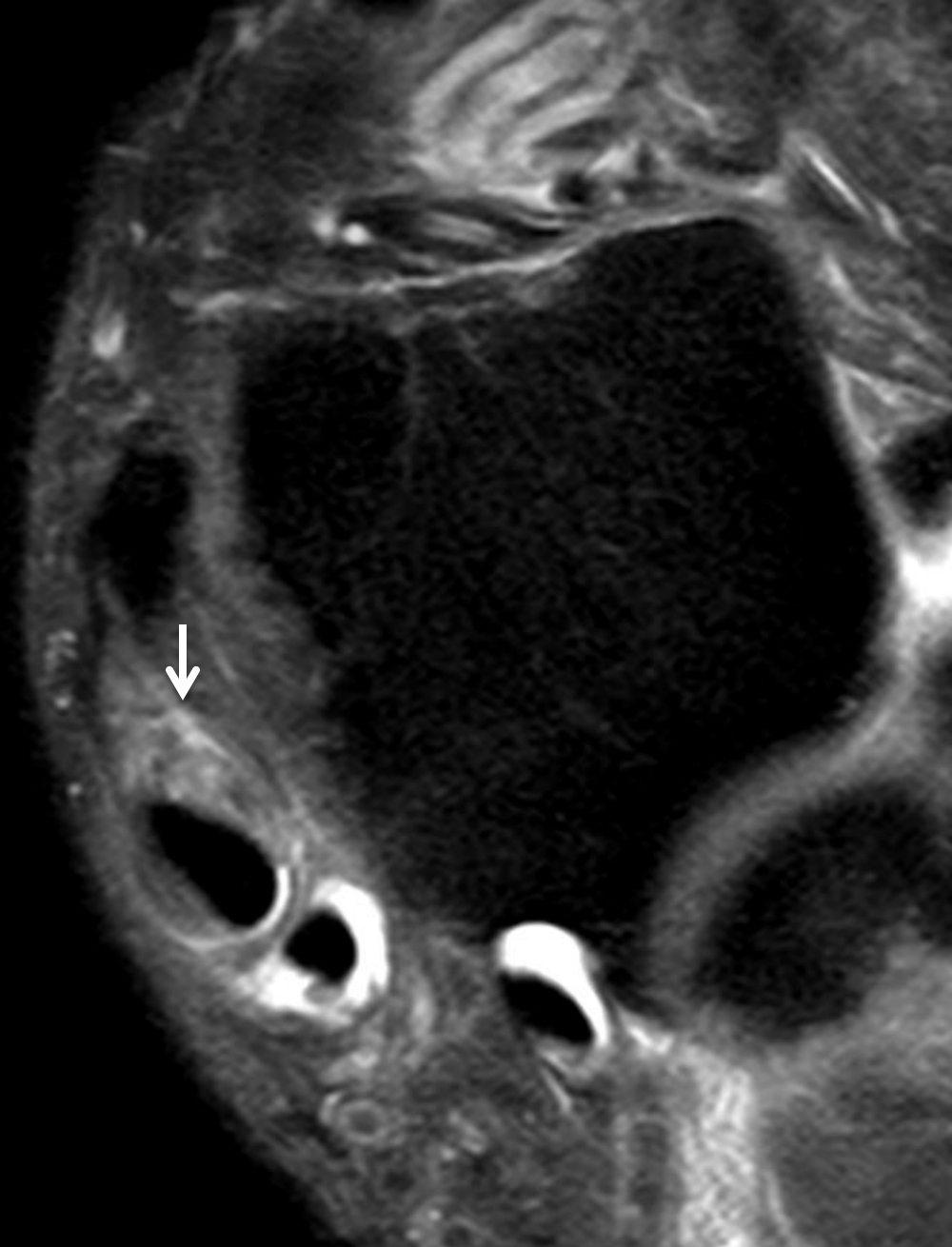
PTT full thickness tear



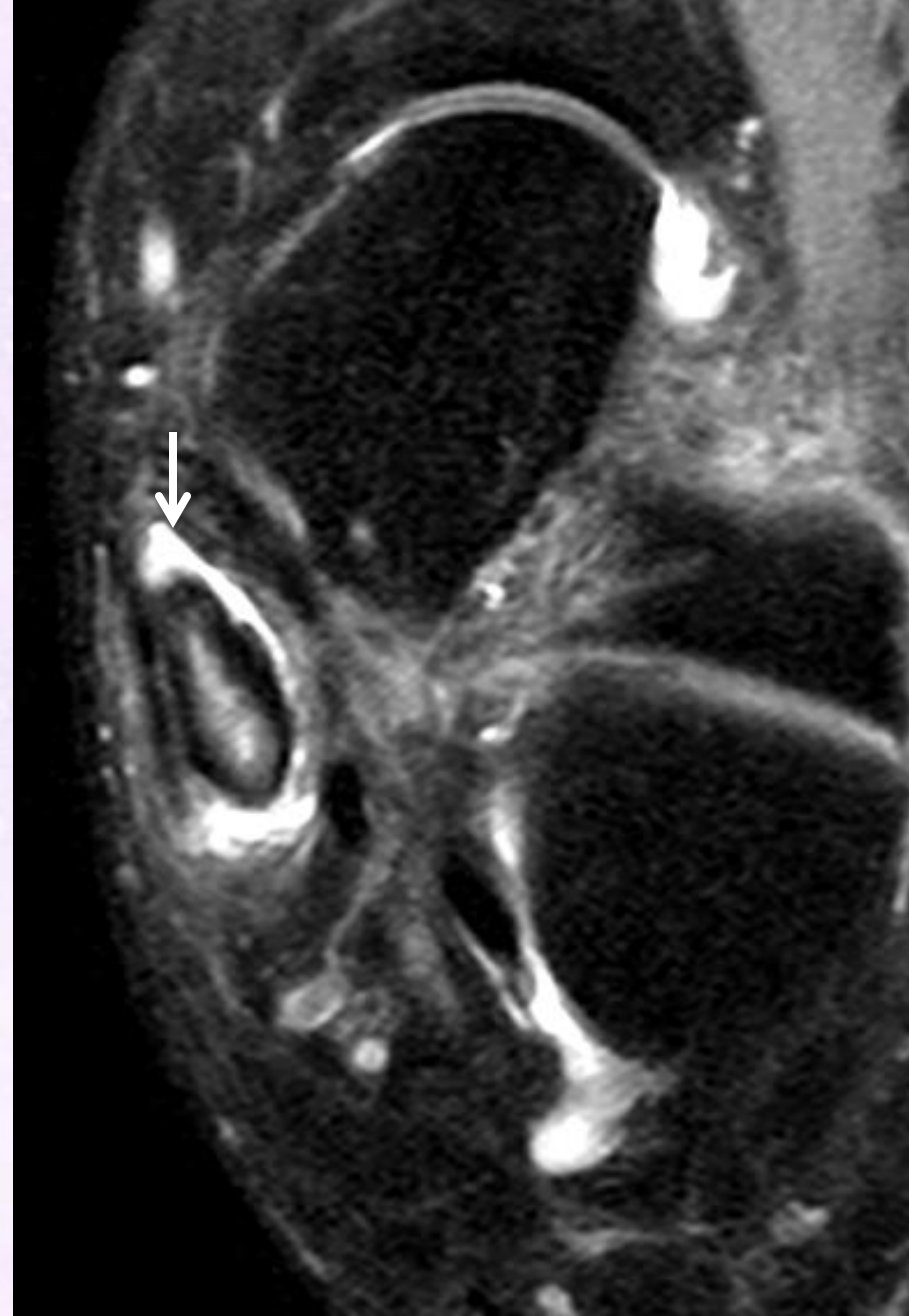
Four tendon signs



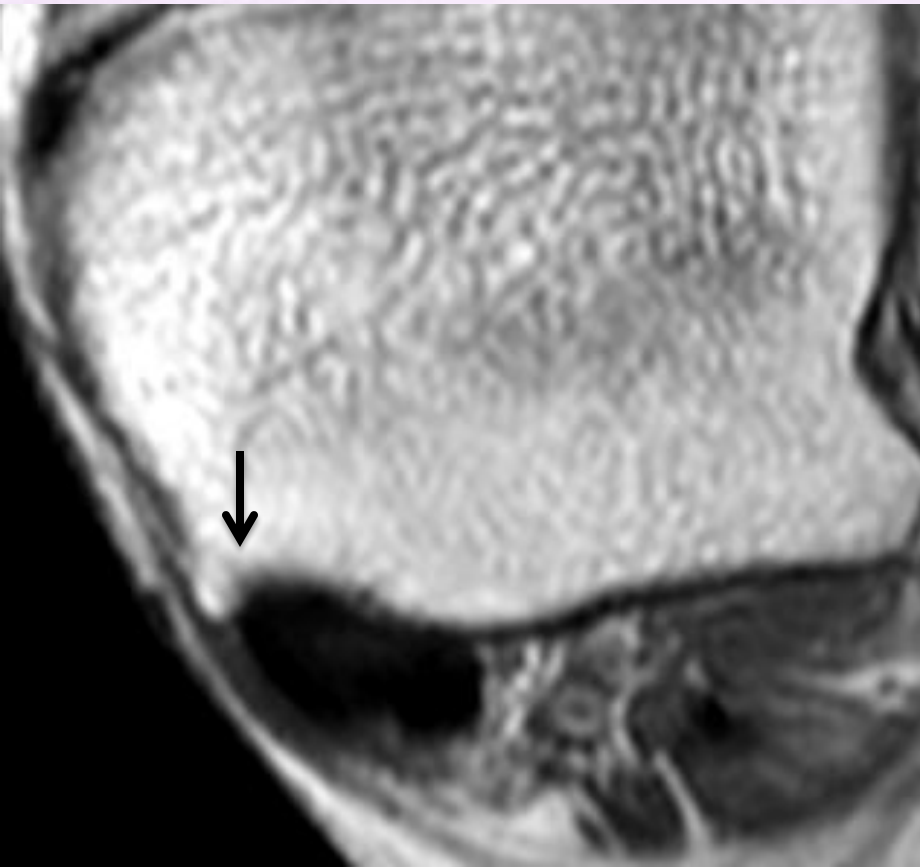
Four tendon signs



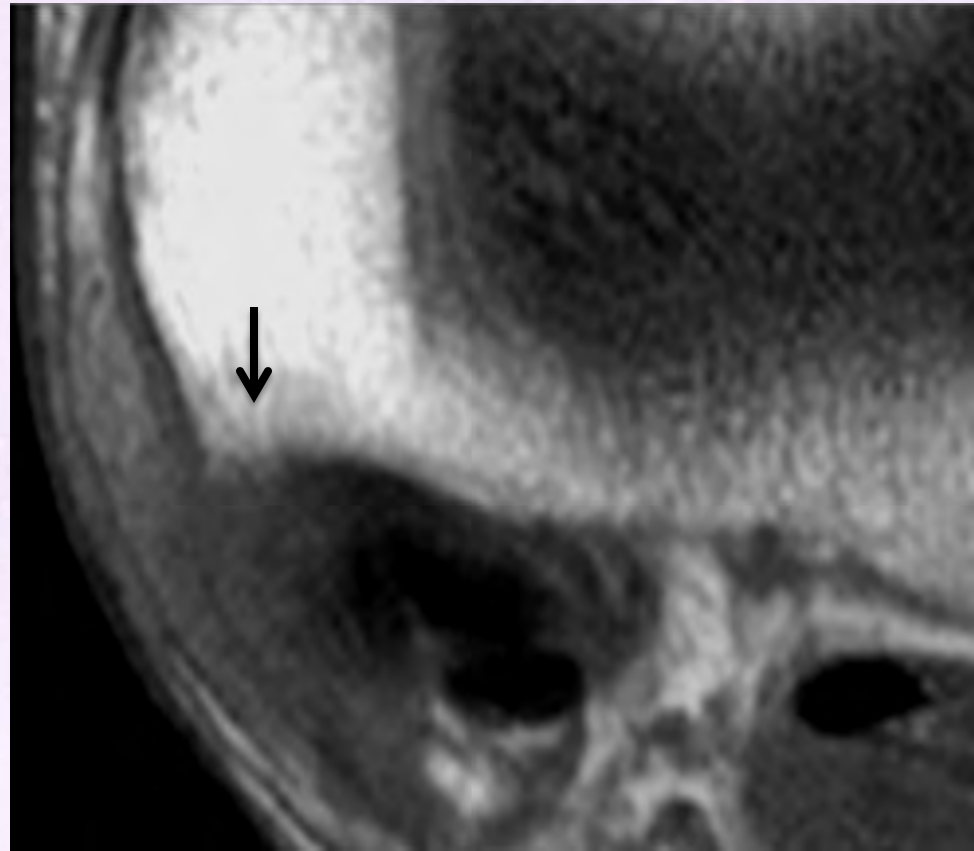
Tenosynovitis - synovitis



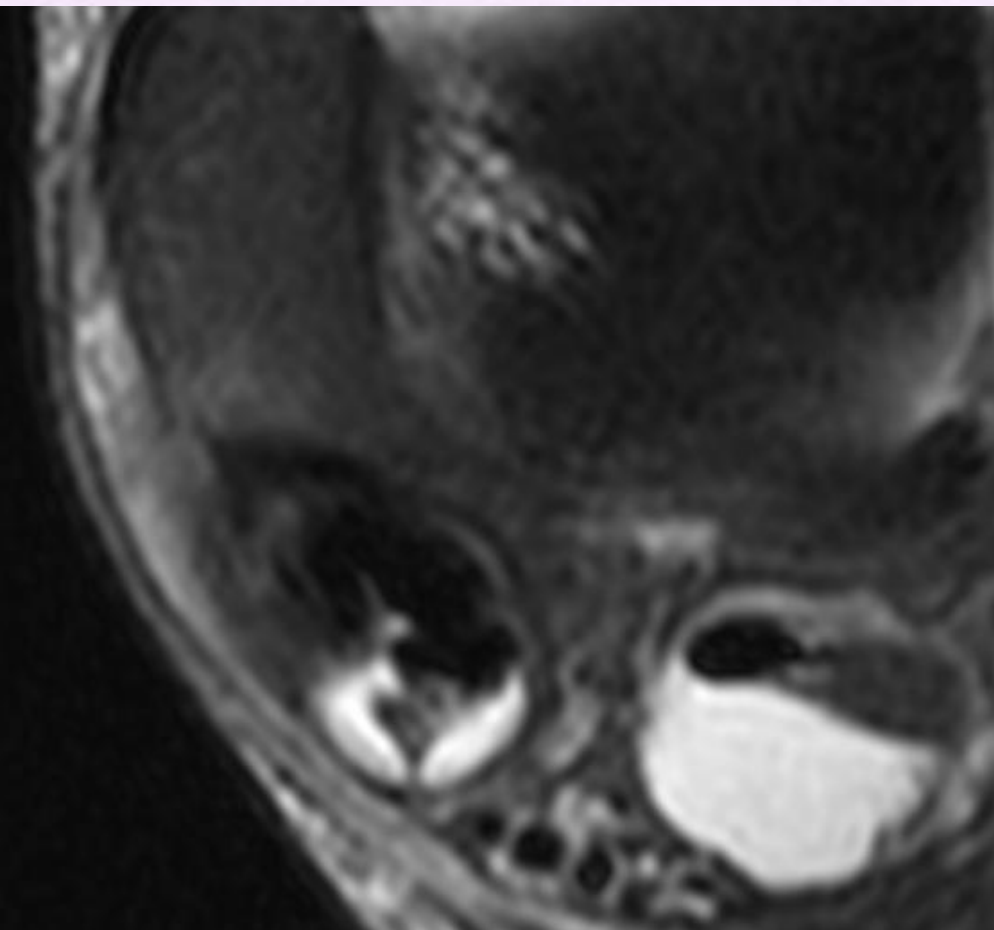
Tenosynovitis – tendon sheath effusion



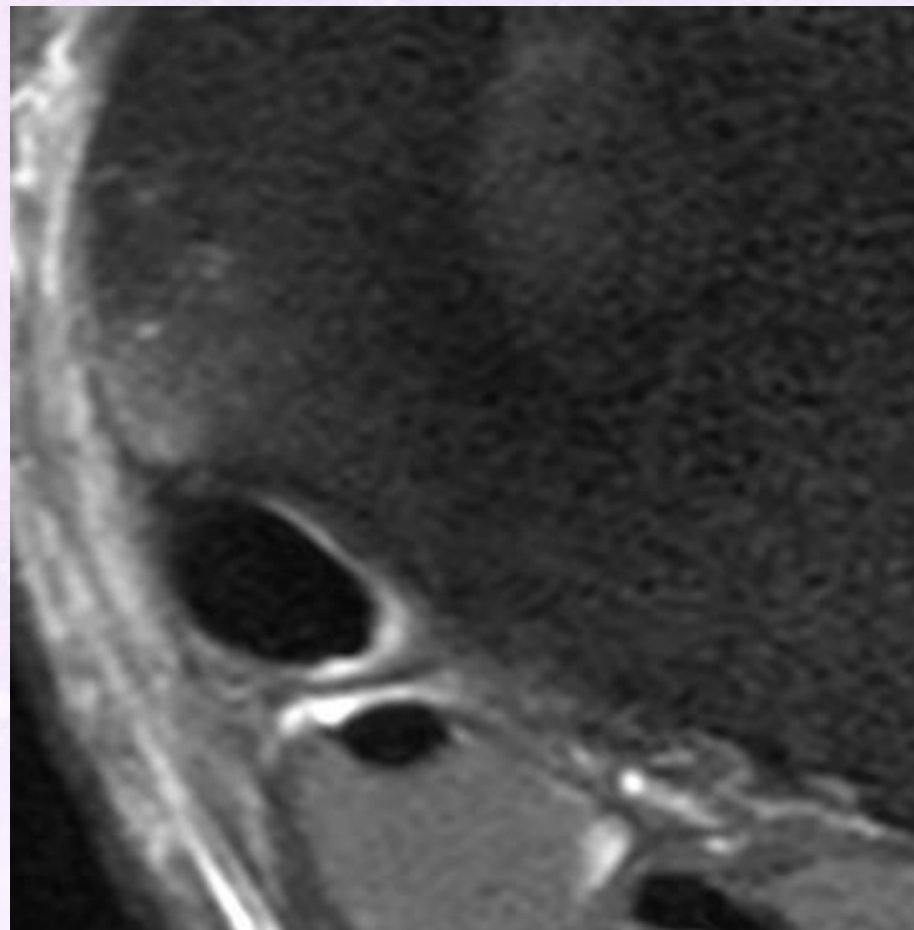
Bony spur medial malleolus



Bony spur medial malleolus



Bony edema medial malleolus



Bony edema medial malleolus

Accessory navicular

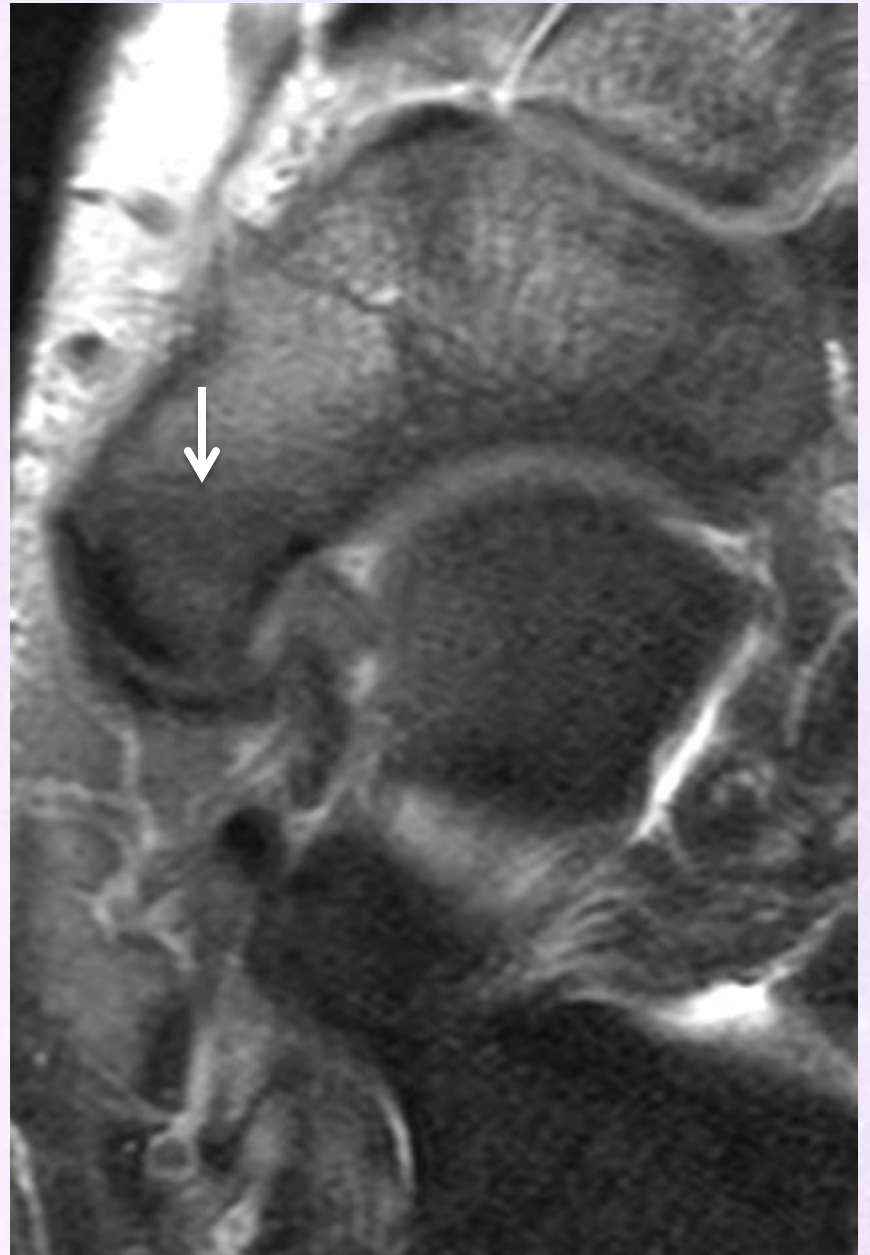




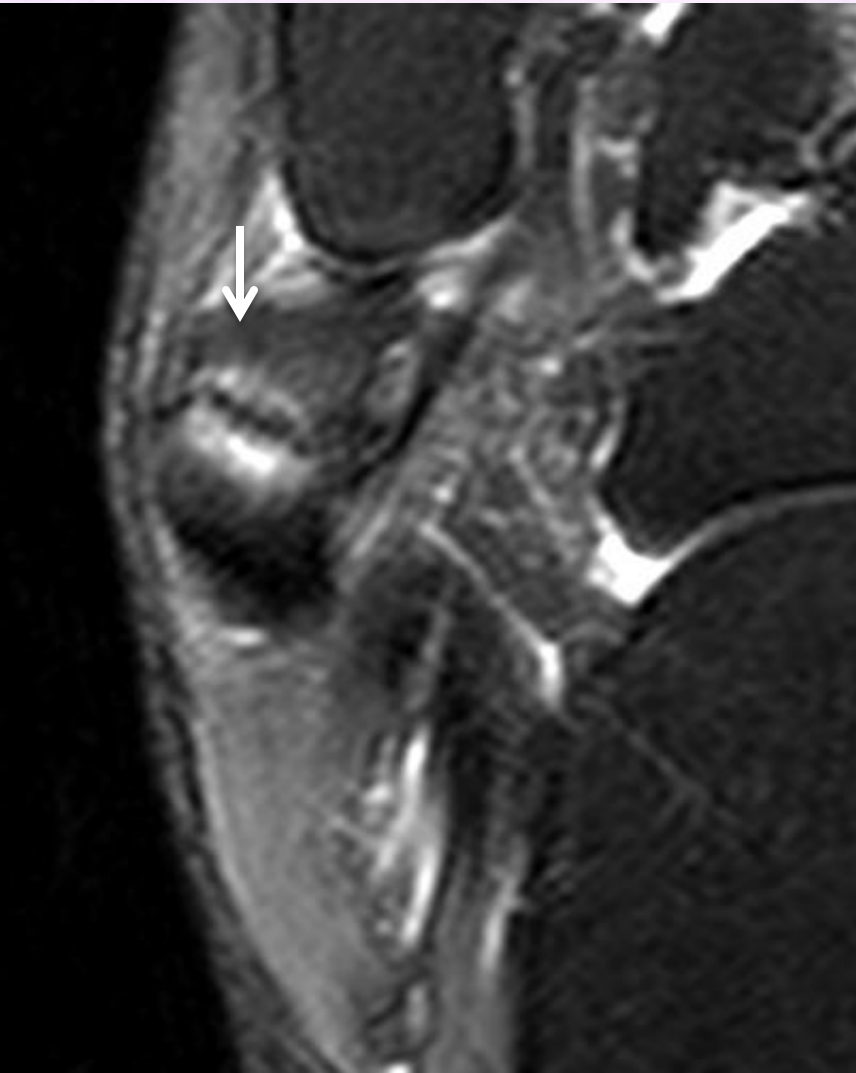
Type 1 accessory navicular bone



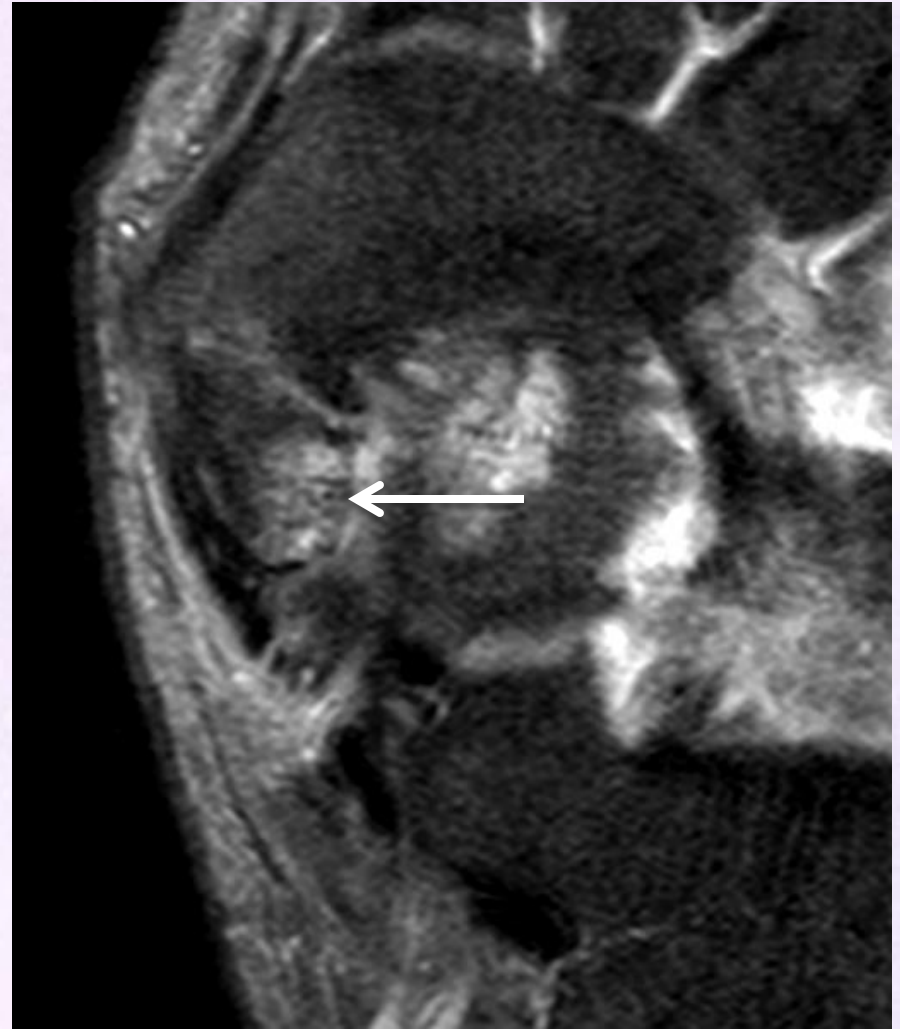
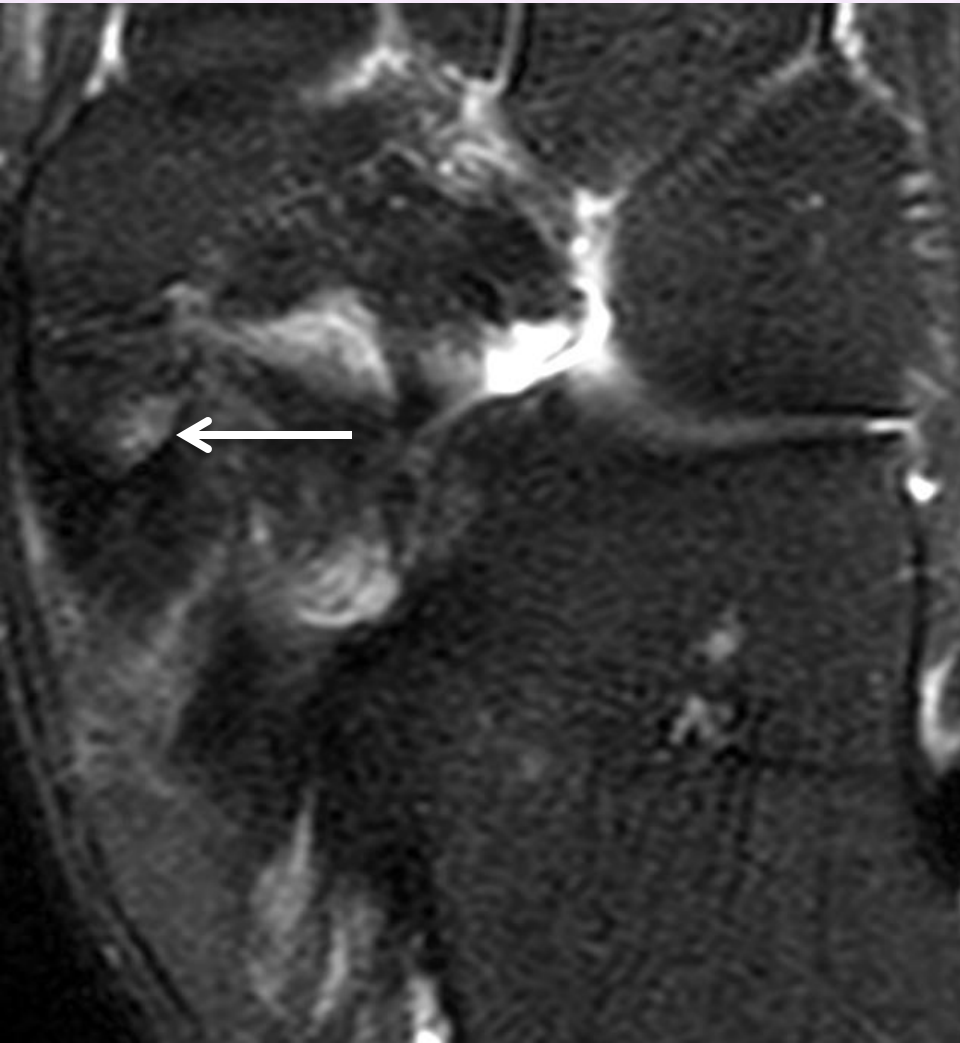
**Type 2 accessory navicular bone
with fibrous connection**



Type 3 accessory navicular bone = cornuate navicular bone



Type 2 accessory navicular bone with fibrous connection and edema



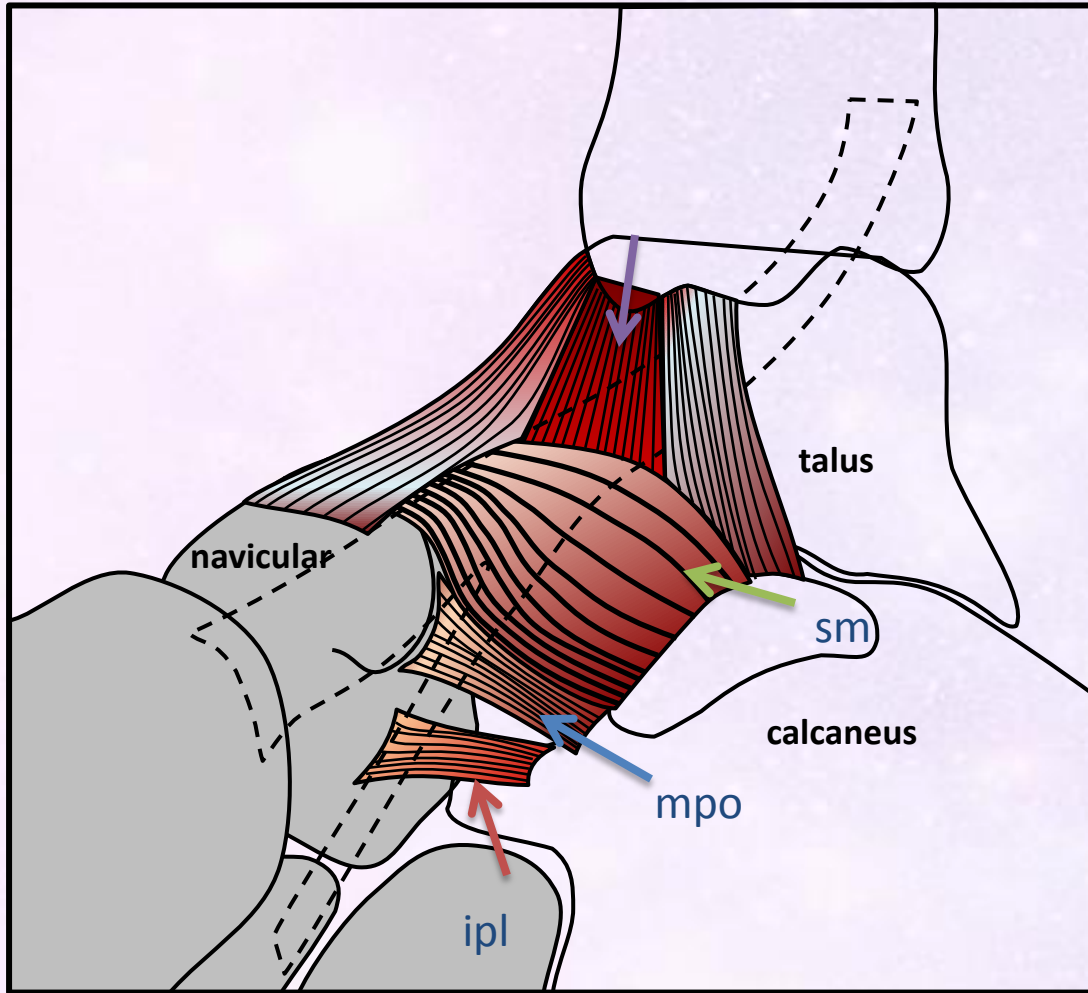
Type 2 accessory navicular bone with edema at PTT insertion

B. Spring ligament complex

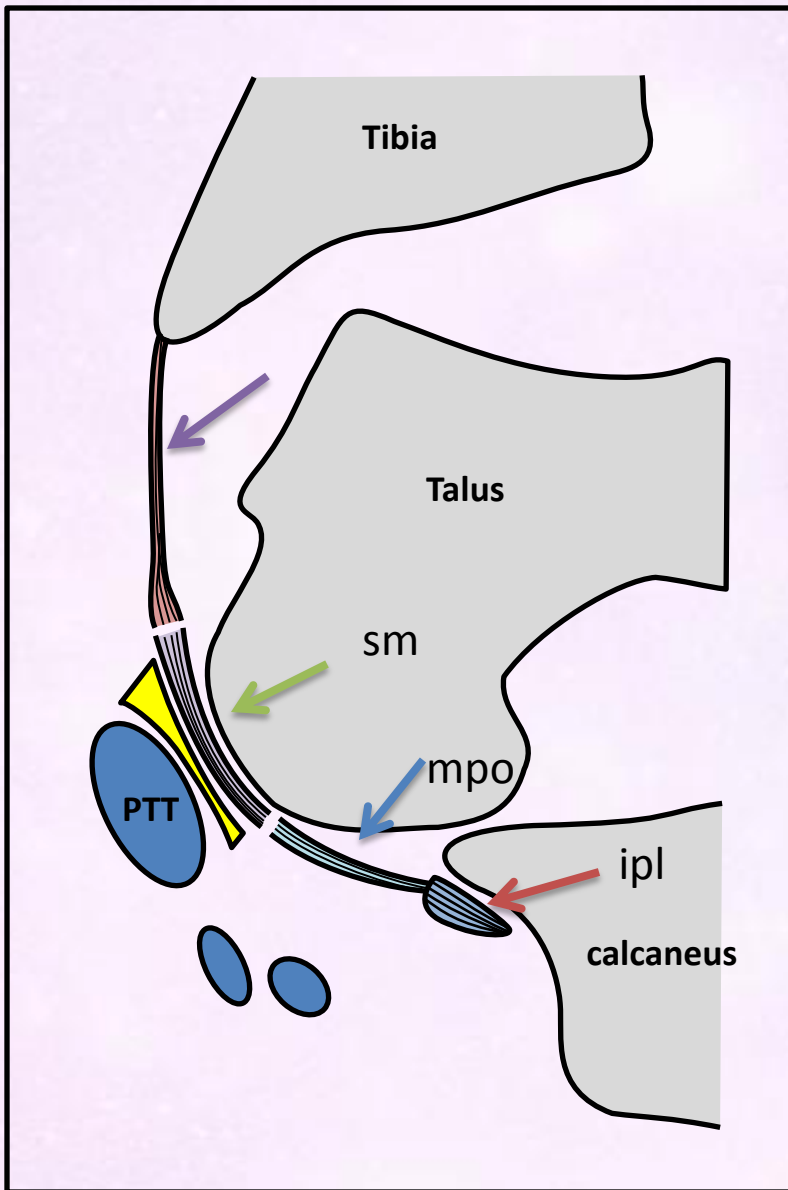
- Also called calcaneonavicular ligament (CNL)
- Superomedial CNL (**sm CNL**)
- Inferoplantar longitudinal CNL (**ipl CNL**)
- Mediolplantar oblique CNL (**mpo CNL**)

(past : superomedial and inferomedial CNLs)

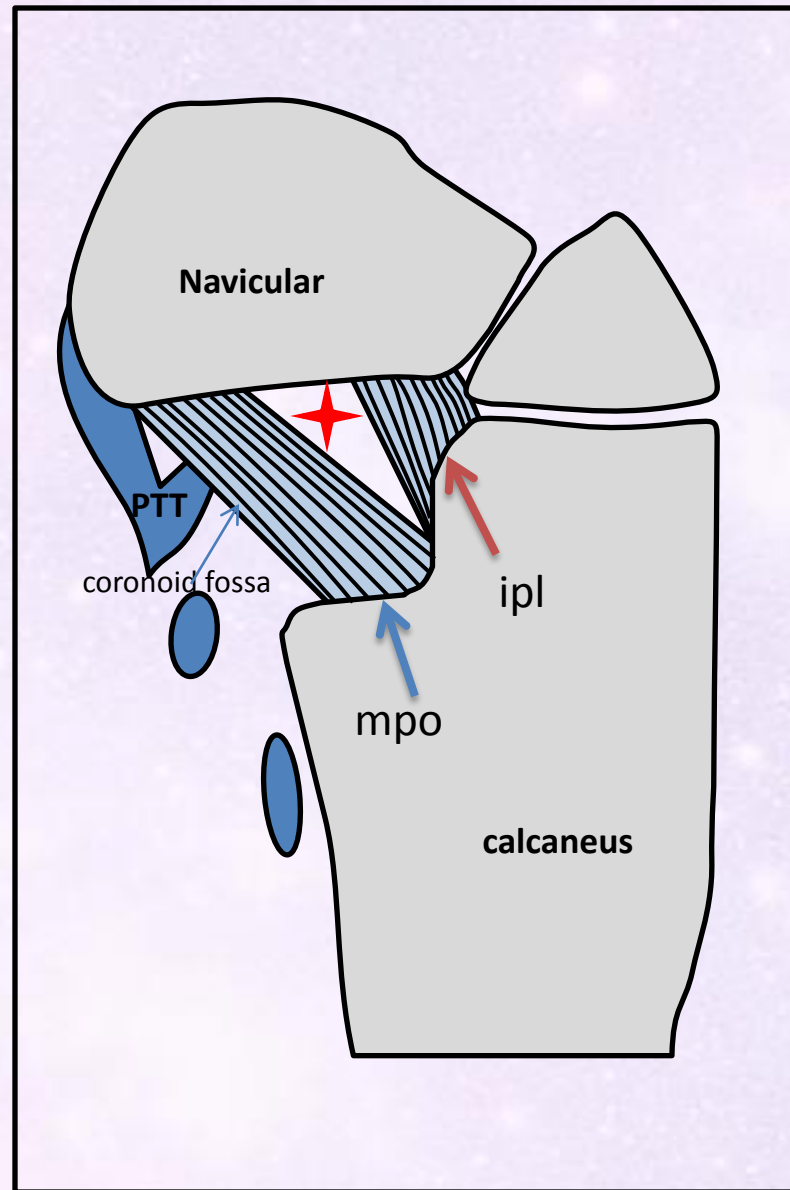
- Superomedial ligament mostly important and involved in flat foot



Coronal

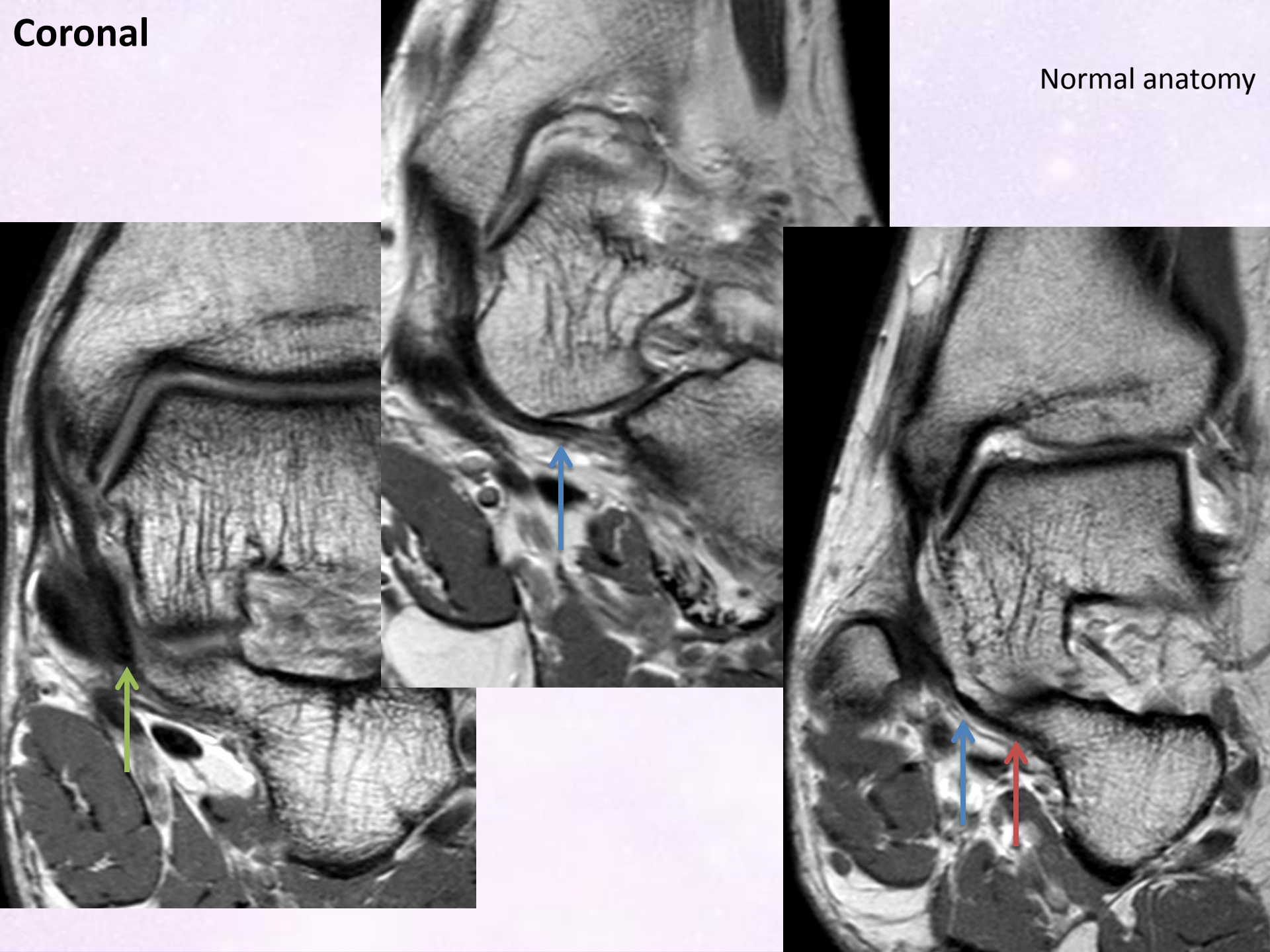


Axial



Coronal

Normal anatomy



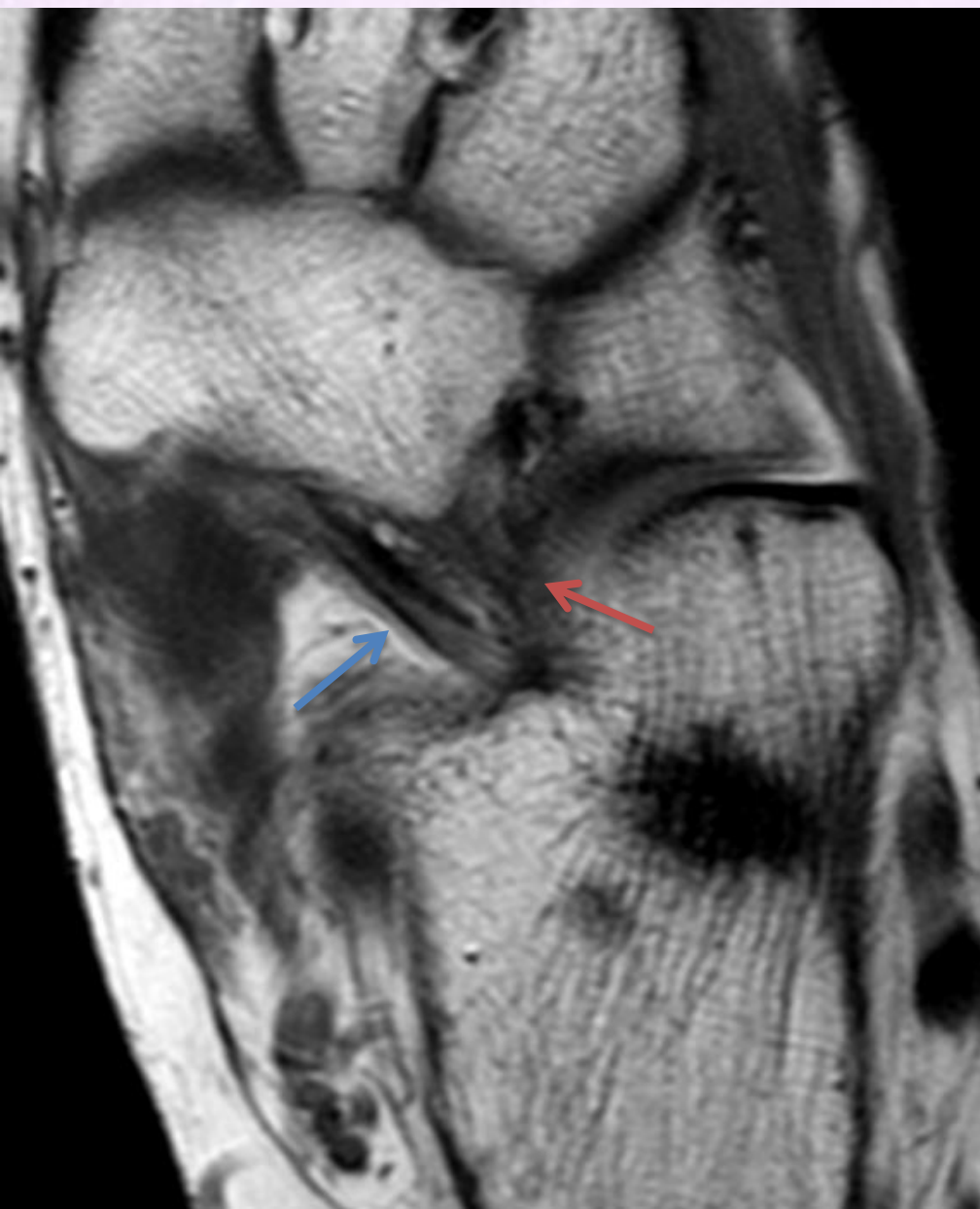
Coronal



Normal anatomy

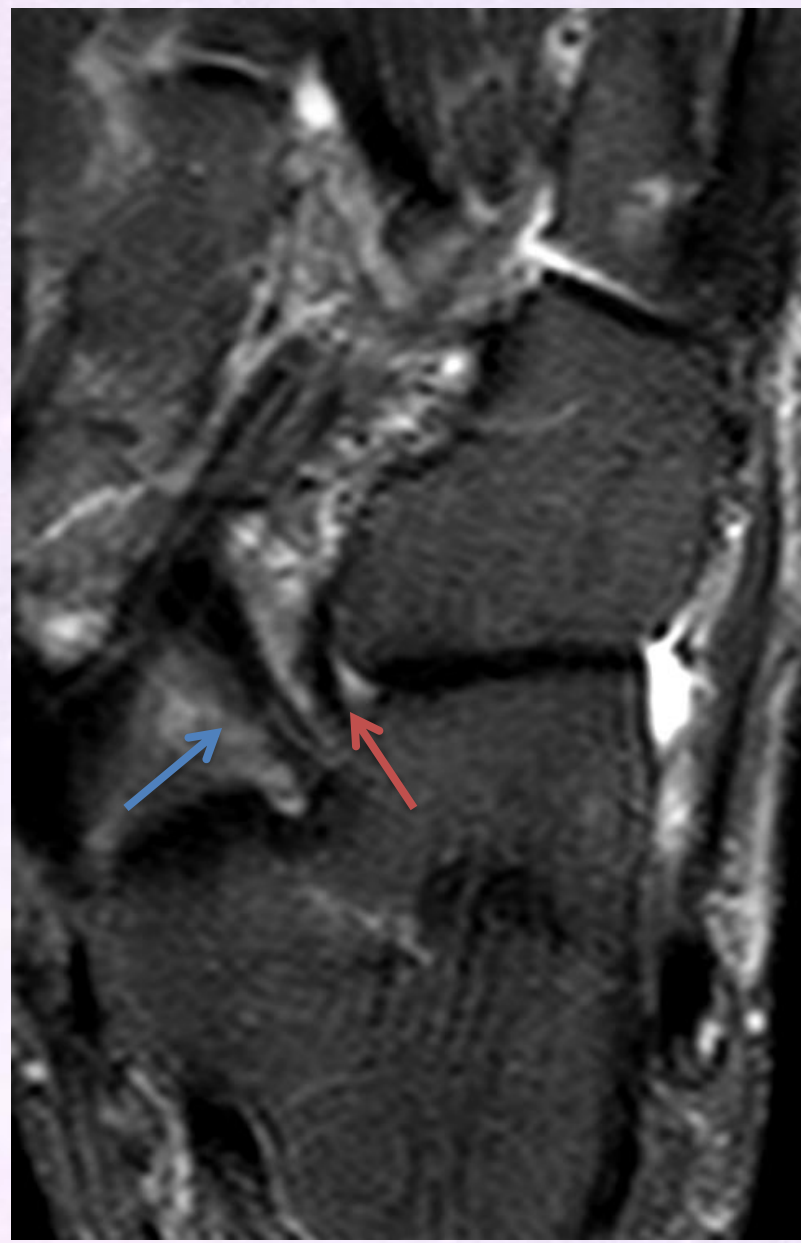


Axial

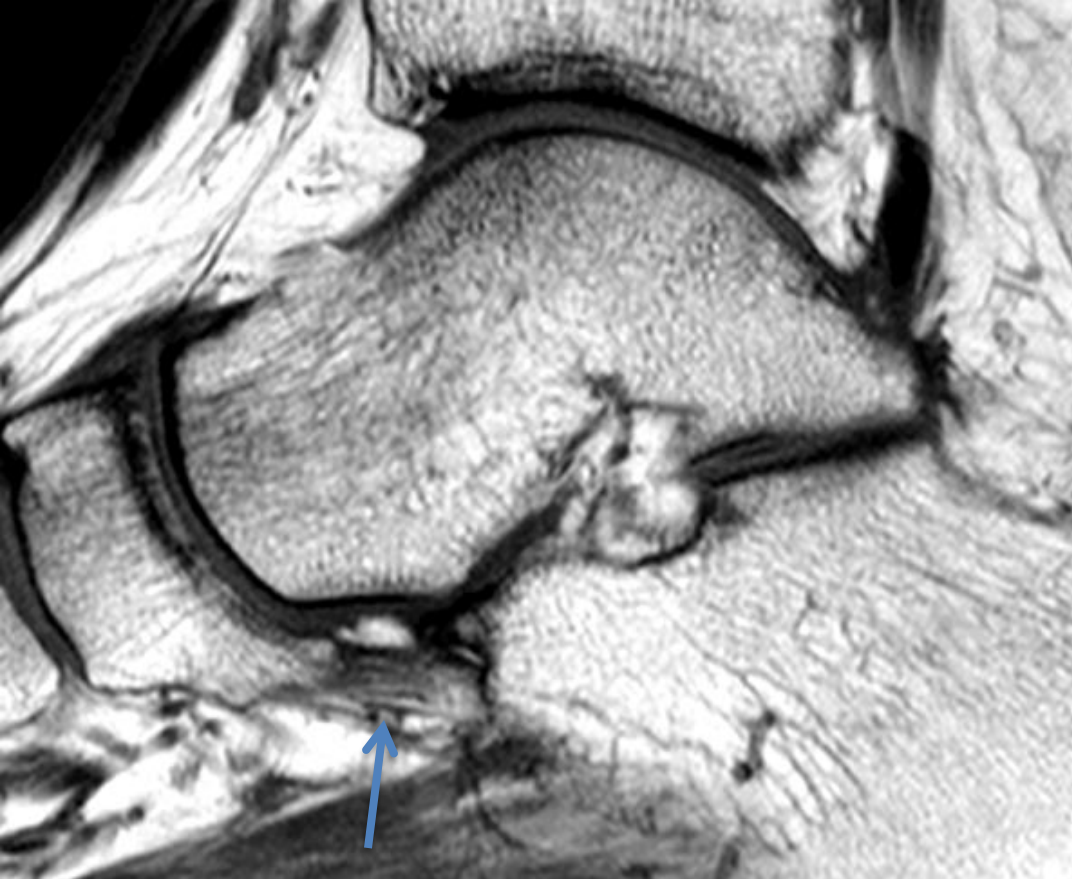


Coronoid fossa

Normal anatomy

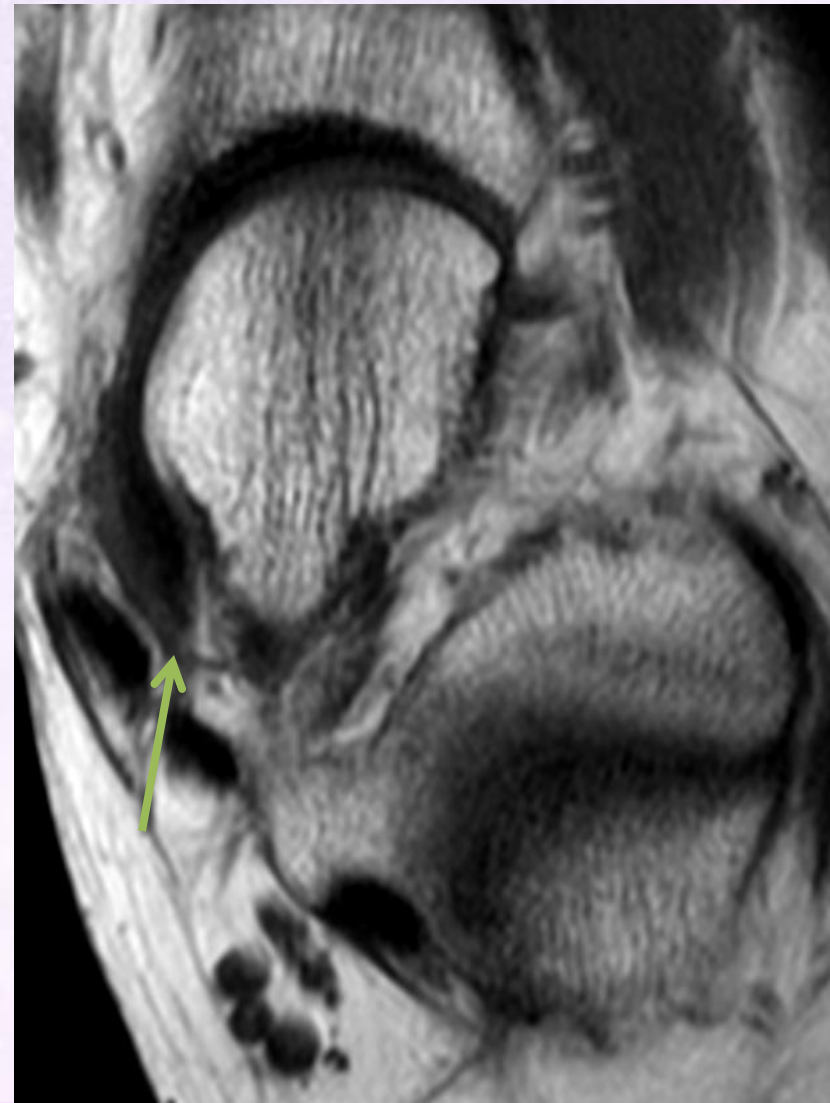


Normal anatomy



Sagittal

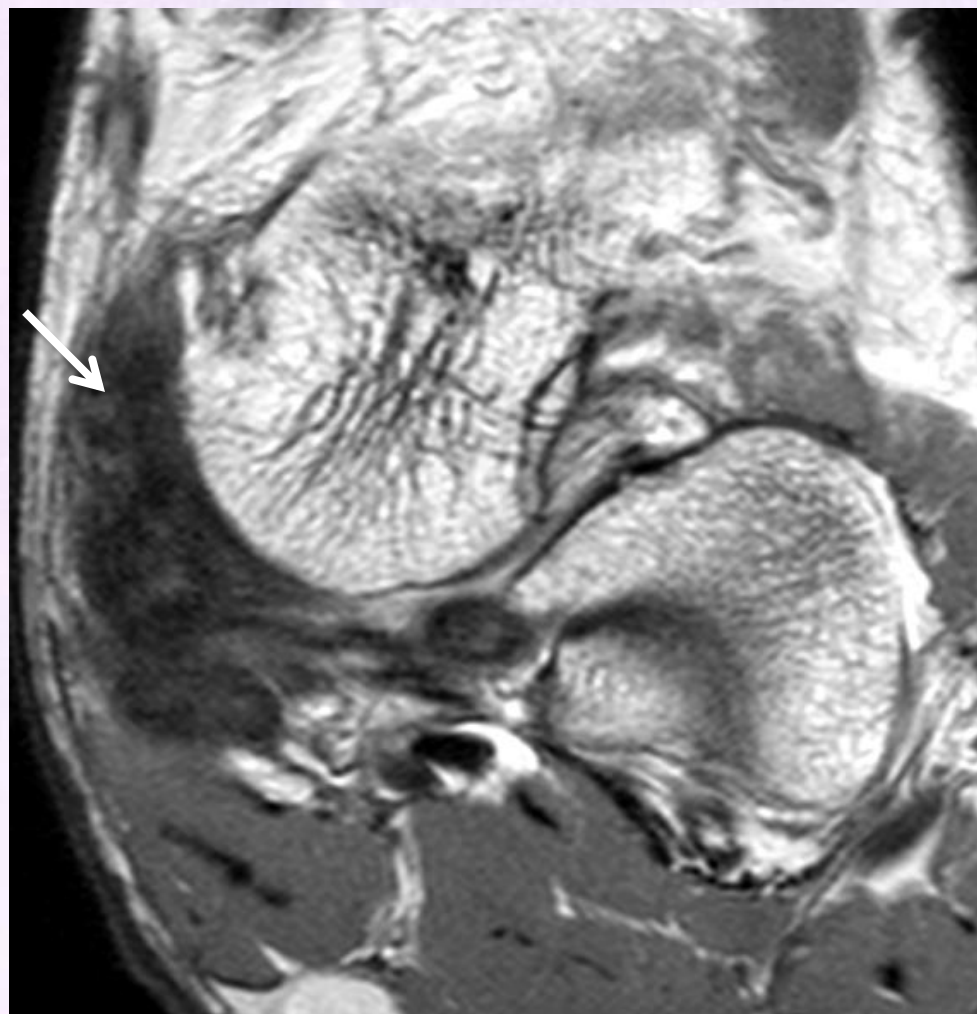
Axial



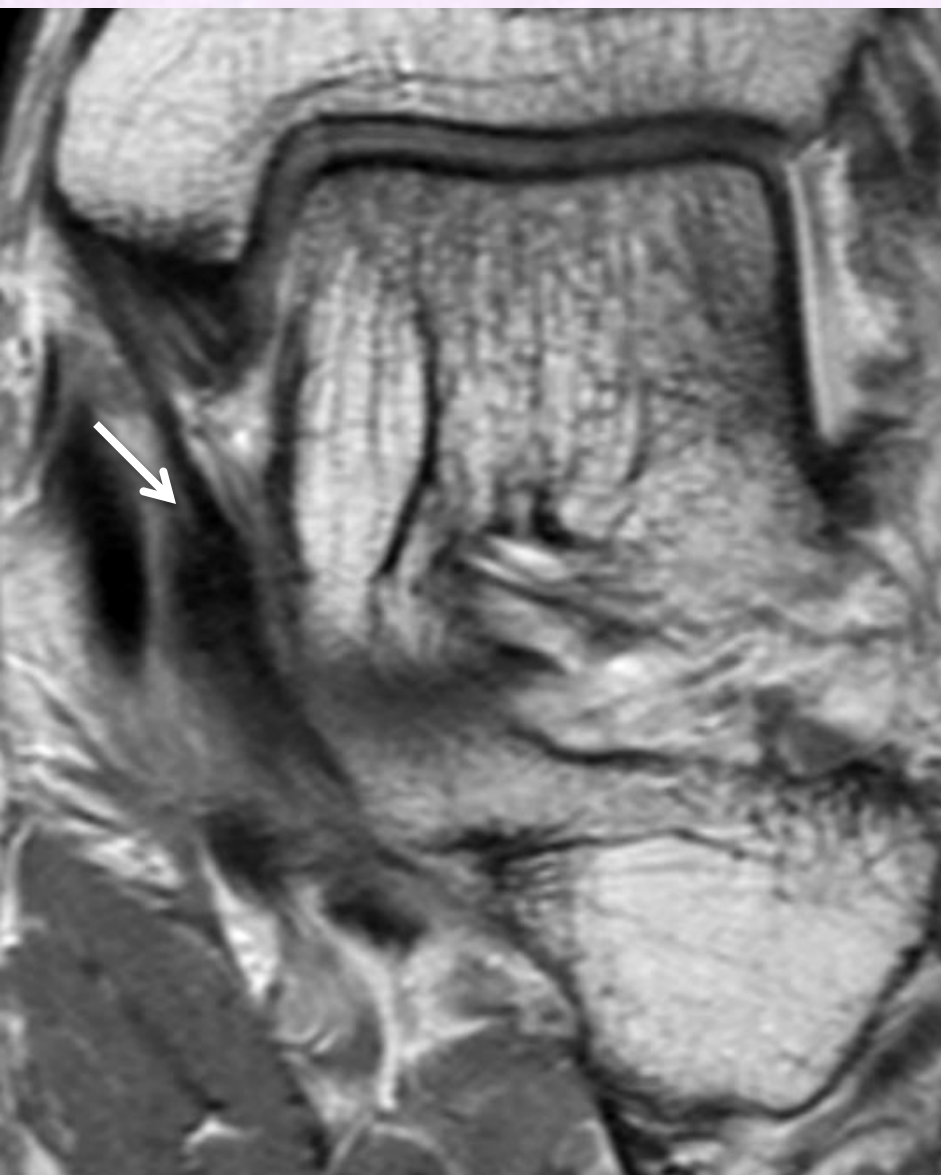




Mild thickening



Moderate thickening



Moderate to severe thickening



Severe thickening

Axial



Moderate thickening



Severe thickening



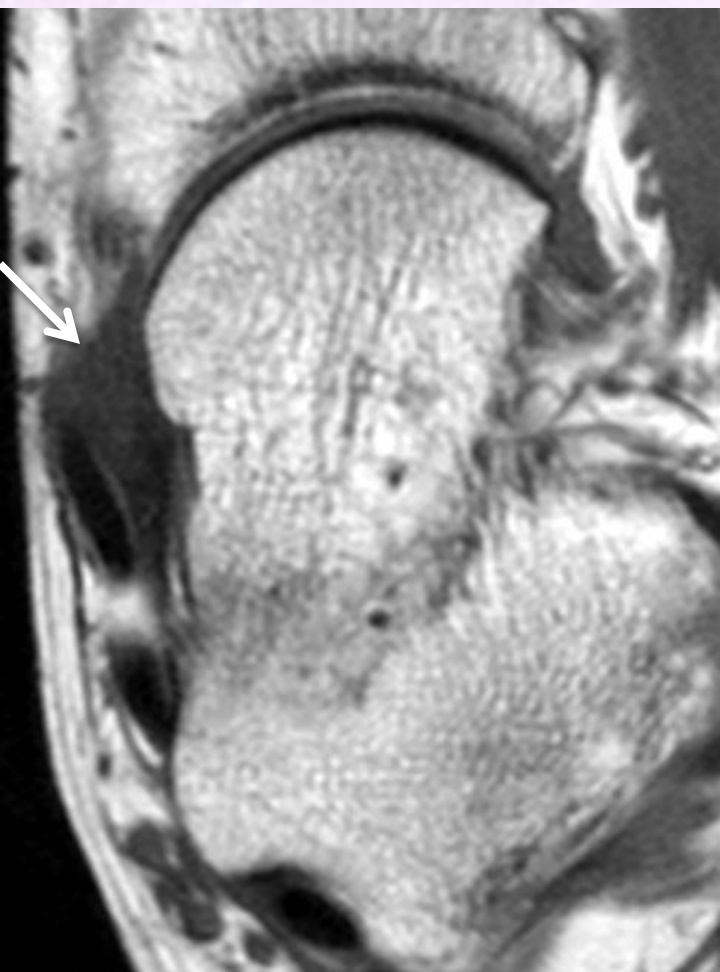
Attenuation of fibers (partial tear) : superomedial CNL



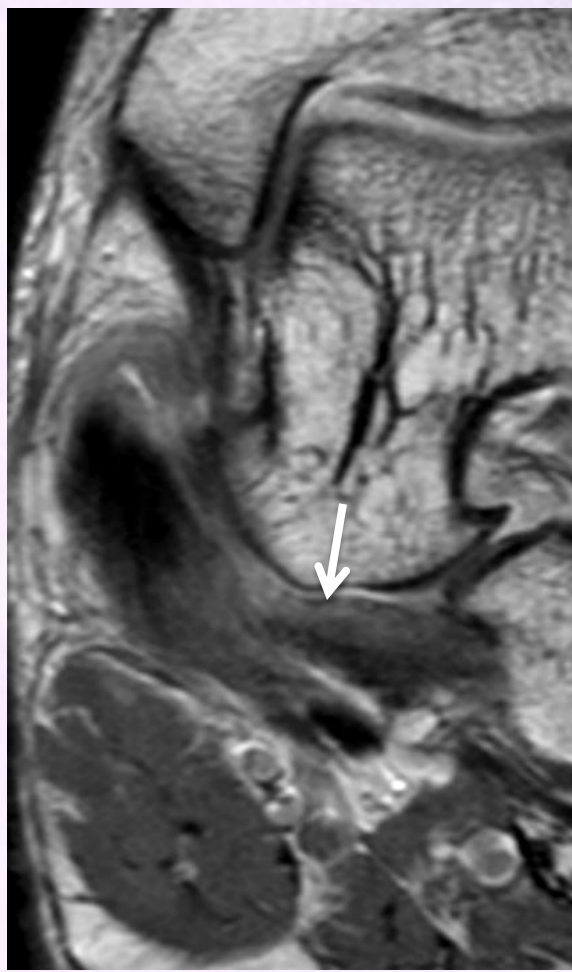
**Attenuation of fibers :
superomedial CNL**



**Attenuation of fibers : medioplantar
oblique and inferoplantar
longitudinal CNL**



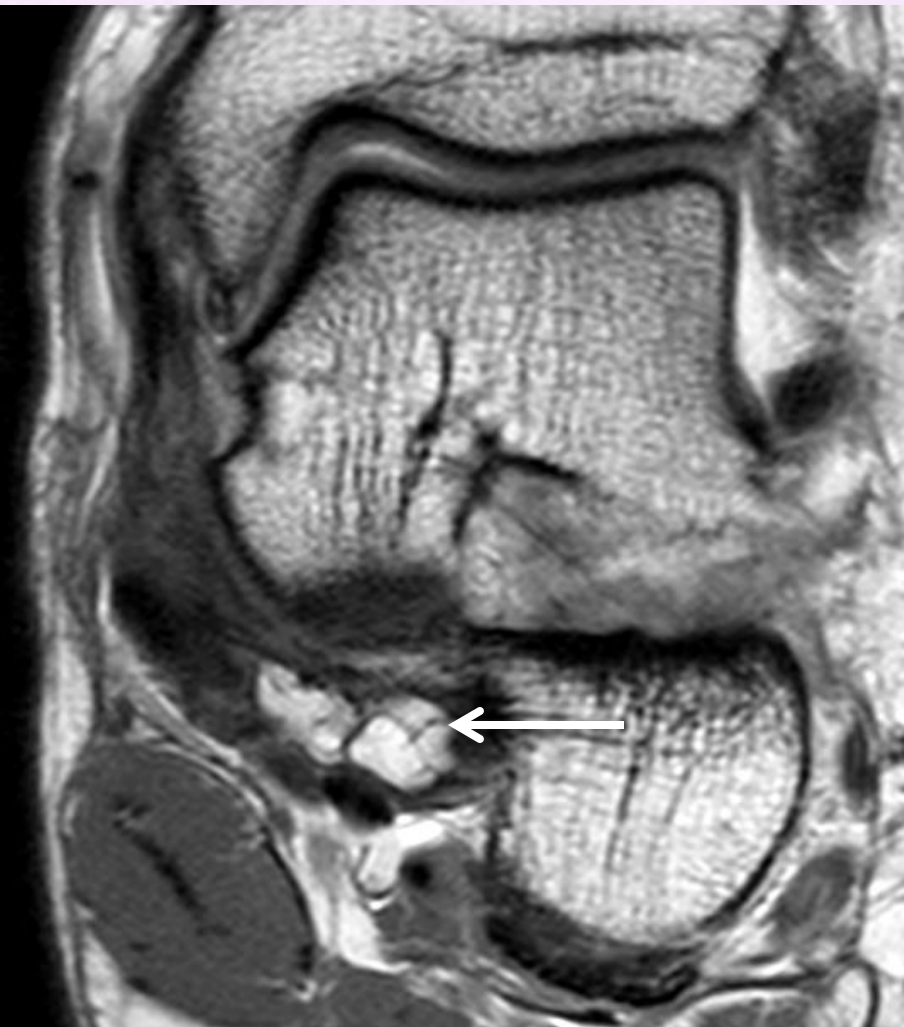
Superomedial
CNL : **axial plane**



Medioplantar
oblique CNL :
coronal plane



Inferoplantar
longitudinal CNL :
coronal plane



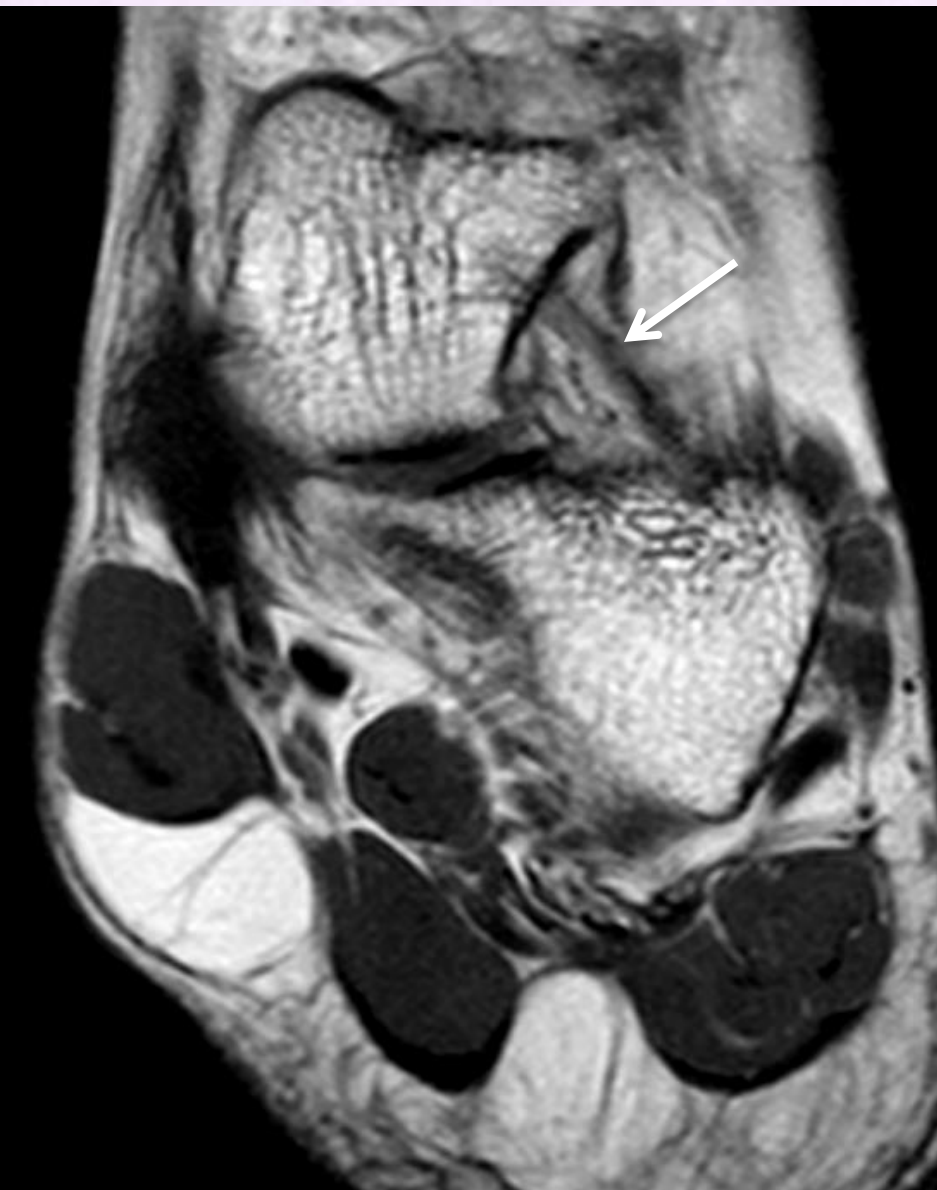
Spring ligament ganglion cysts

Coronal



Tibiospring ligament tear

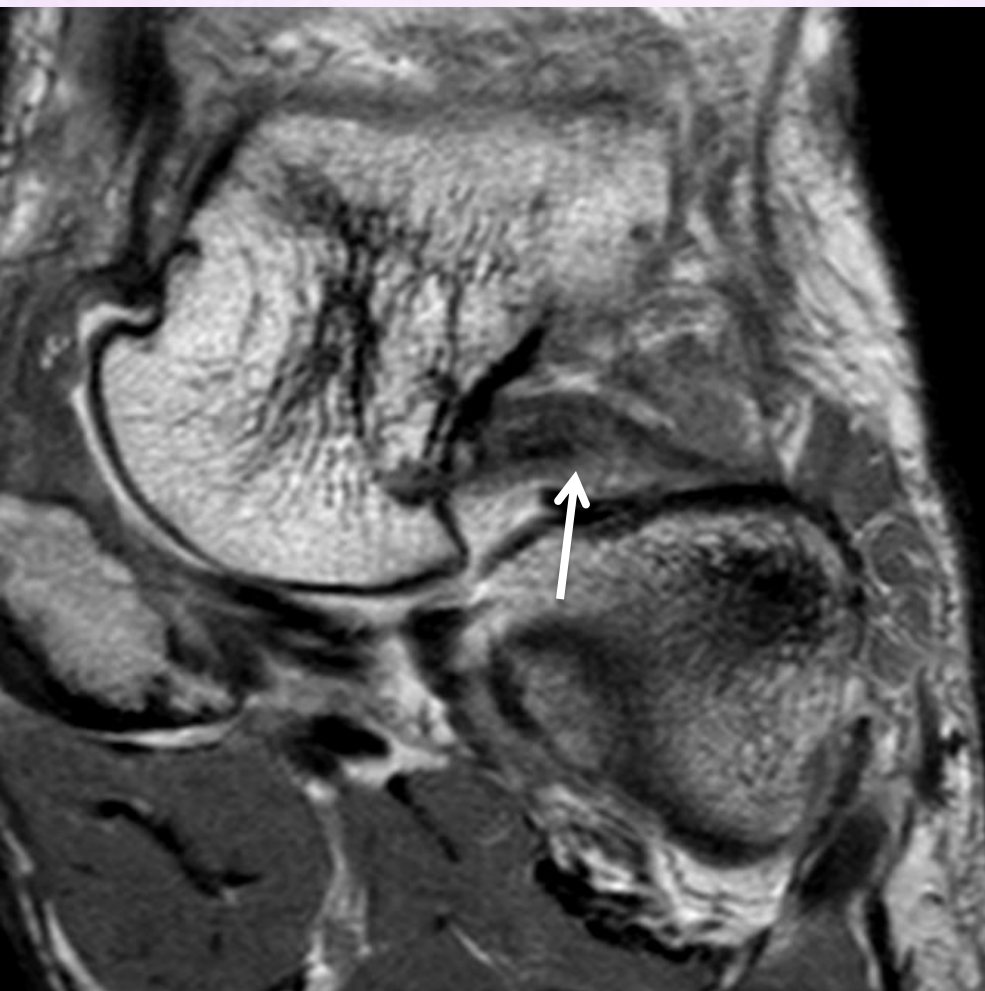
C. Sinus tarsi



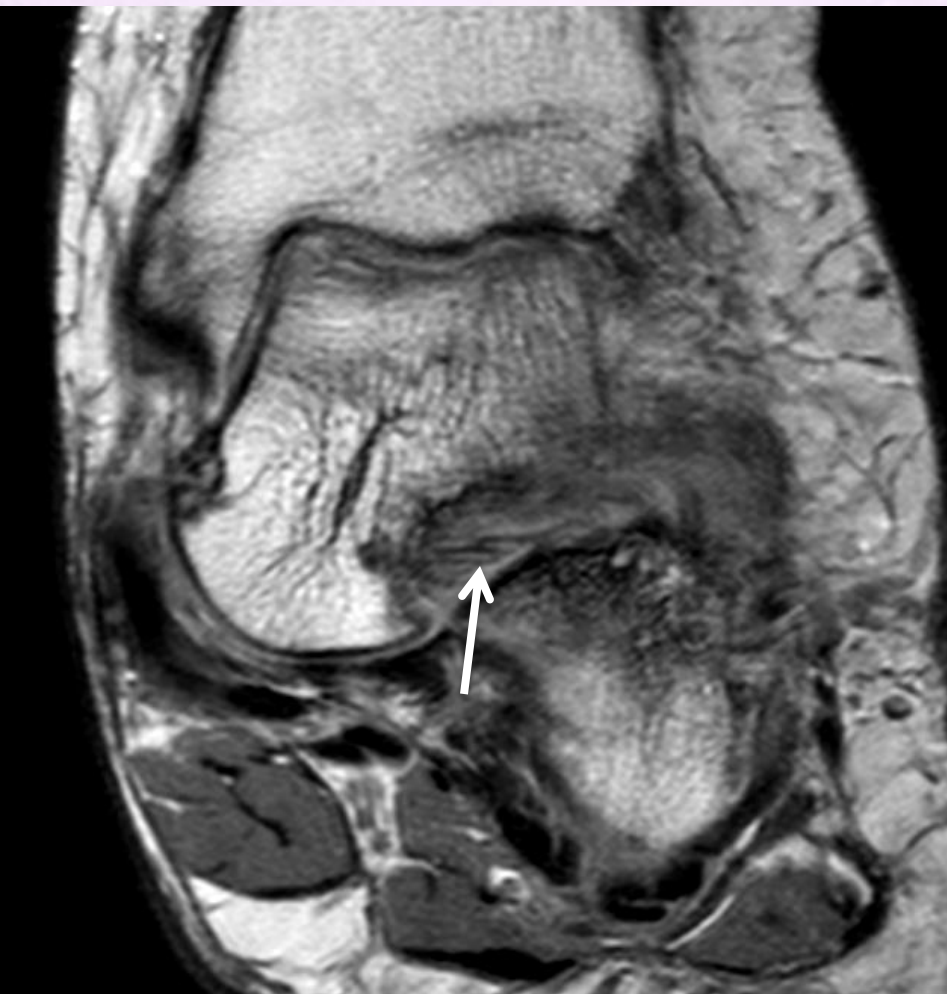
Normal cervical ligament



Normal talocalcaneal interosseous ligament



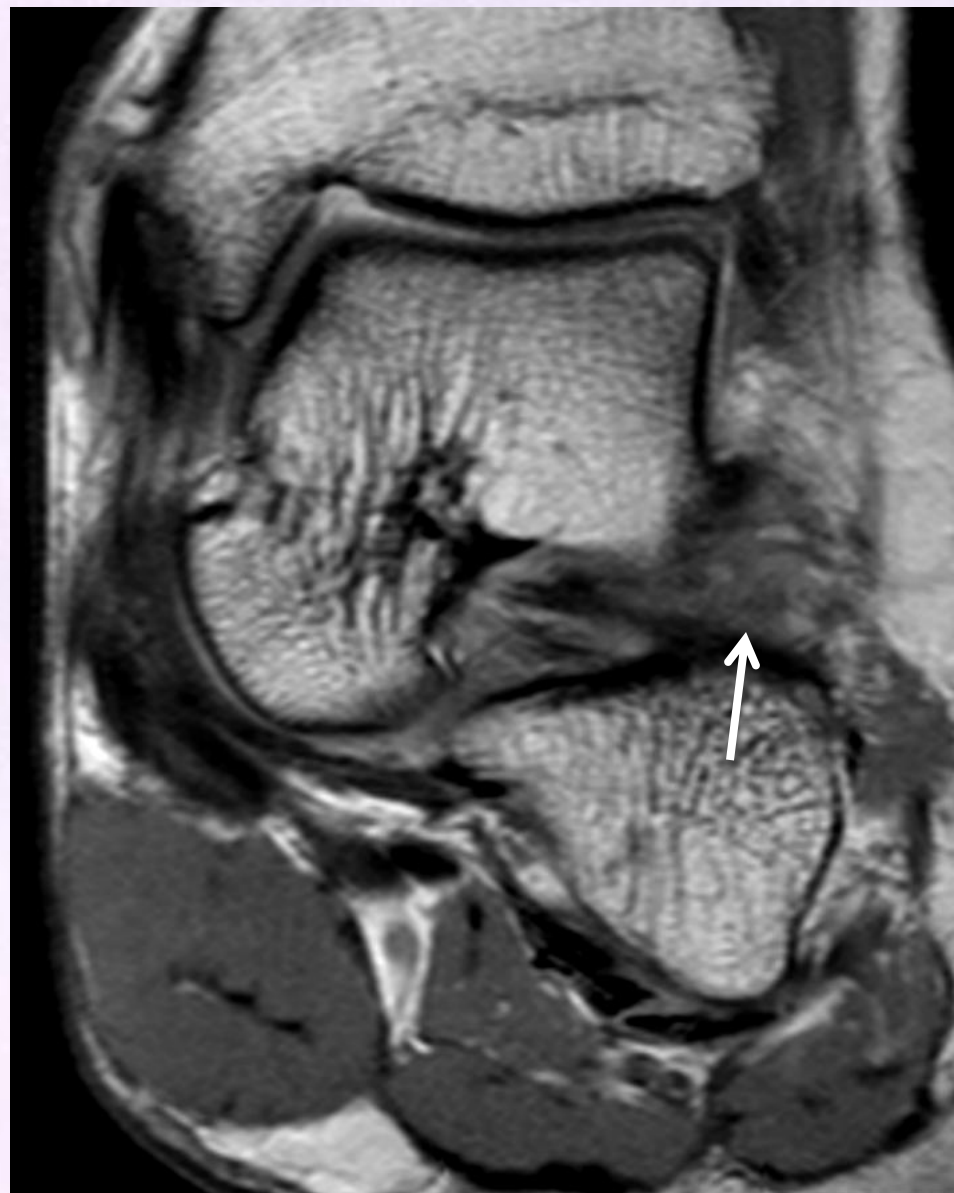
Sinus tarsi ligament thickening



Sinus tarsi ligament attenuation



Sinus tarsi edema



Sinus tarsi fibrosis



Sinus tarsi edema

D. Deltoid ligament and talar dome osteochondral lesion

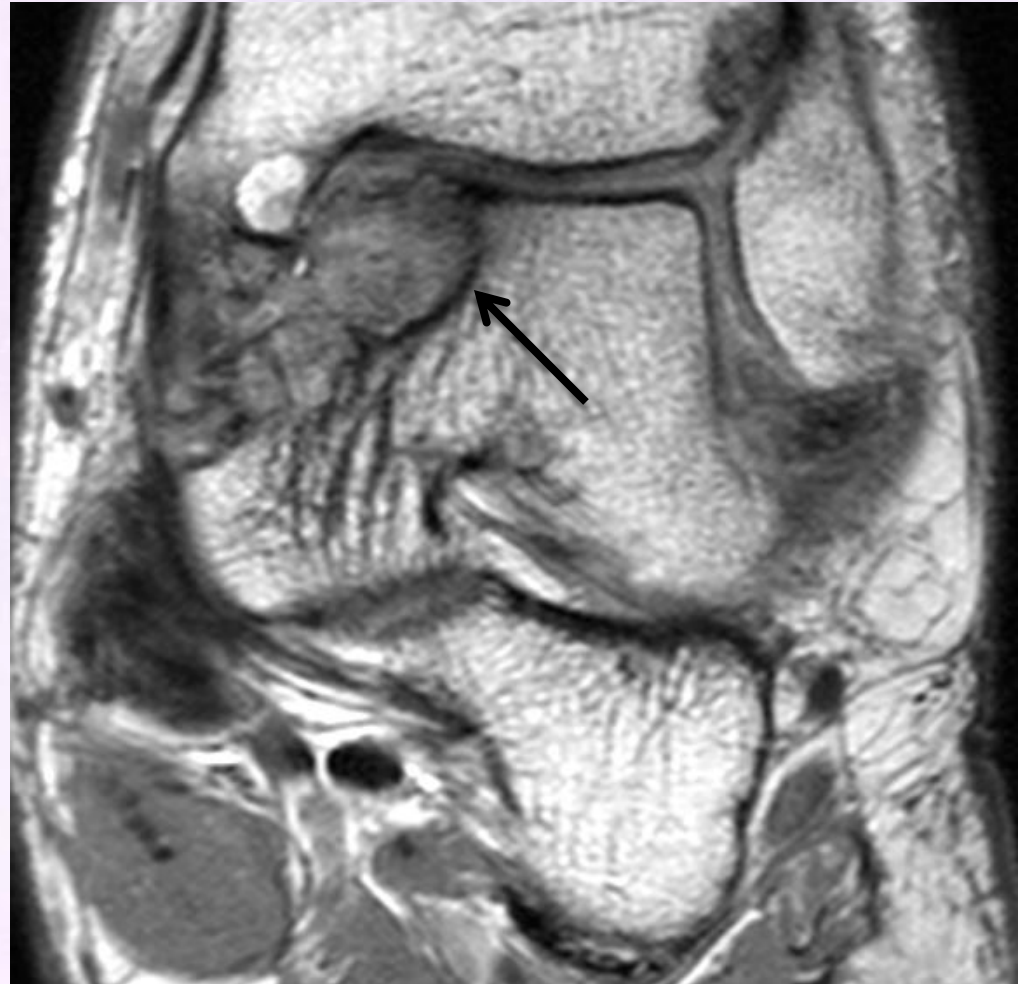
Normal



Flat foot



**Medial talar dome
osteochondral lesion**



**Medial talar dome
osteochondral lesion**



Medial talar dome osteochondral lesion + deltoid ligament tear



Medial talar dome osteochondral lesion

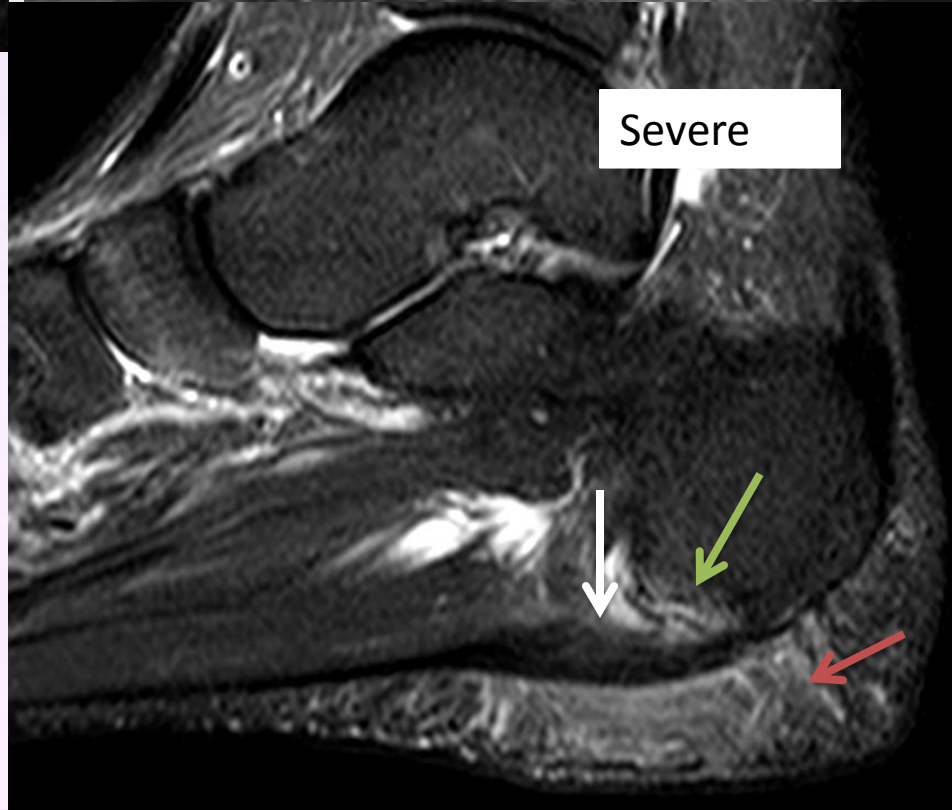
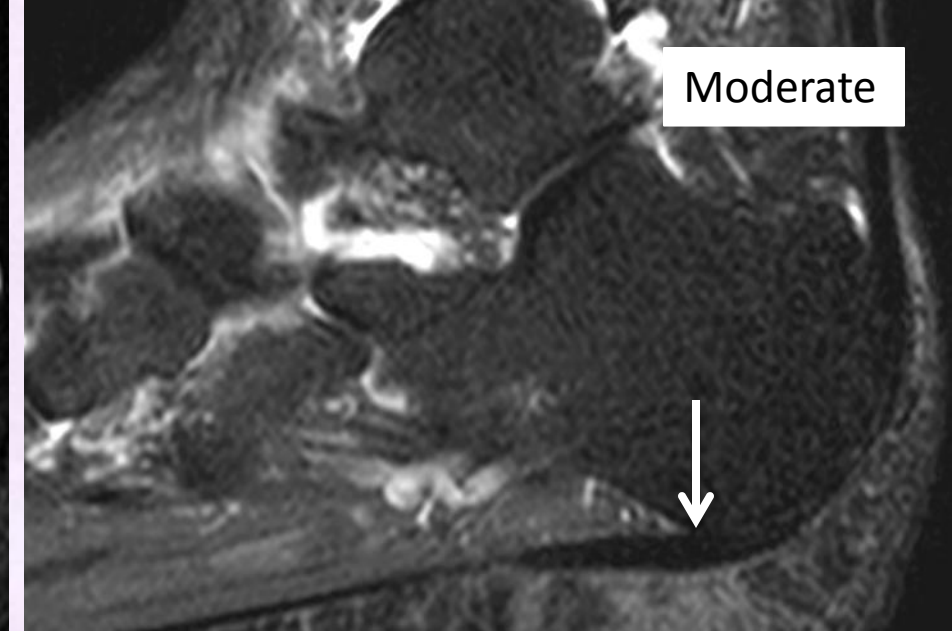
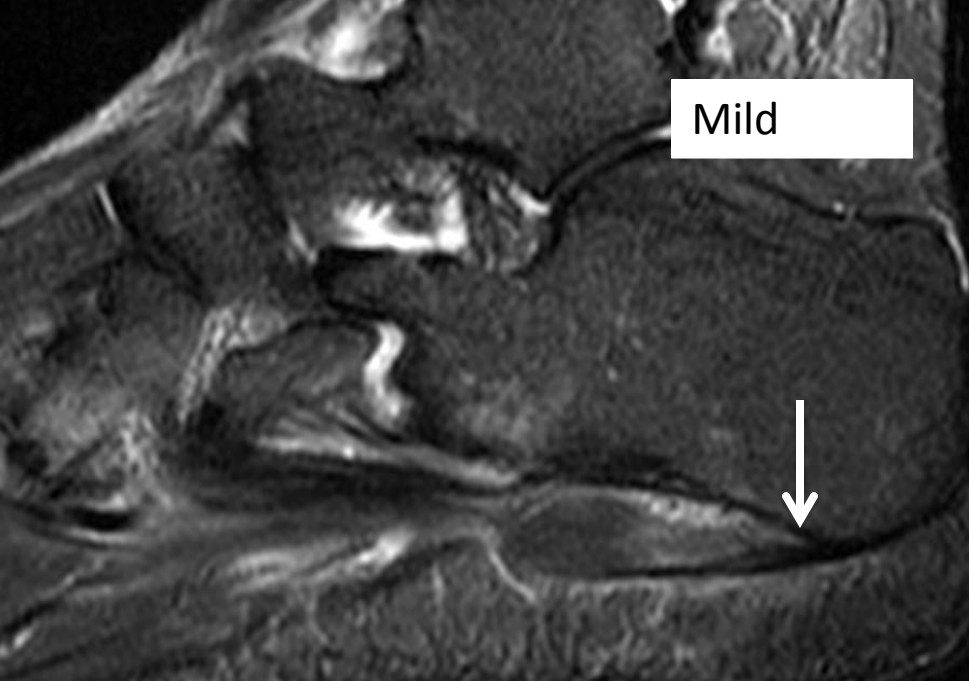


**Lateral talar dome
osteochondral lesion**

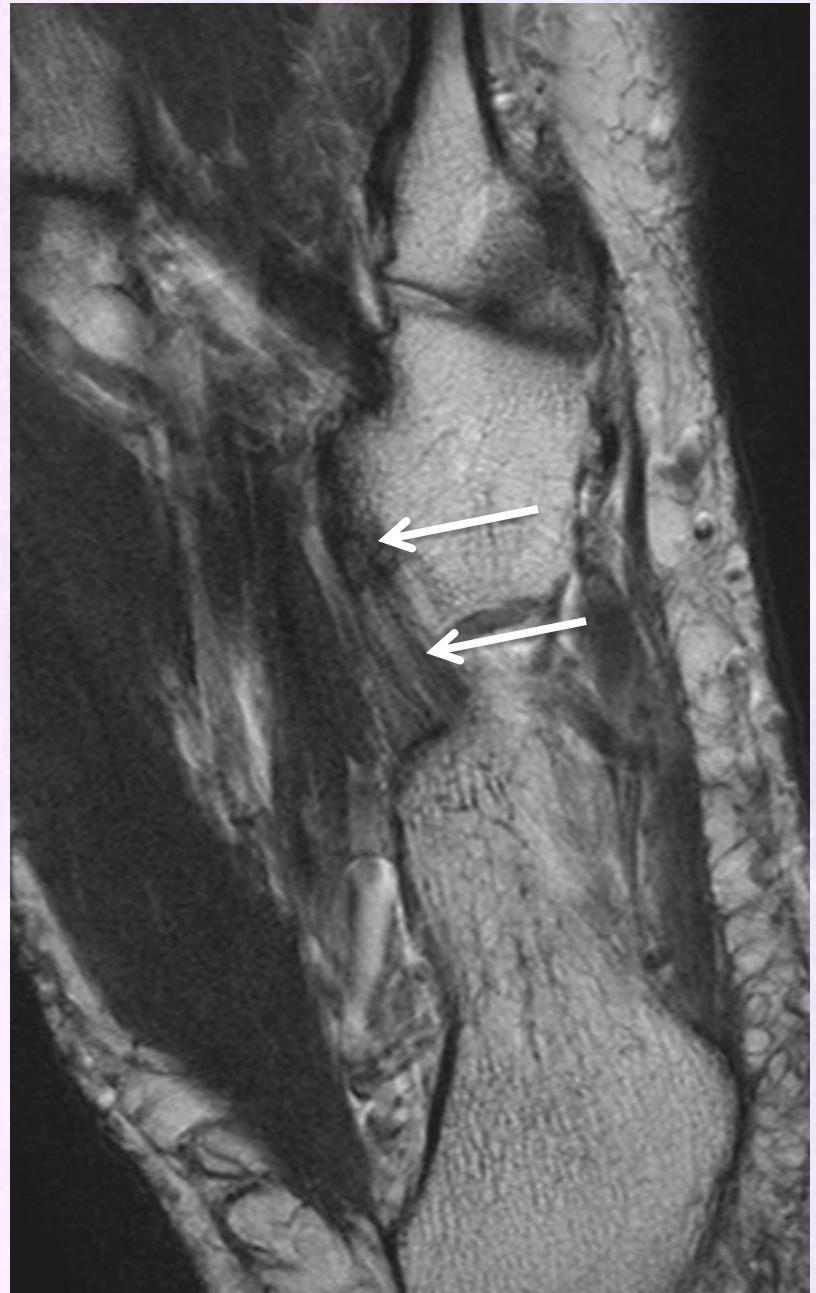


**Lateral talar dome
osteochondral lesion**

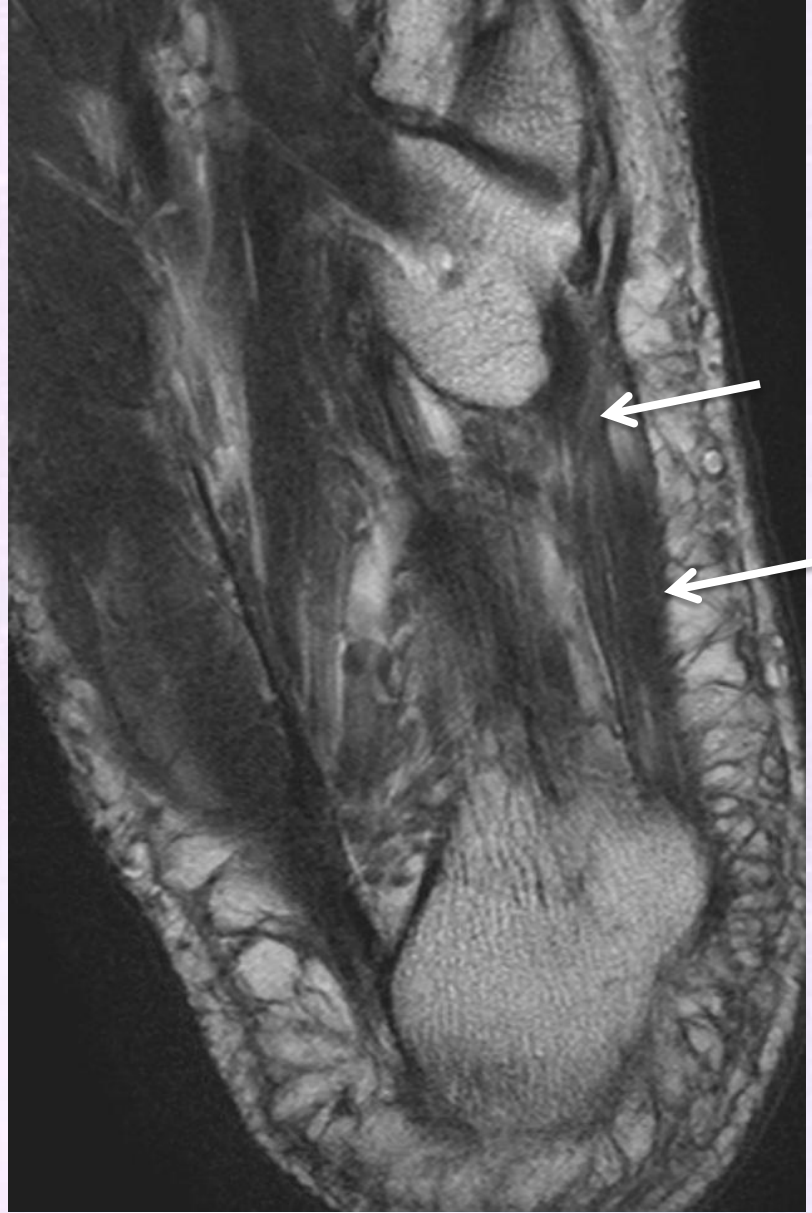
E. Plantar fasciitis



F. Short and long plantar ligaments



Short plantar ligament

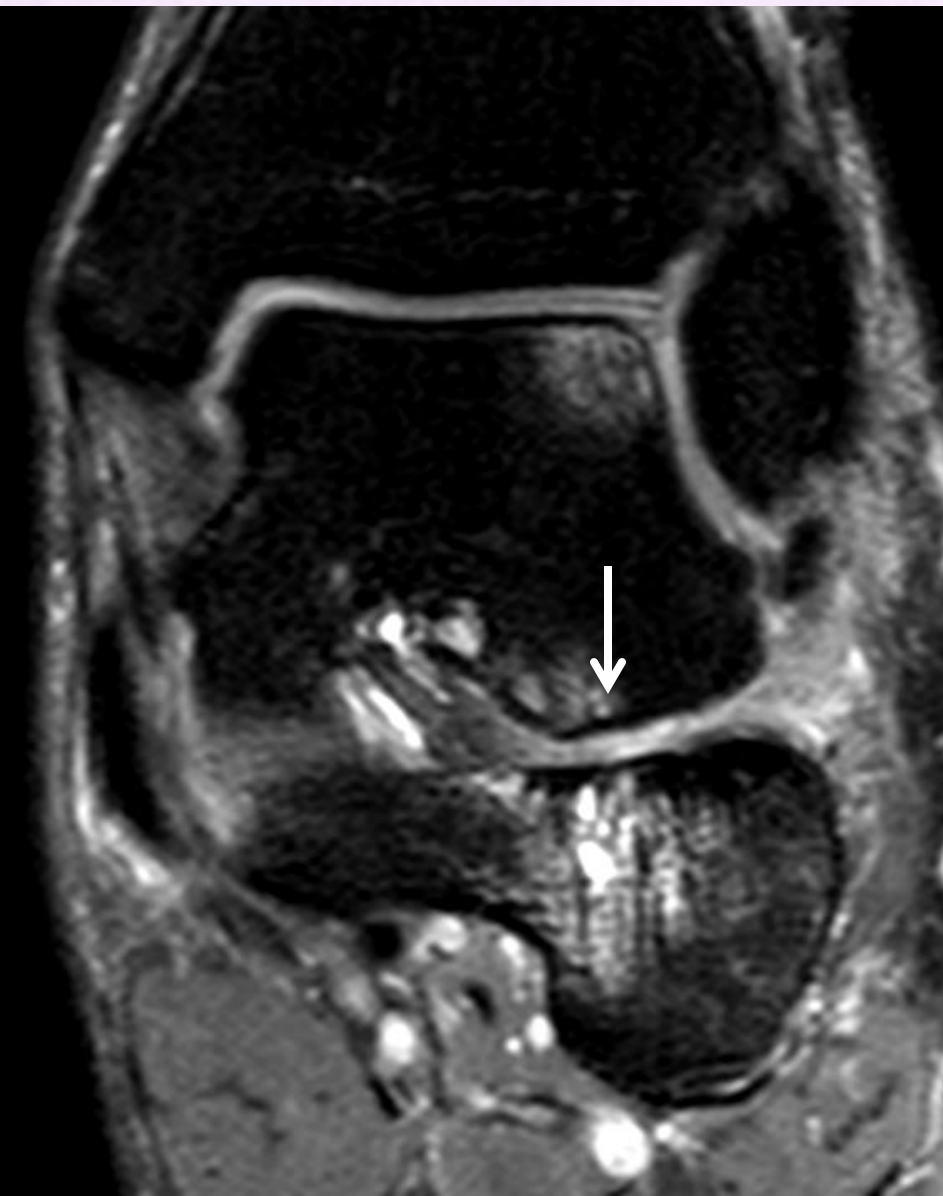


Long plantar ligament

3. Secondary bony abnormalities

- Talocalcaneal impingement
 - Caneofibular impingement (subfibular)
 - Osteoarthritis
 - Hallux valgus
- } Lateral hind foot impingement

A. Talocalcaneal impingement

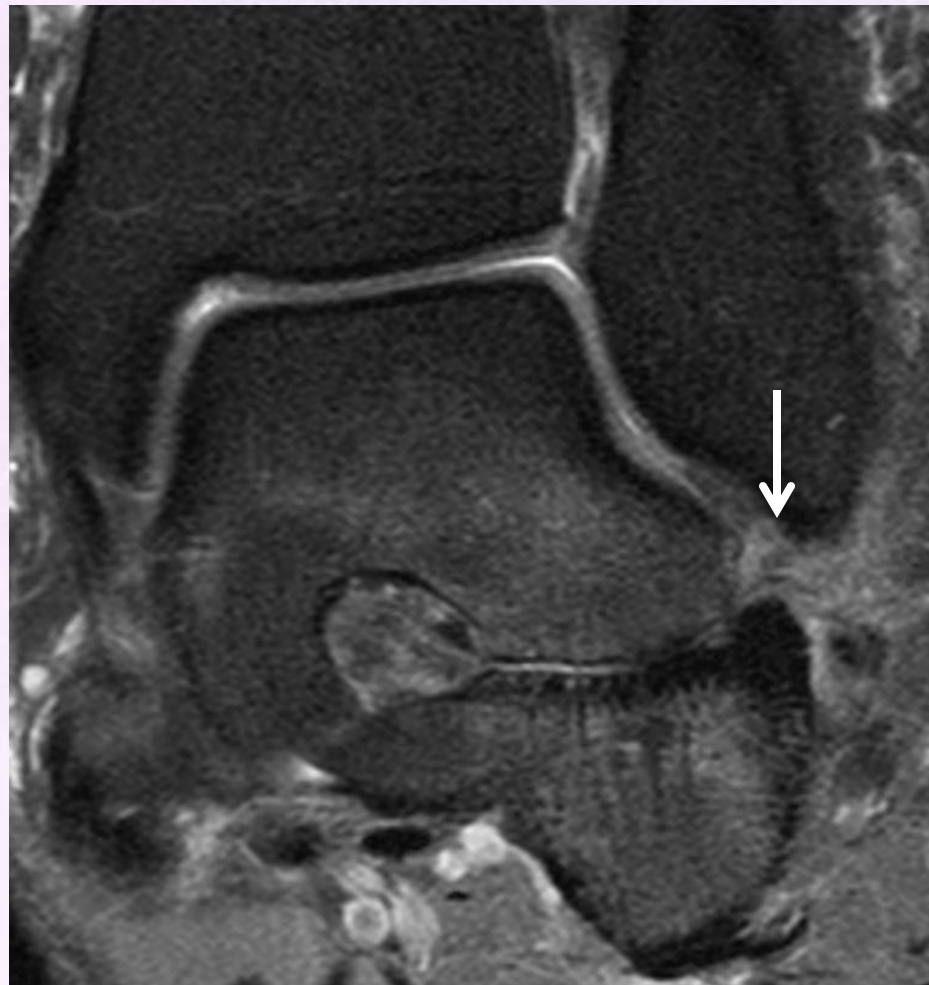




B. Subfibular impingement



Soft tissue impingement



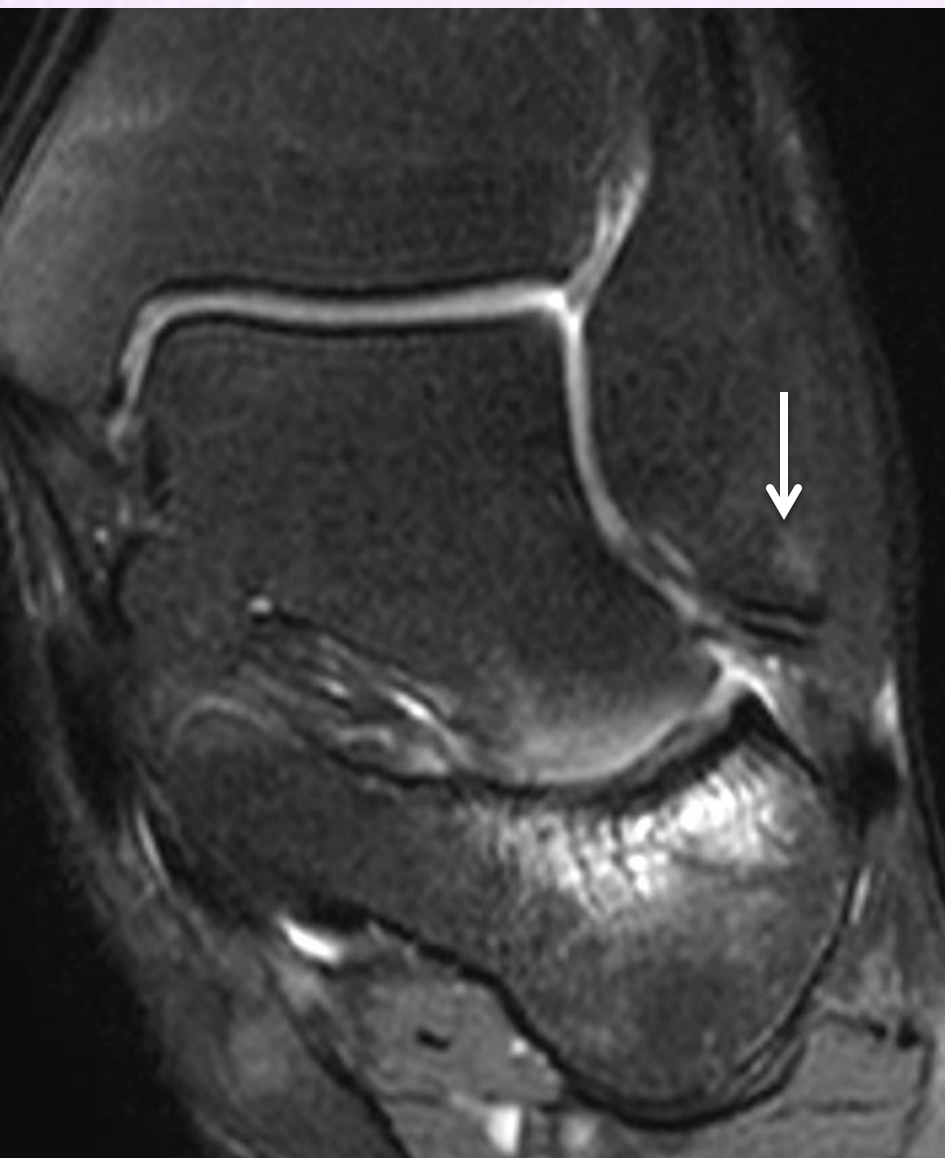
Soft tissue impingement



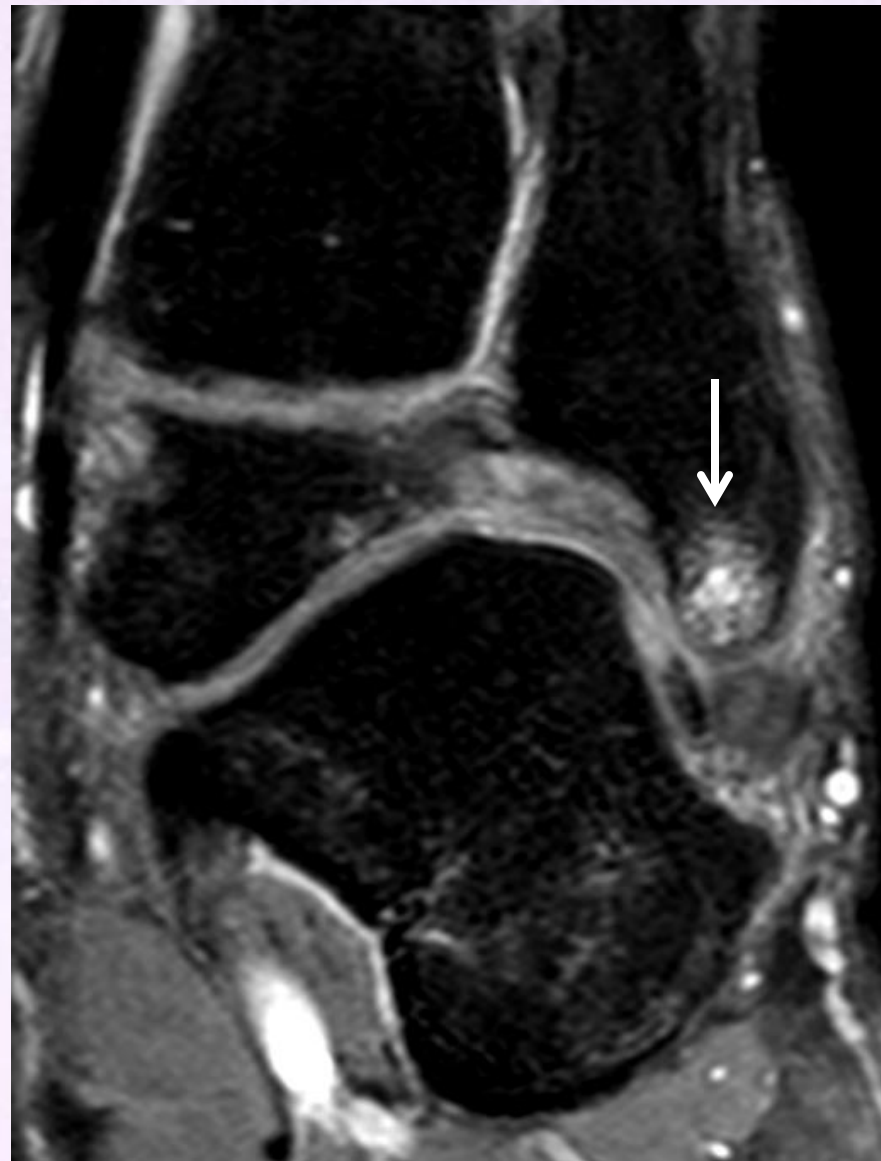
**Peroneal tendon
impingement**



**Peroneal tendon impingement with
hypertrophic peroneal tubercle**



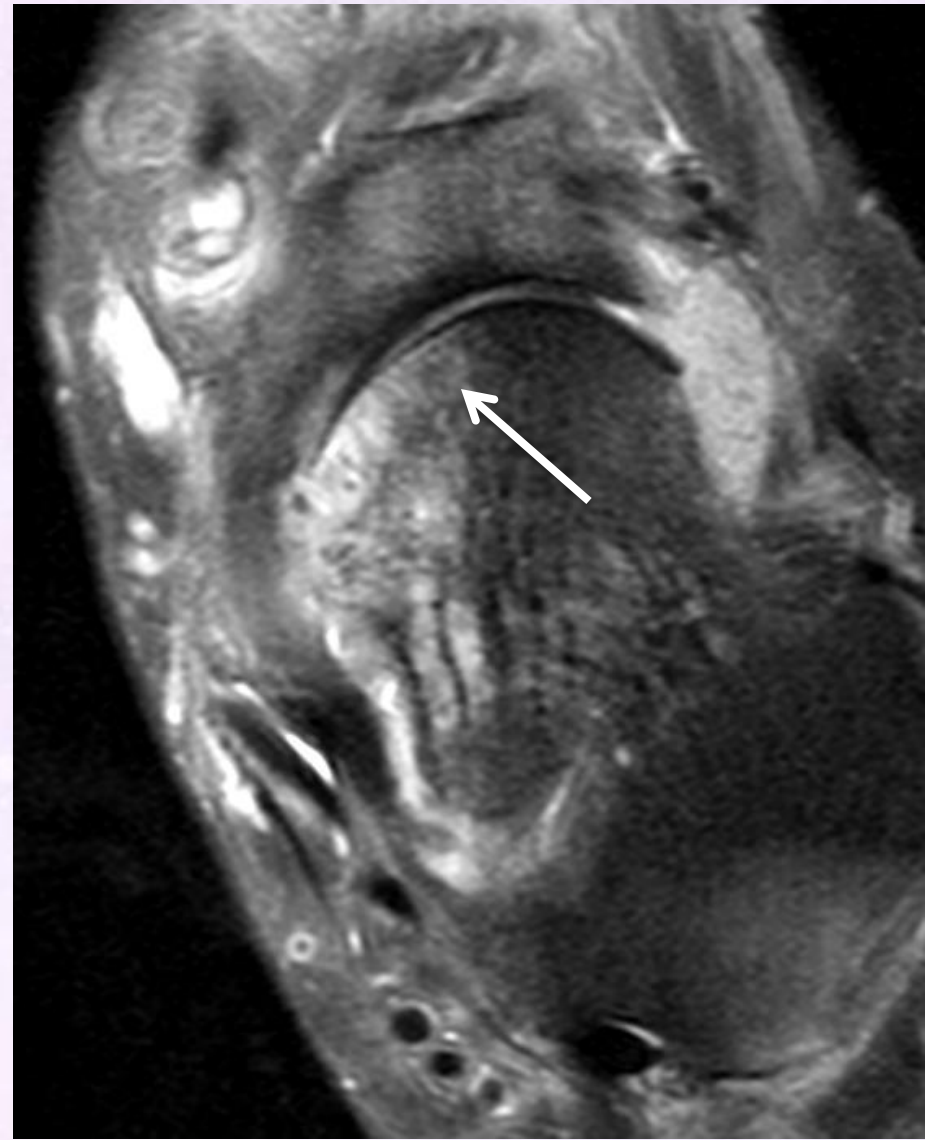
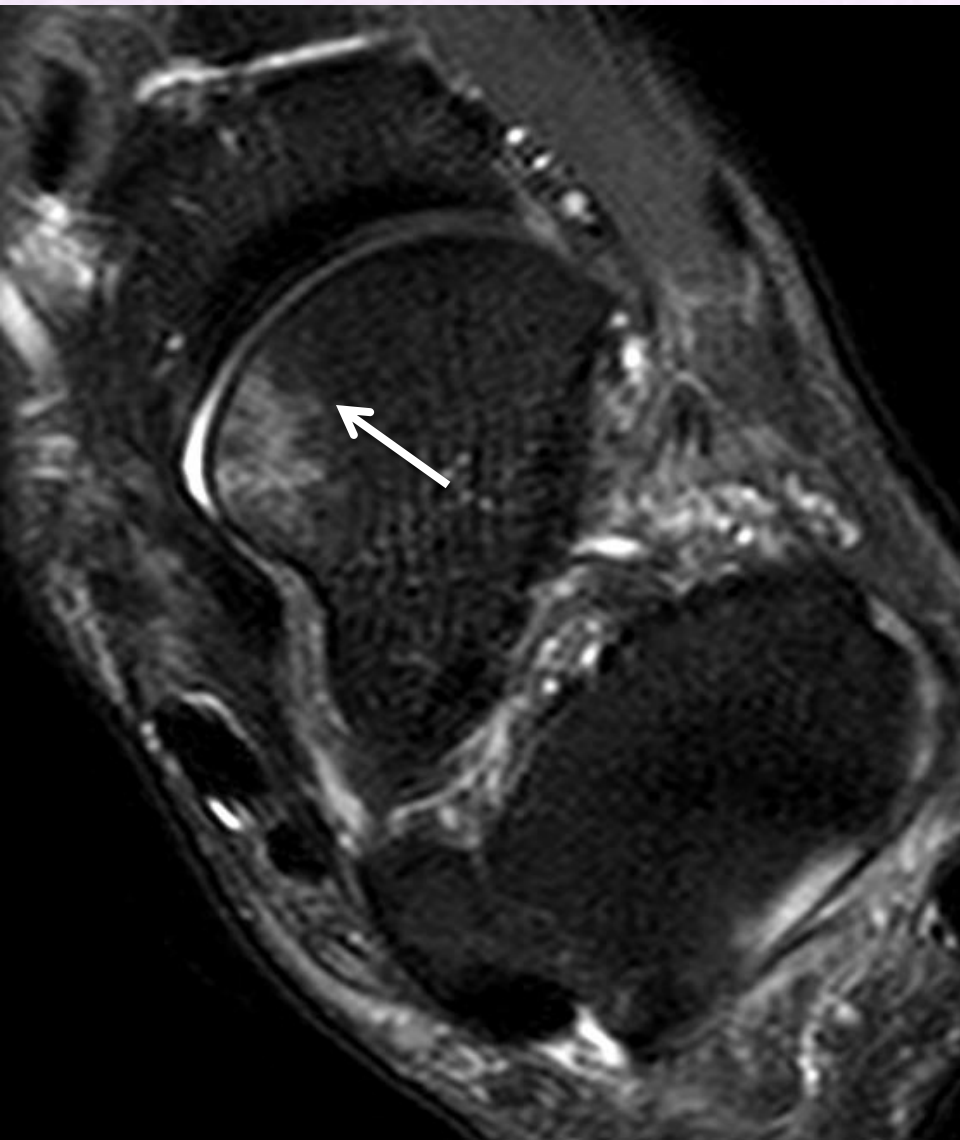
Bony impingement



Bony impingement

C. Osteoarthritis

1. Tibiotalar – ankle joint
2. Subtalar
3. Talonavicular
4. Naviculocuneiform
5. Metatarsocuneiform
6. Calcaneocuboid



Talonavicular articulation



Calcaneocuboid articulation

D. Hallux valgus

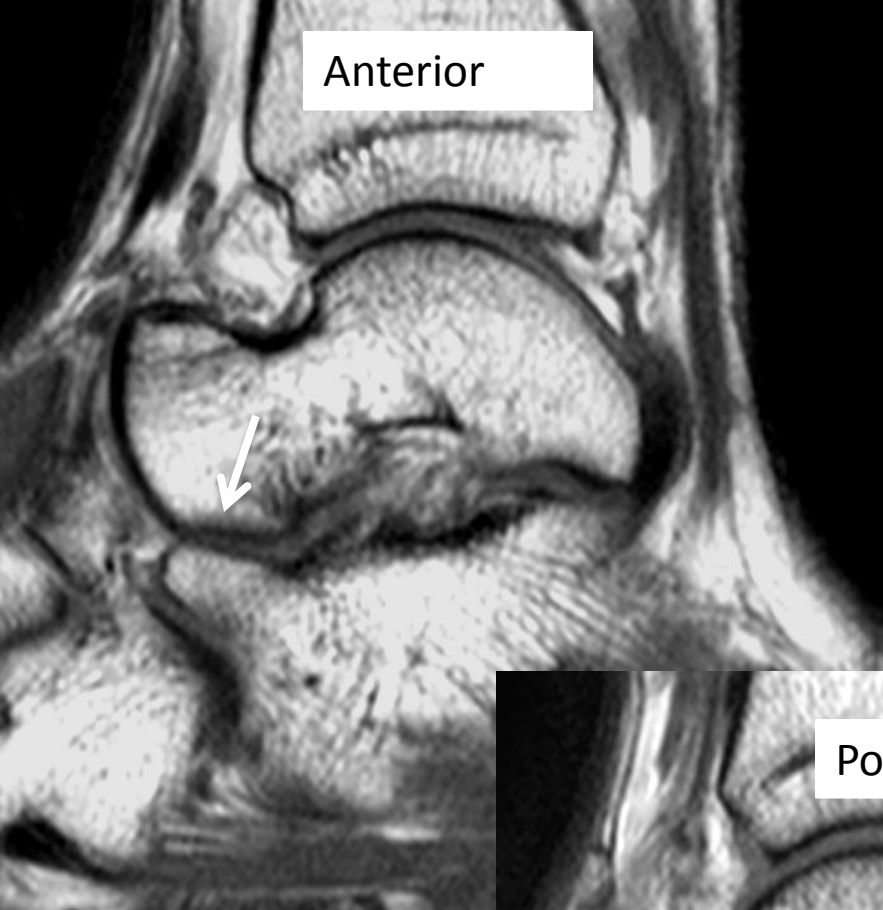


4. Underlying relevant congenital abnormalities

- Tarsal coalition
- (Accessory navicular bone)

Tarsal coalition

1. Talocalcaneal
2. Calcaneonavicular
3. Others

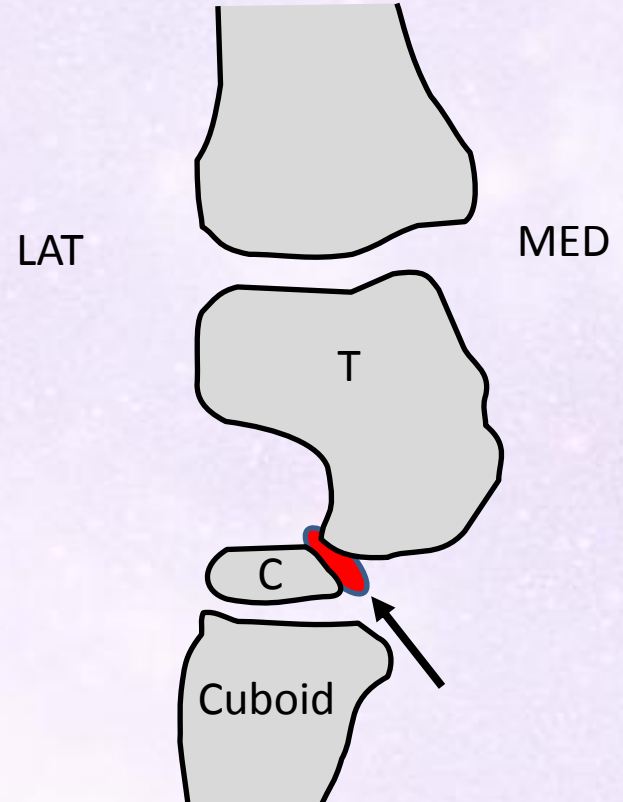
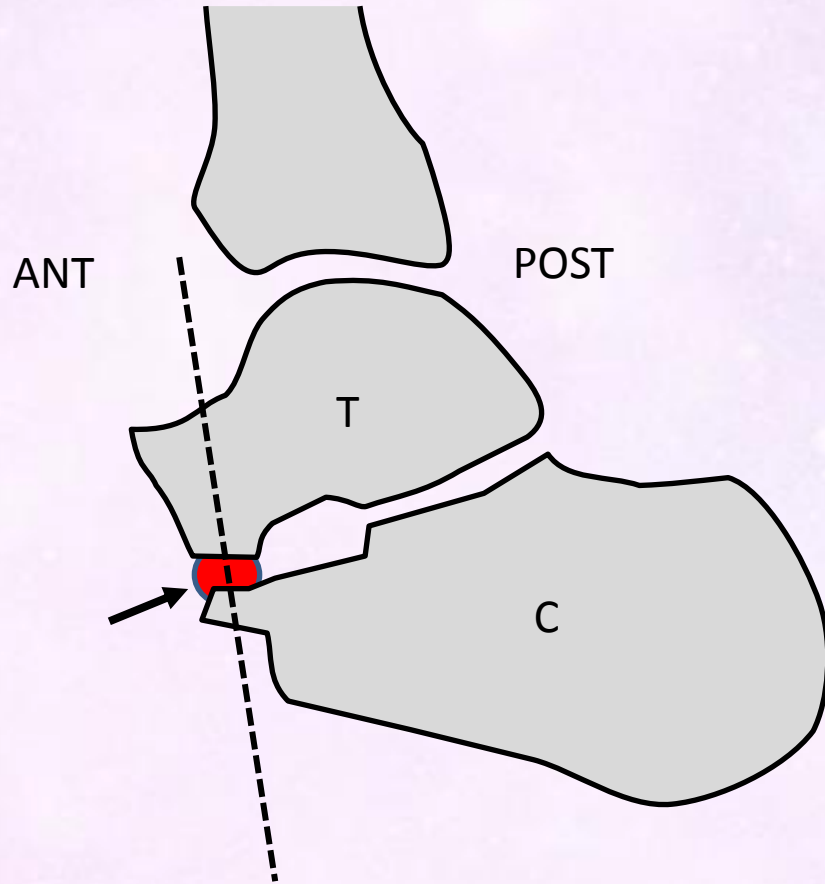


Normal
sagittal

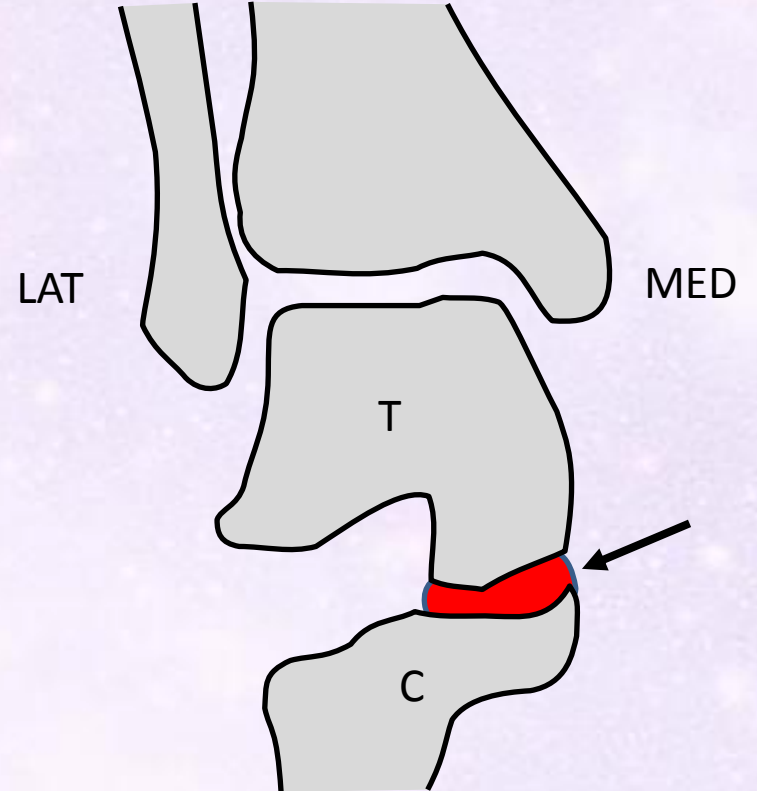
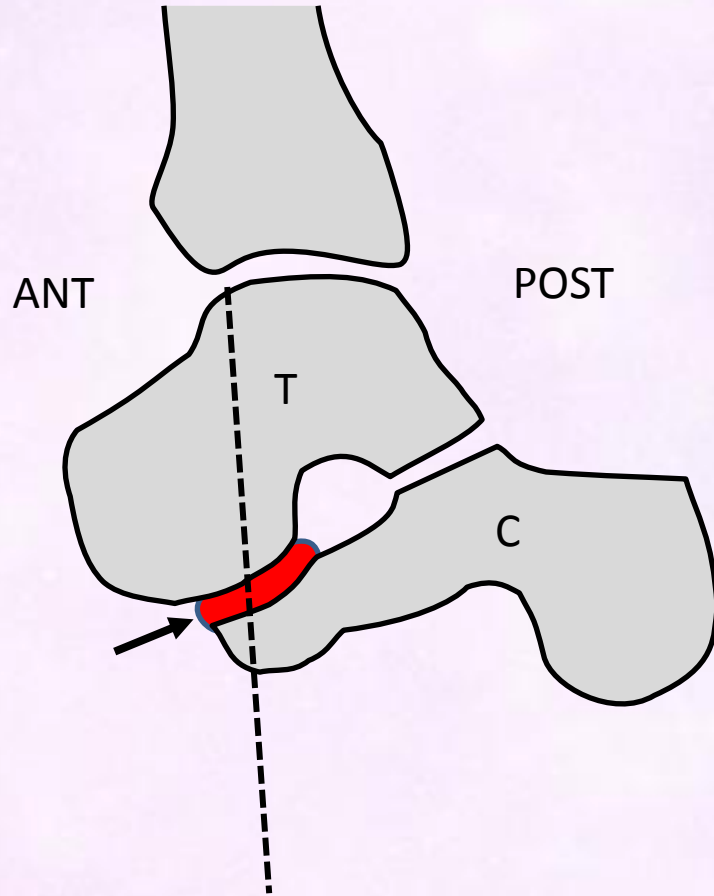
Talocalcaneal coalition

- Intra-articular
 - a. Middle
 - b. Posterior
 - c. Anterior
- Extra-articular

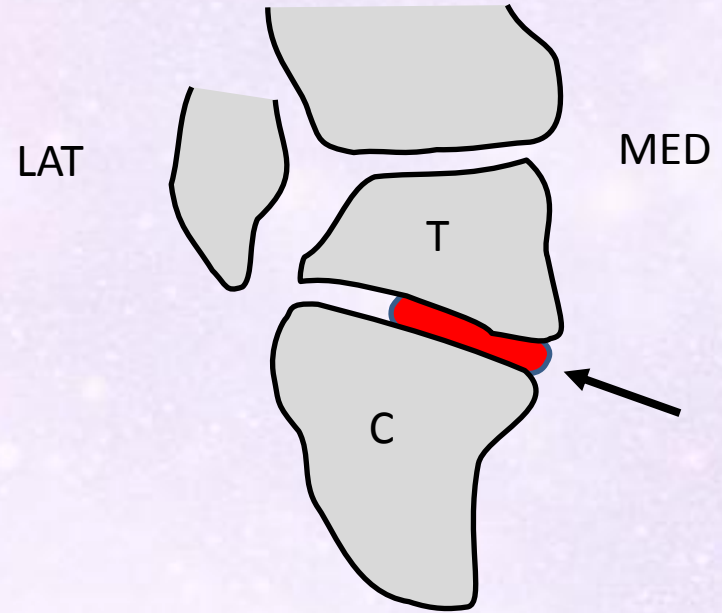
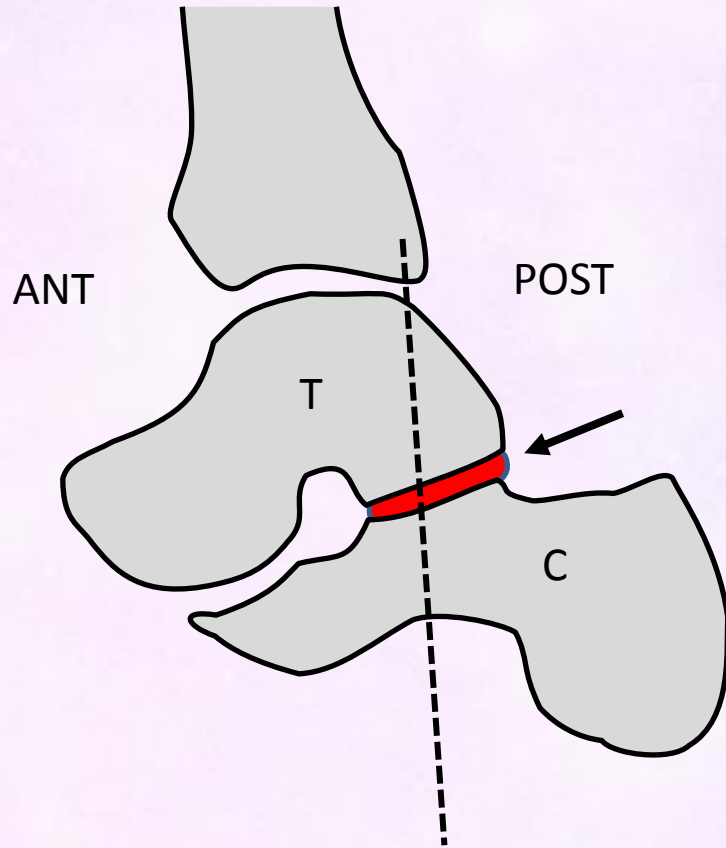
ANTERIOR FACET FUSION



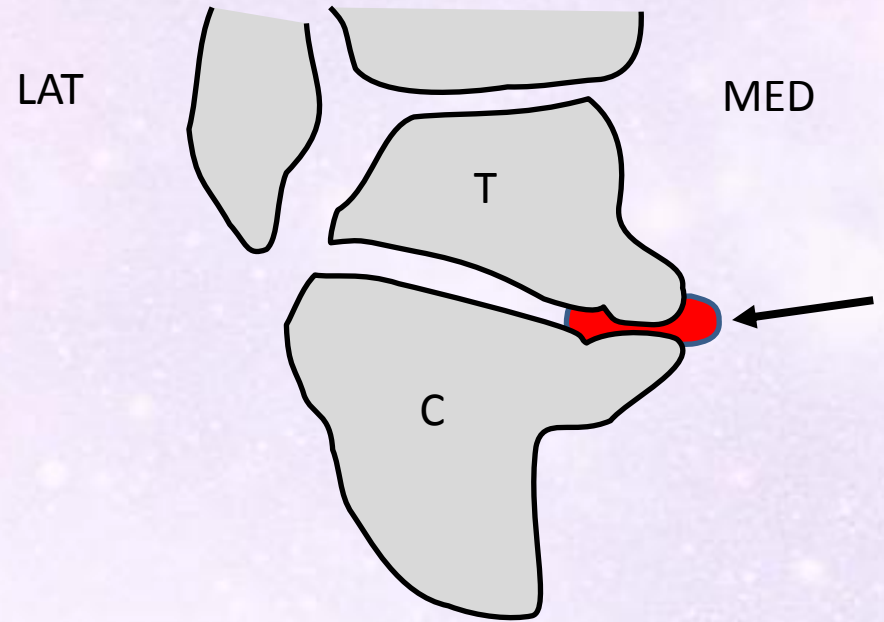
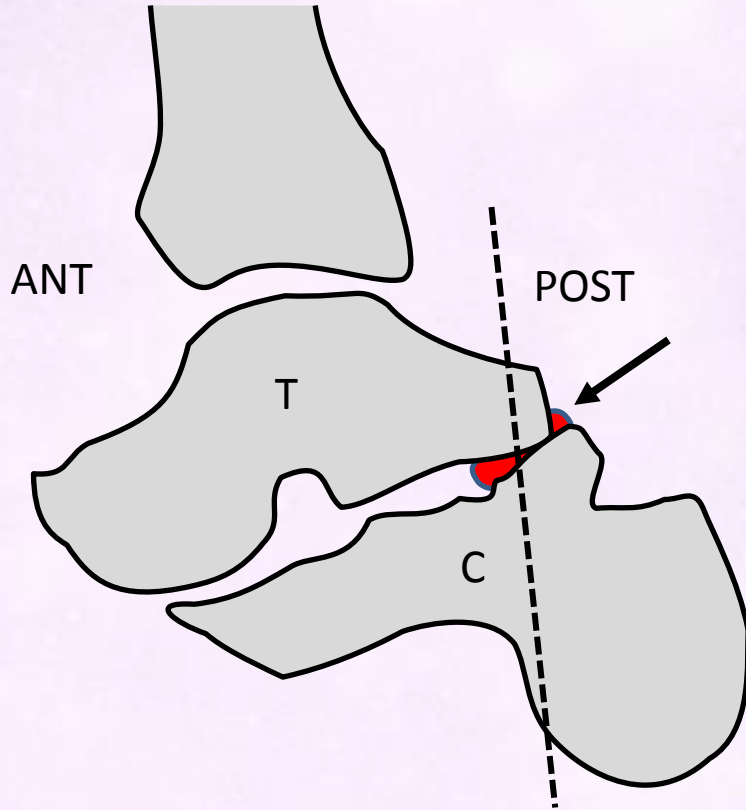
MIDDLE FACET FUSION



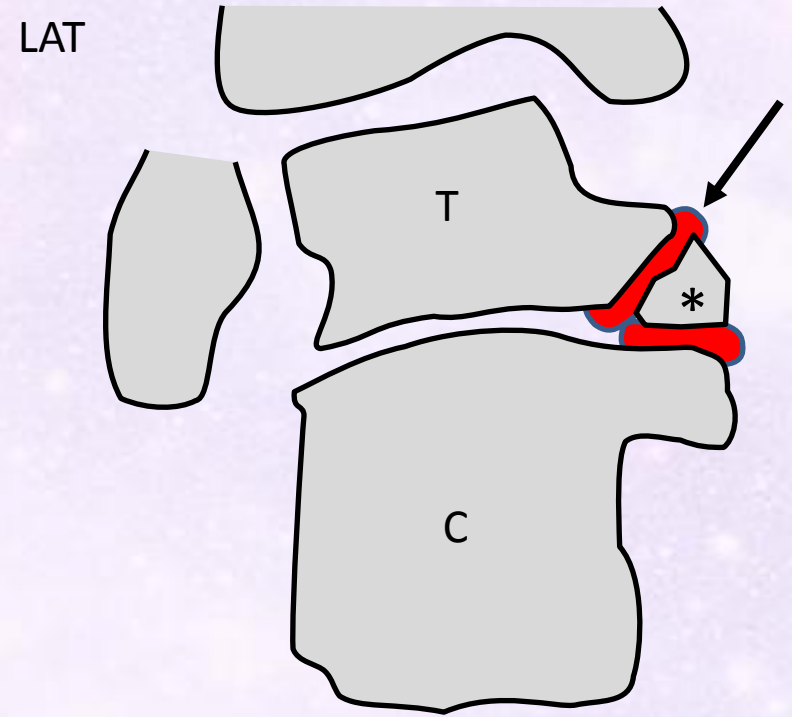
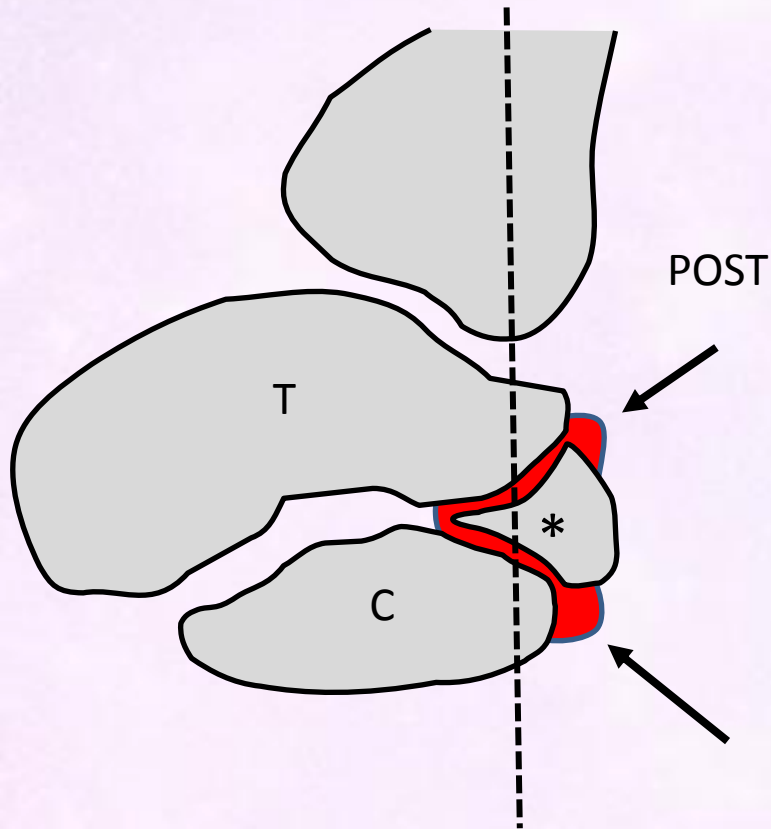
POSTERIOR FACET FUSION

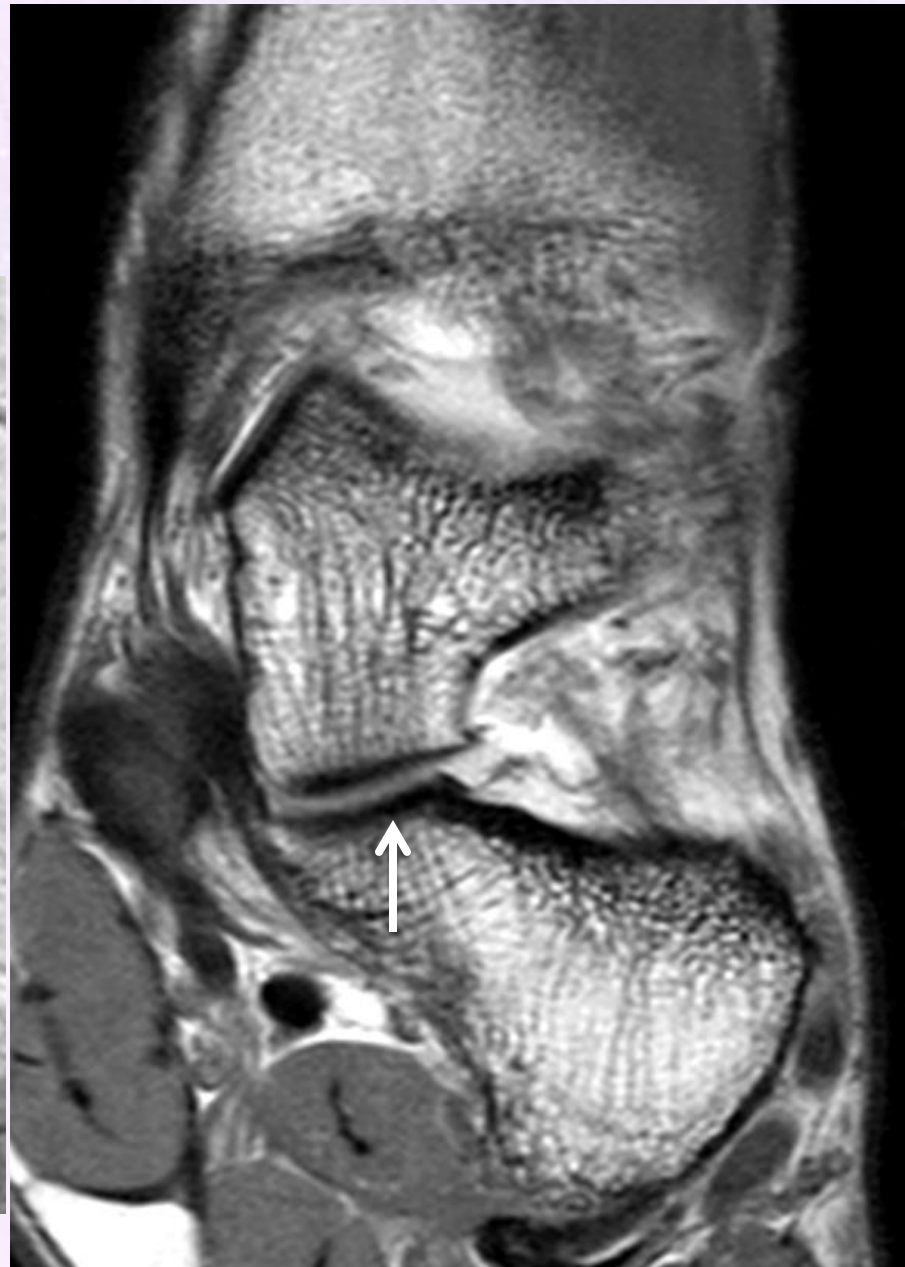


EXTRA-ARTICULAR

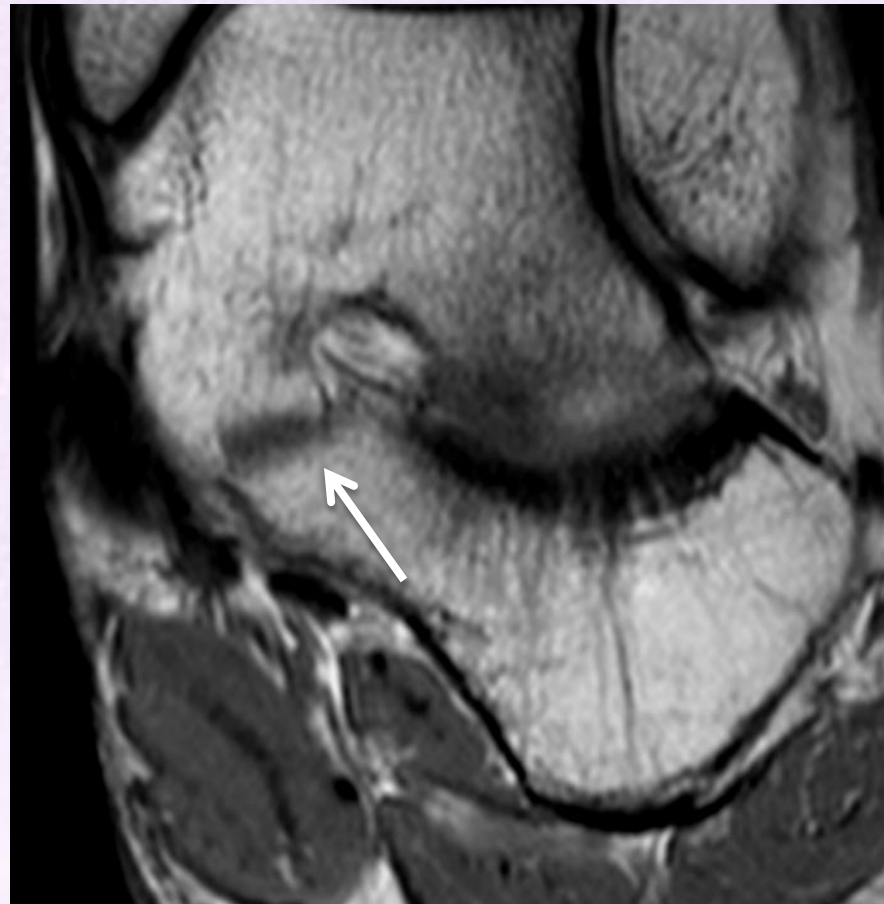
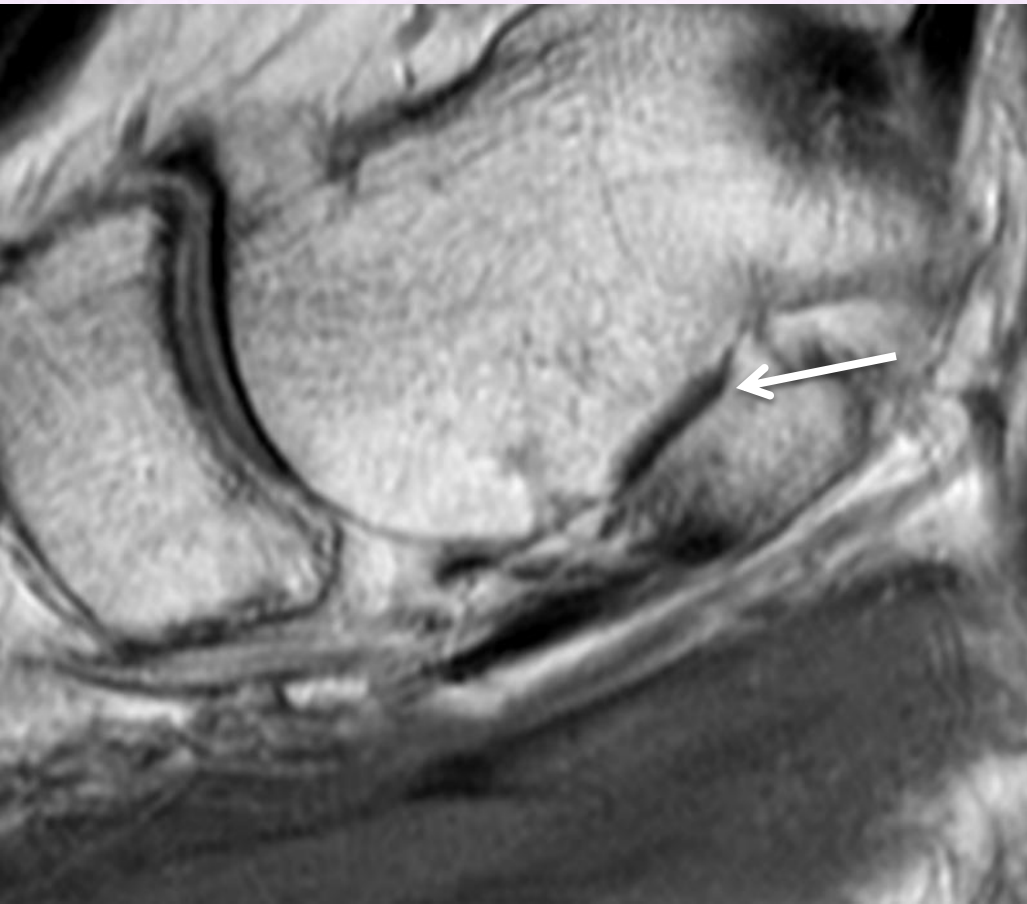


EXTRA-ARTICULAR with OS SUSTENTACULUM

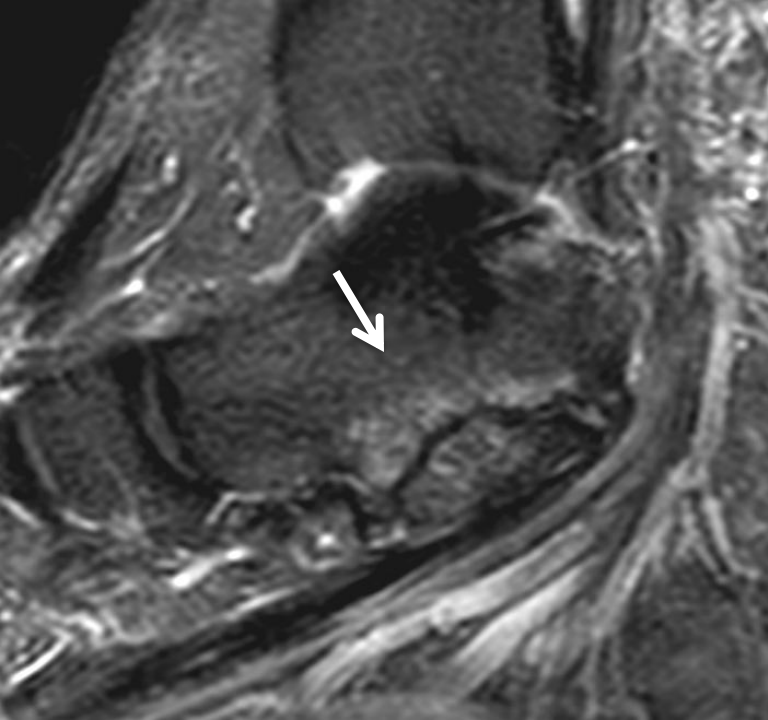
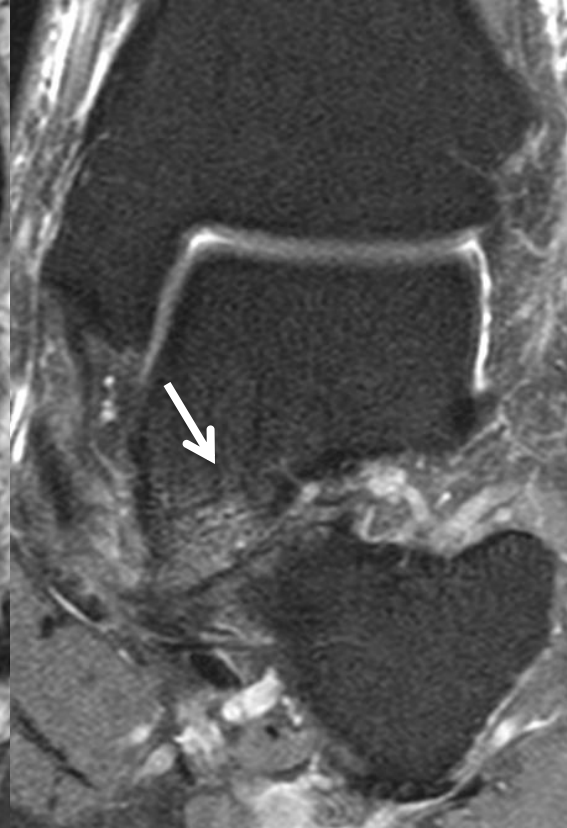




Normal middle subtalar facet



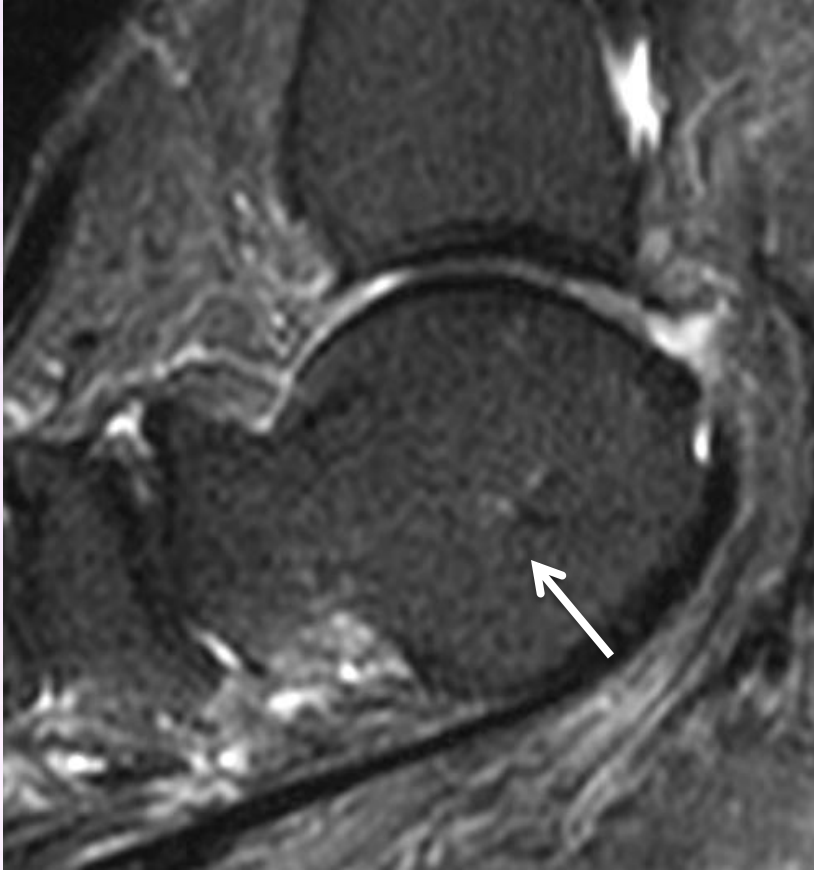
Talocalcaneal coalition – middle facet



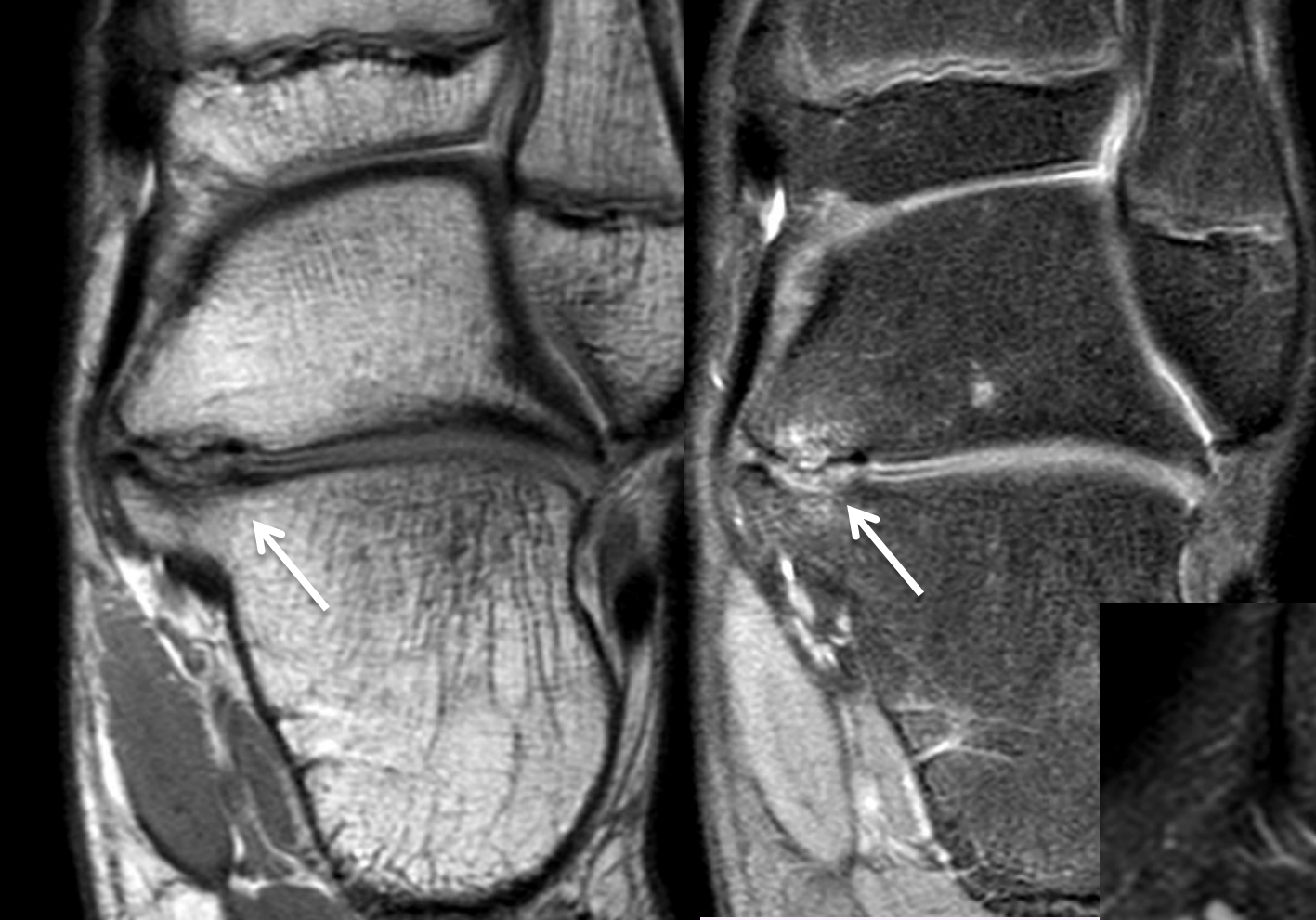
Talocalcaneal coalition – middle facet



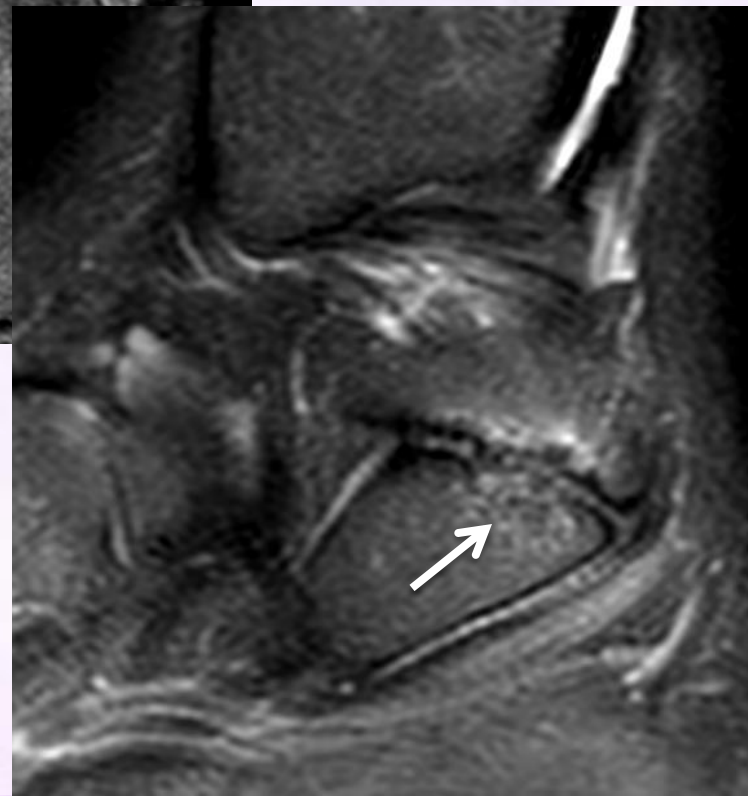
Normal posterior subtalar facet

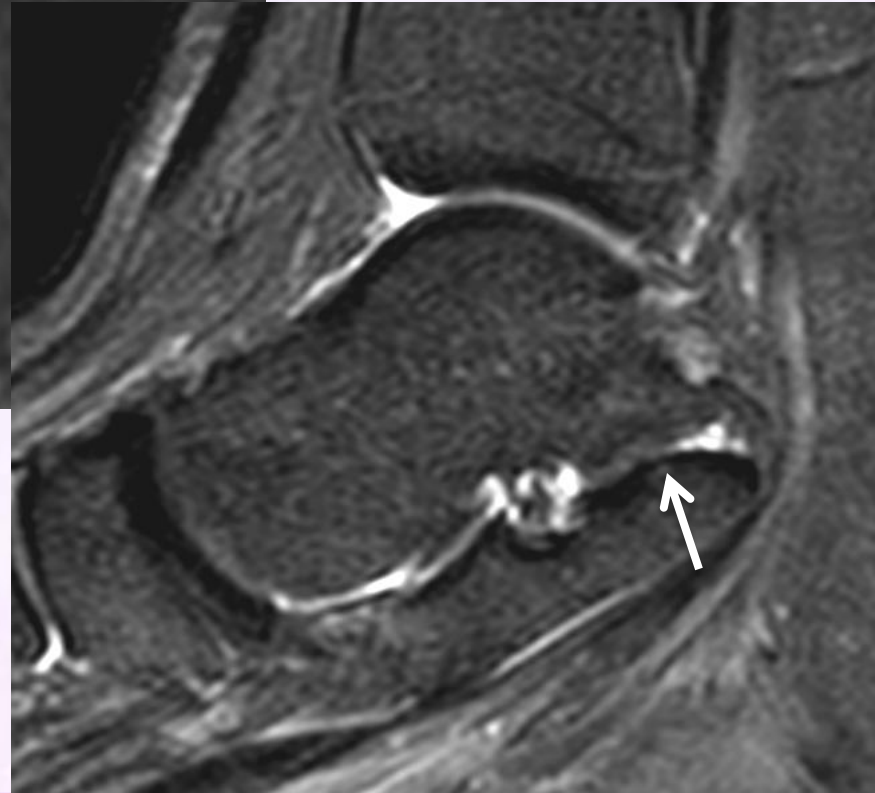
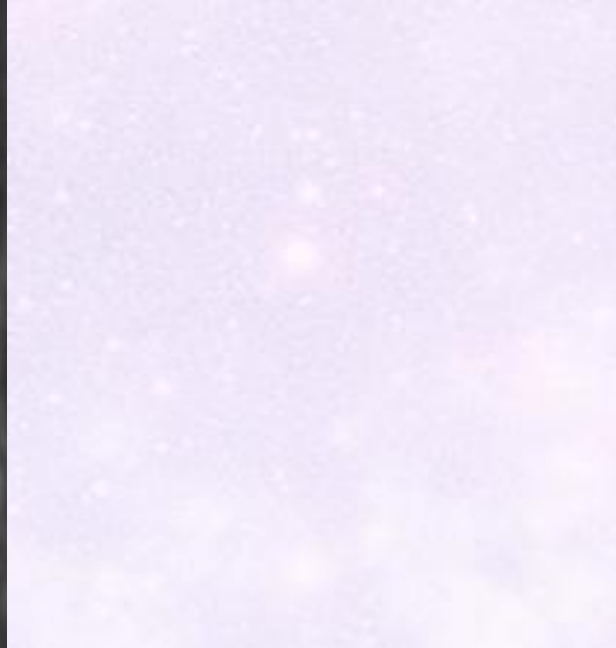
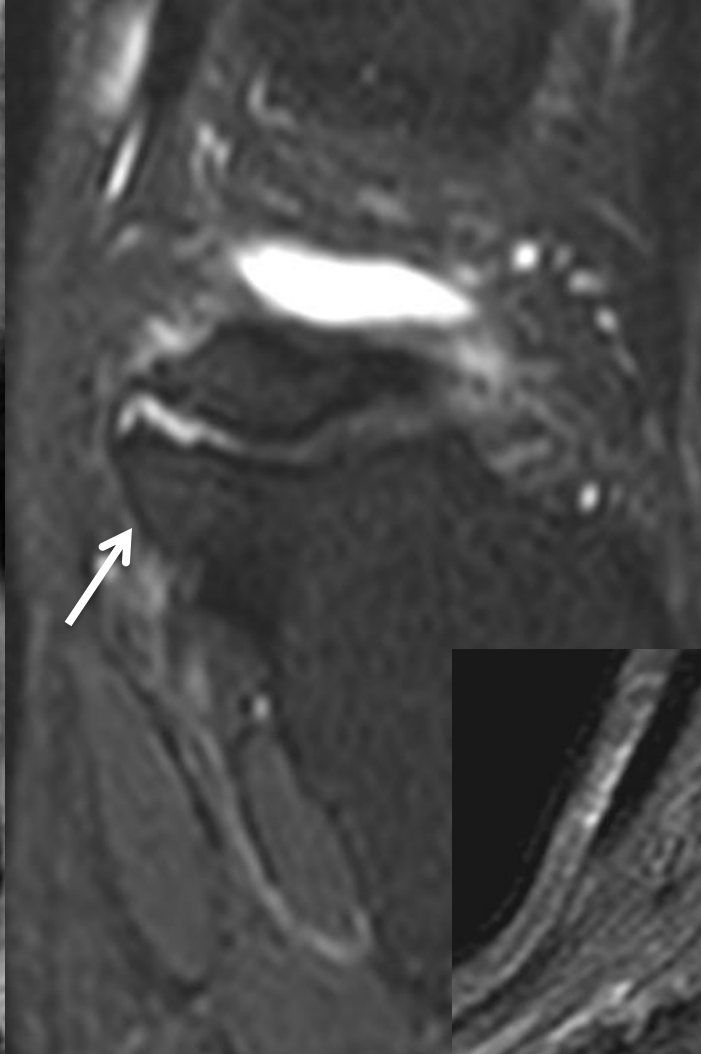


Talocalcaneal coalition – posterior facet



Talocalcaneal coalition – extra-articular posterior facet



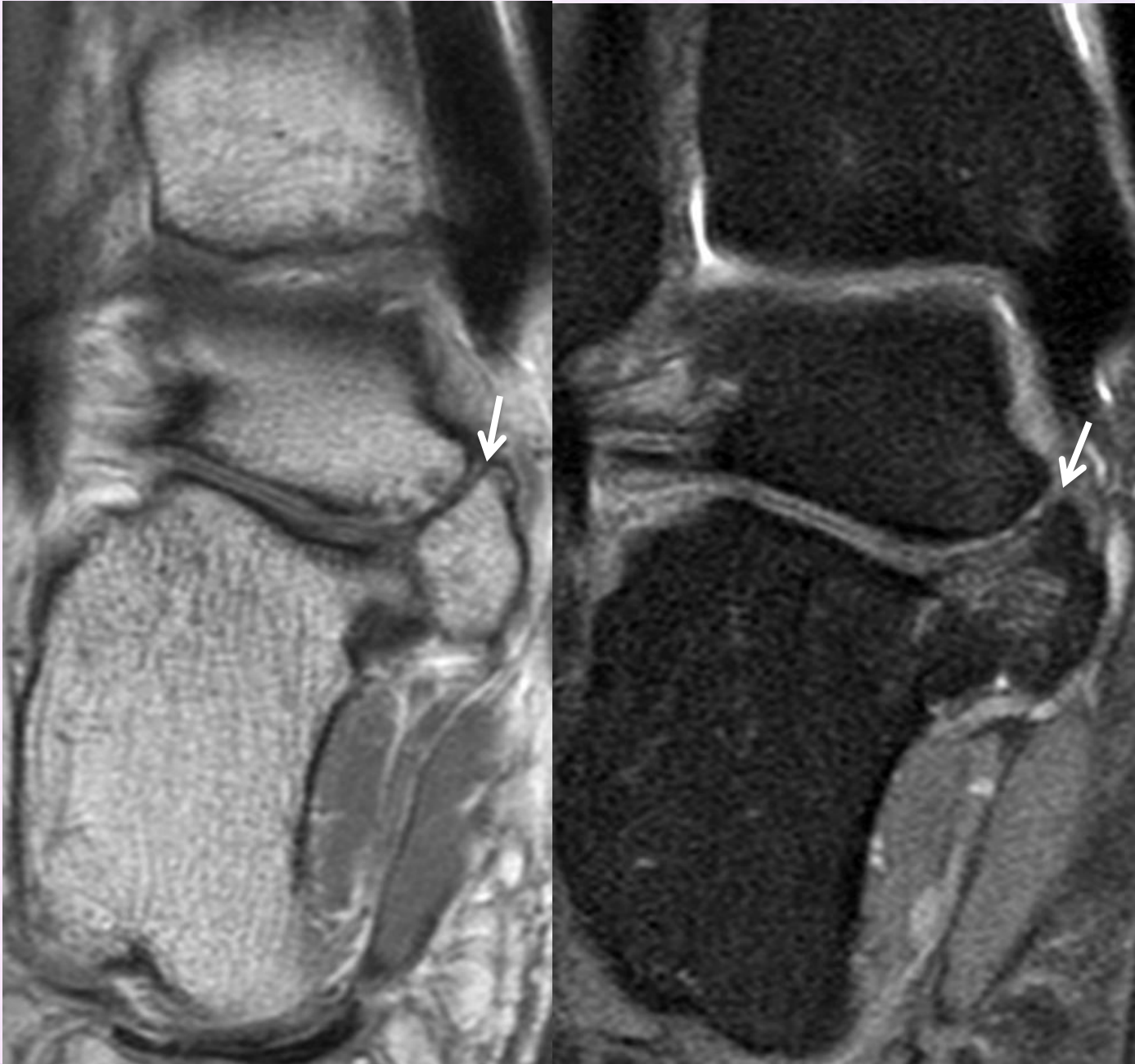


Talocalcaneal coalition – extra-articular posterior facet



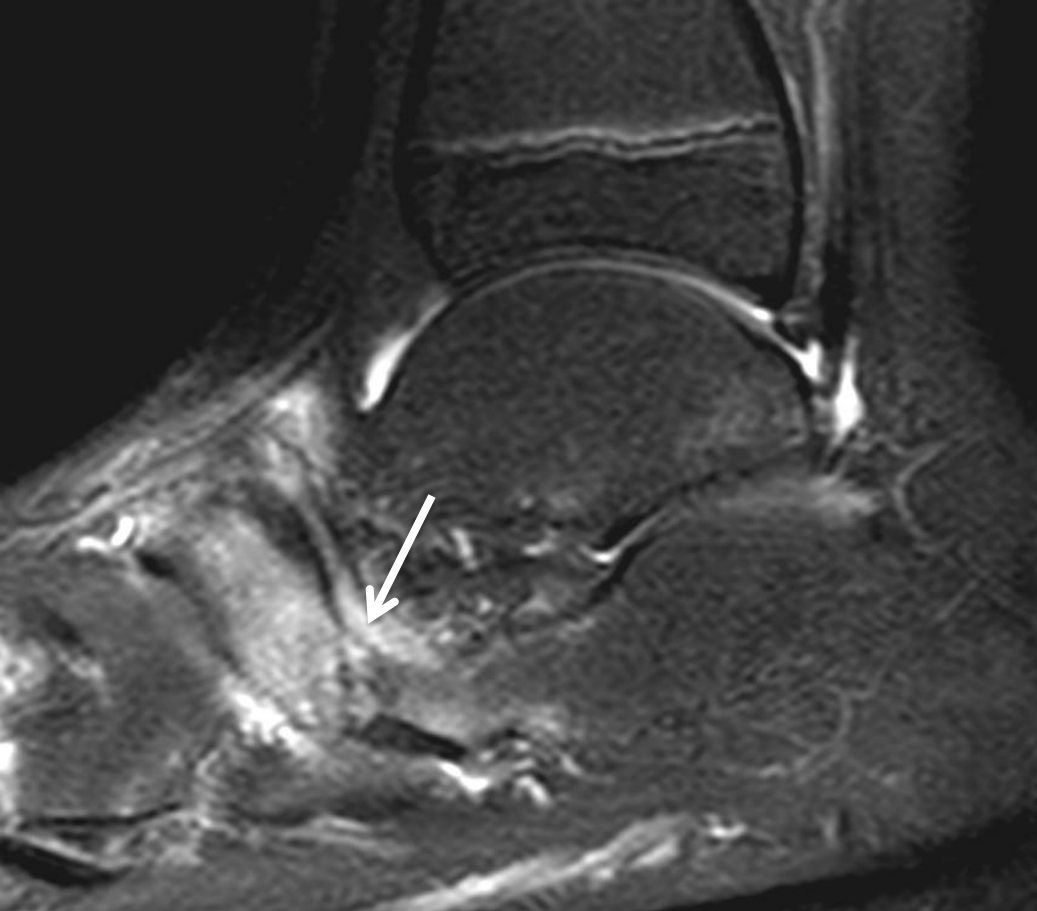
Talocalcaneal coalition – extra-articular middle facet

Os subtentaculi with extra-articular type talocalcaneal coalition

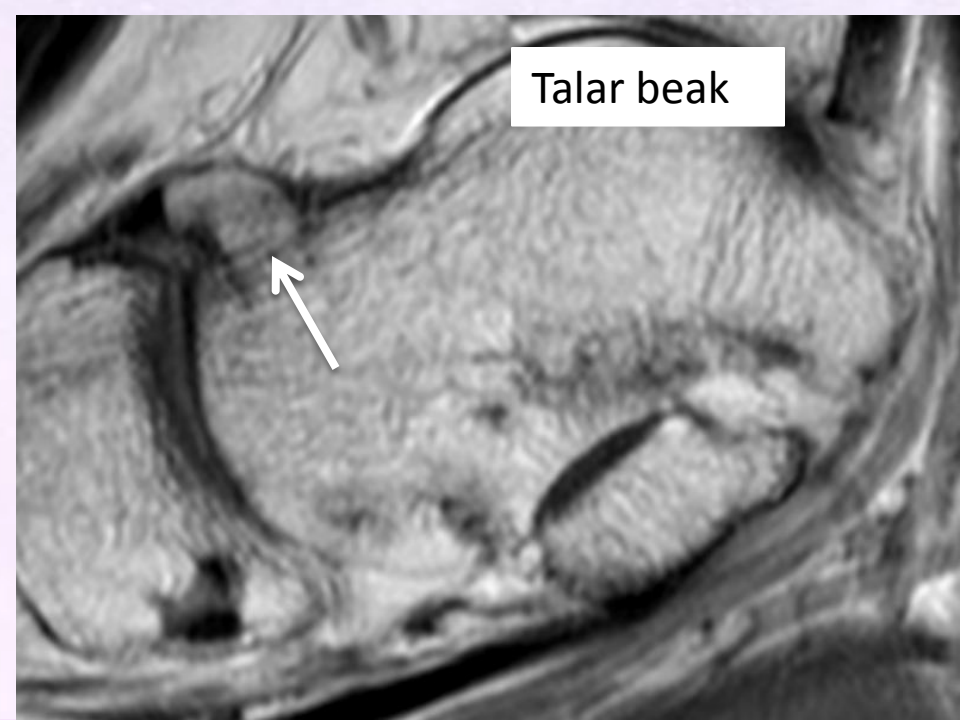
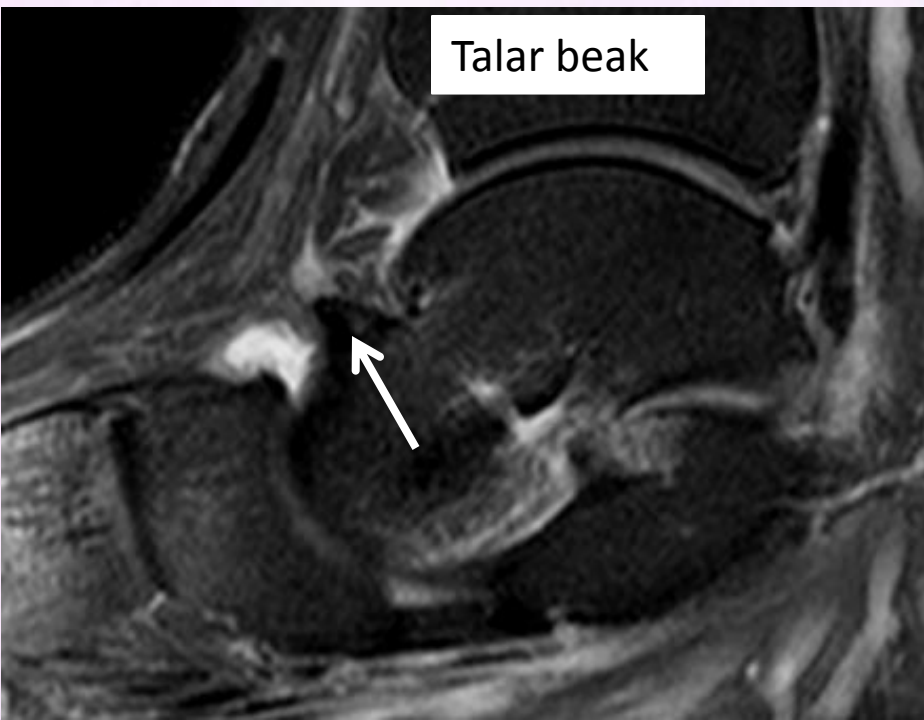
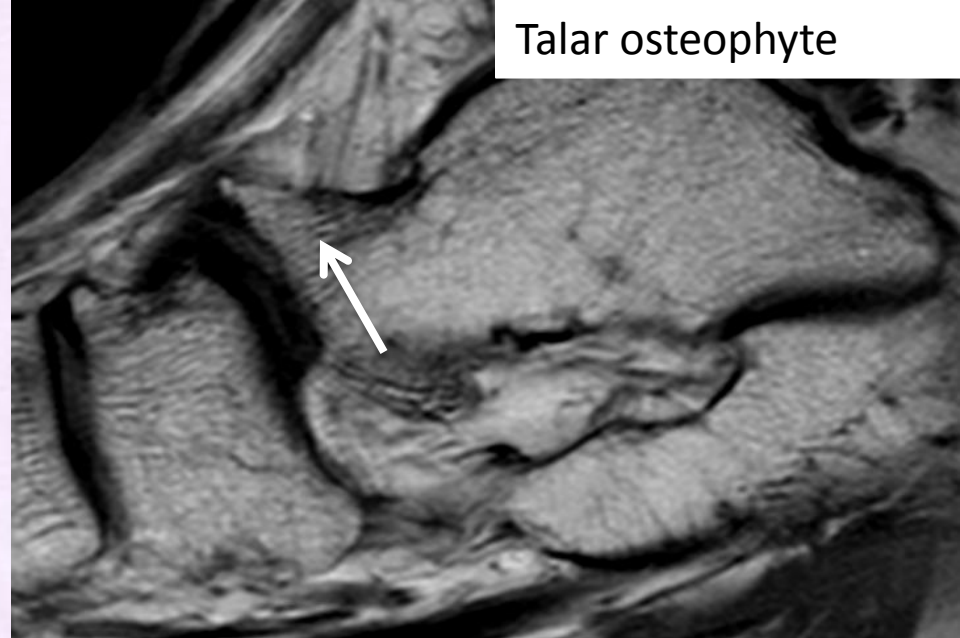
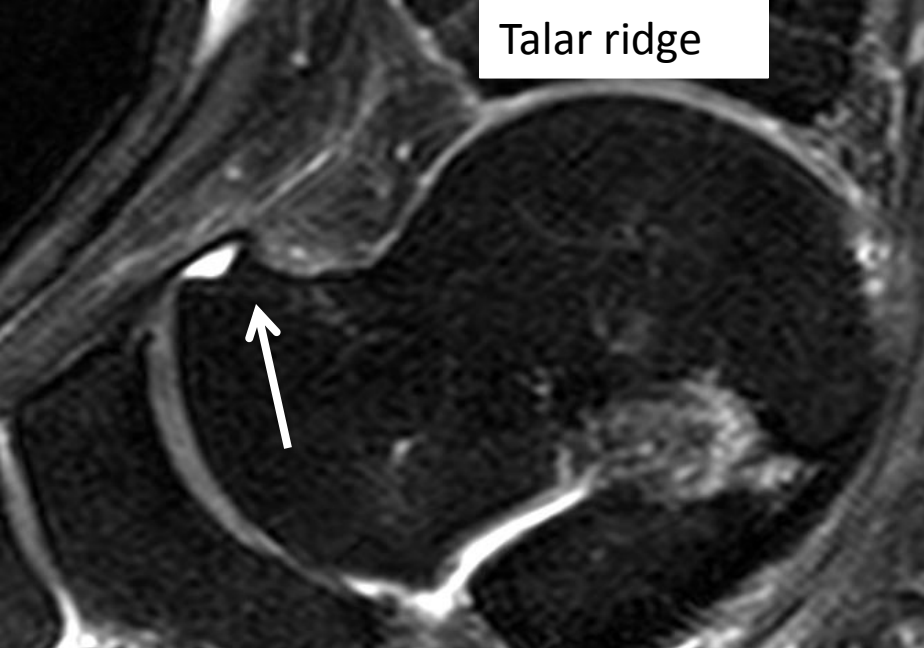




normal



Calcaneonavicular coalition



Acquired adult flatfoot deformity: stages, MR imaging findings, and therapy

Stage		AAFD I	AAFD II	AAFD III	AAFD IV
Clinical		Medial pain Mild weakness	Flexible Pes planovalgus	Fixed Pes planovalgus	AAFD III and tibiotalar valgus o IVA: No osteoarthritis o IVB: Osteoarthritis
MR imaging	PTT	Tenosynovitis Normal PTT or Mild tendinopathy	Tenosynovitis Severe tendinopathy High-grade tear	Tenosynovitis Severe tendinopathy High-grade tear	Tenosynovitis Severe tendinopathy High-grade tear
	Spring ligament (smCNL)	Intact	Abnormal	Abnormal	Abnormal
	MCL	Intact	Intact	TSL abnormality	Chronic lesion of superficial and deep layer
	Possible associated findings		Sinus tarsi syndrome Plantar fasciitis	Sinus tarsi syndrome Plantar fasciitis Possible lateral impingement Subtalar osteoarthritis	Osteoarthritis Lateral impingement
Therapy		Mostly conservative management	Mostly surgery: Soft tissue procedures: o PTT, spring Bony procedures: o Lateral column lengthening o Medial column procedures	Mostly surgery o Arthrodesis o Lateral column lengthening	Surgery: o MCL reconstruction o Triple arthrodesis o Tibiotalar arthrodesis o Arthroplasty

Checklist for reading MR images of patient with flat foot

1) Bony alignment

- ✓ Heel valgus
- ✓ Inferomedial migration of talus head
- ✓ Uncovering of talus head by navicular
- ✓ Talus plantar flexion

2) Associated soft tissue abnormalities

- ✓ Posterior tibialis tendon (tendinosis, tenosynovitis, tear)
- ✓ Spring ligament complex (thickening, thinning, tear)
- ✓ Sinus tarsi (edema, fibrosis, sinus tarsi ligaments)
- ✓ Deltoid ligament (particularly tibiospring ligament)
- ✓ Plantar fascia

3) Secondary bony abnormalities

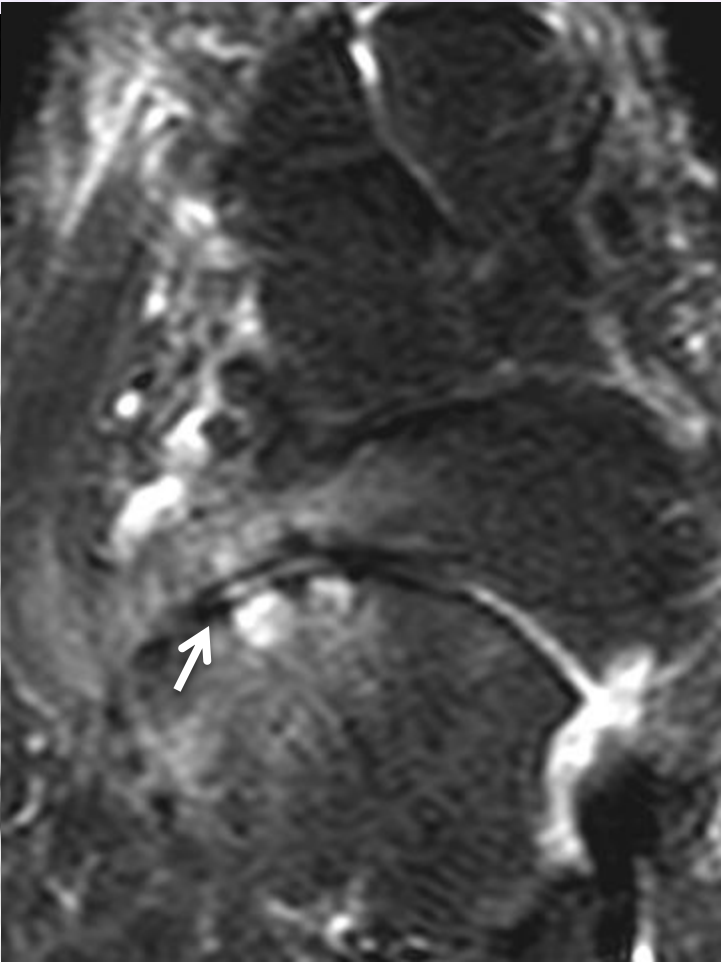
- ✓ Lateral hind foot impingement (talocalcaneal, subfibular)
- ✓ Osteoarthrosis (ankle, subtalar...)
- ✓ Hallux valgus

4) Underlying relevant congenital abnormalities

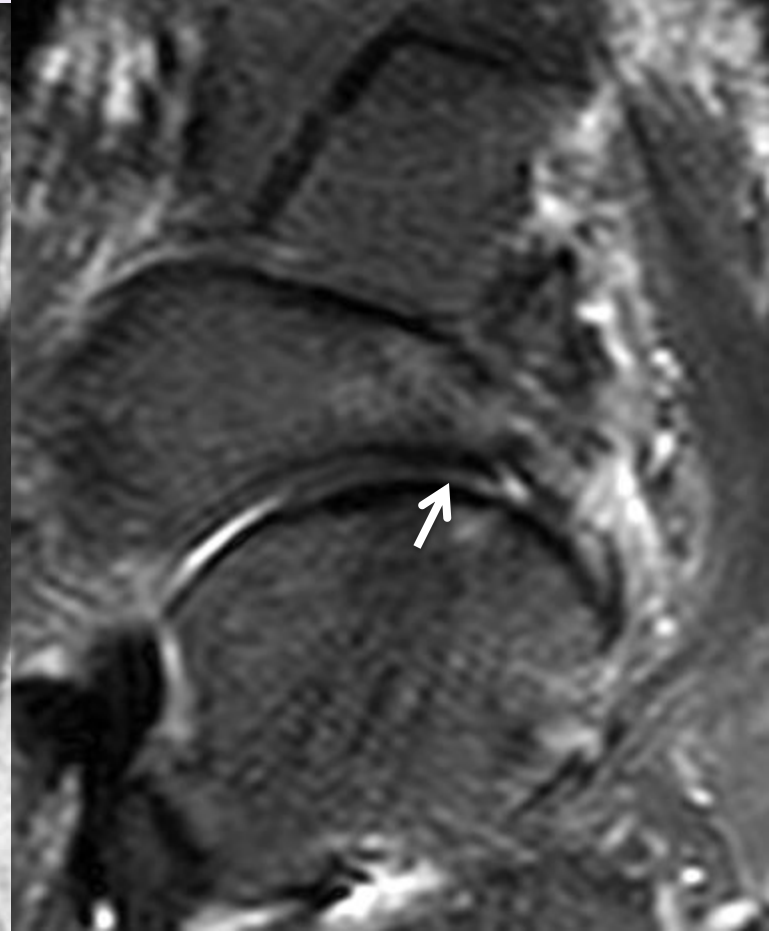
- ✓ Tarsal coalition (talocalcaneal, calcaneonavicular...)
- ✓ Accesory navicular bone

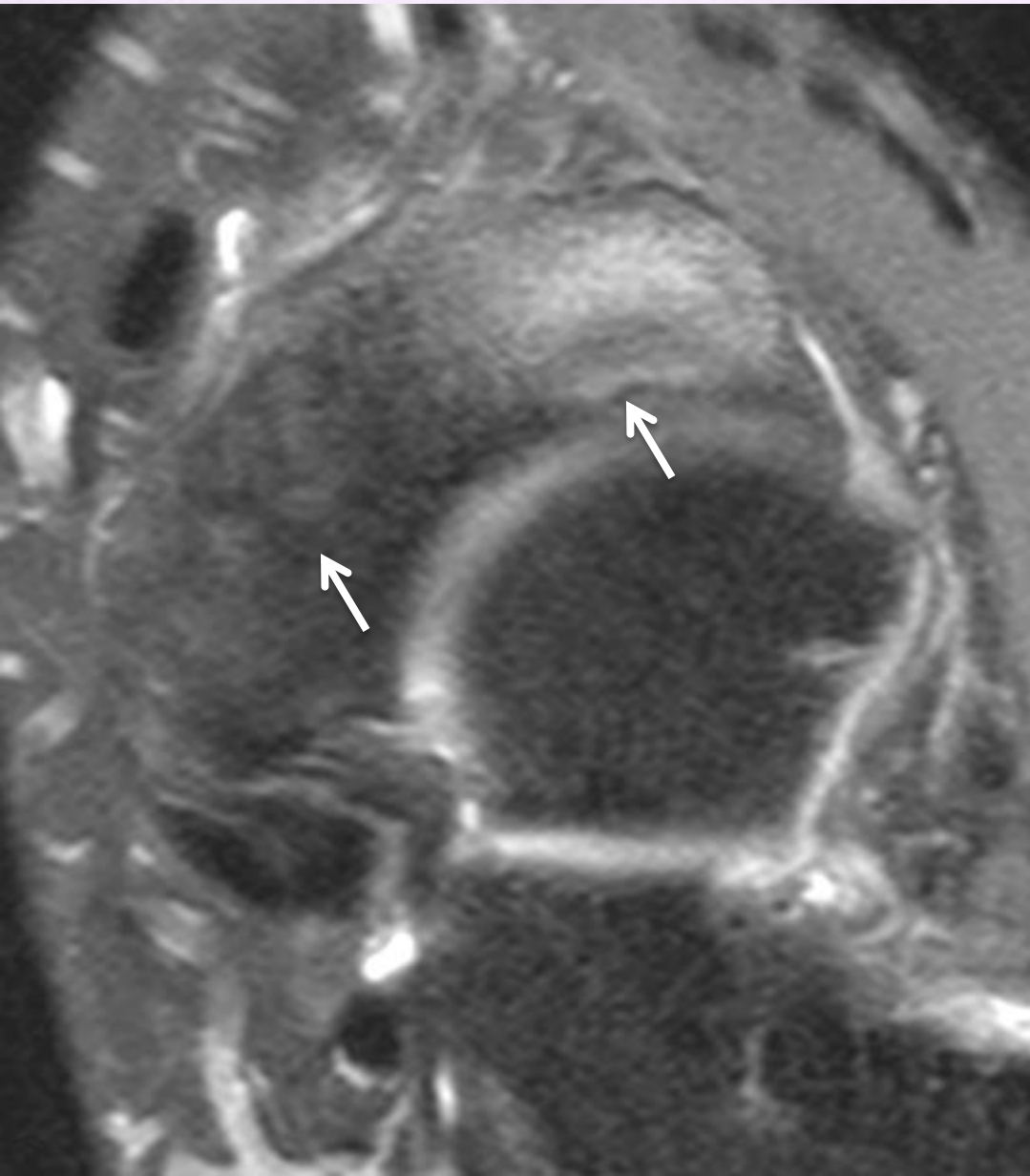
Other navicular pathology

1. Fracture : acute or stress vs bipartite
2. Kohler's disease(ostechondrosis)
3. Mueller Weiss syndrome (or 2° AVN)
4. Accessory ossicle (vs osteochondral lesion/fracture)
5. Coalition



Mueller Weiss syndrome

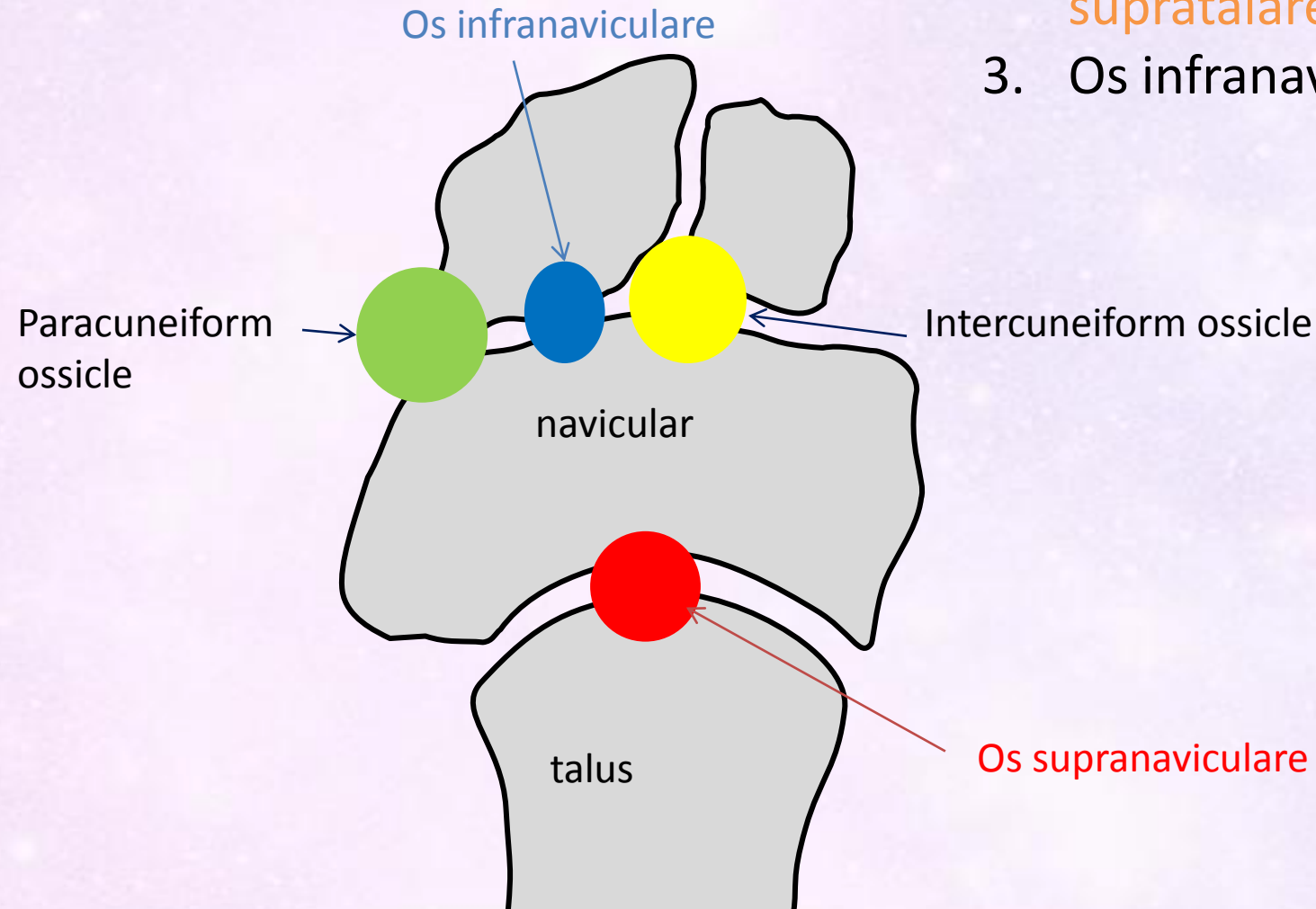


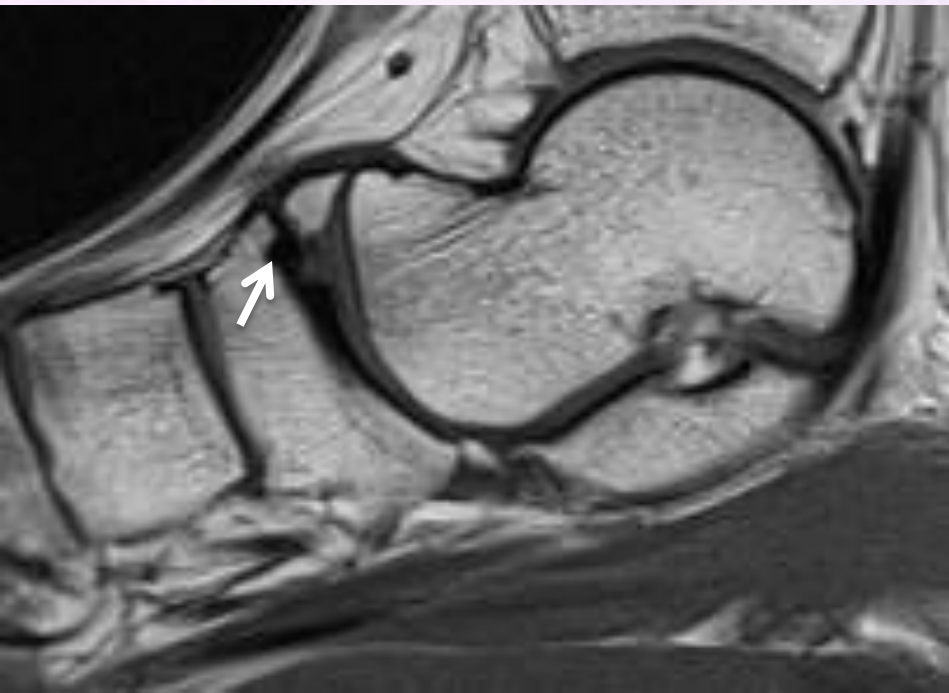
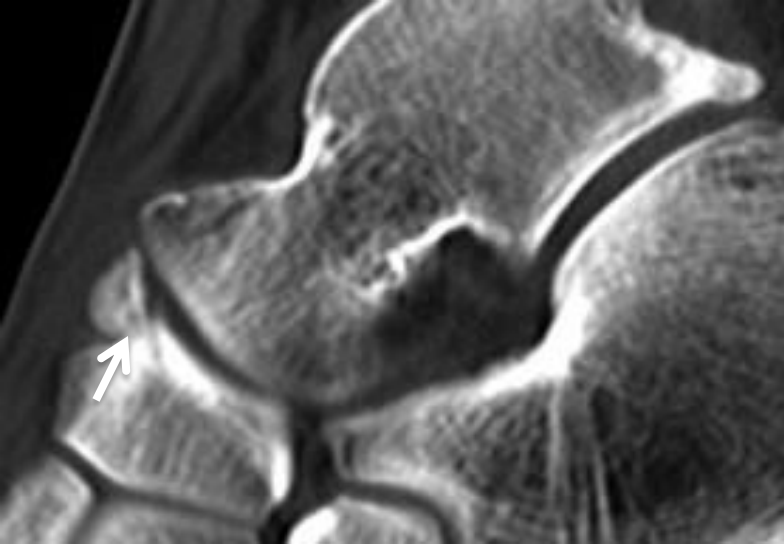


Kohler's
disease

Accessory navicular ossicle:

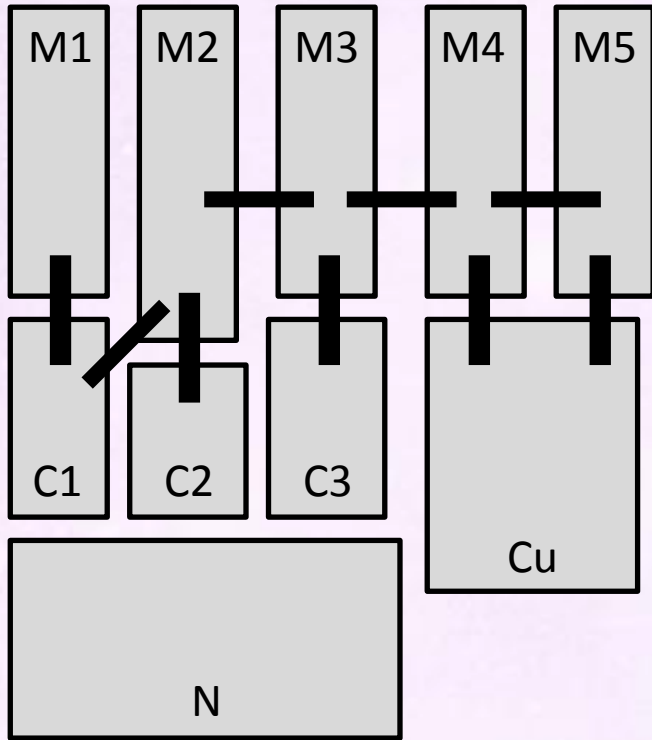
1. Type 1-3
2. Os supranaviculare (os supratalsare)
3. Os infranaviculare



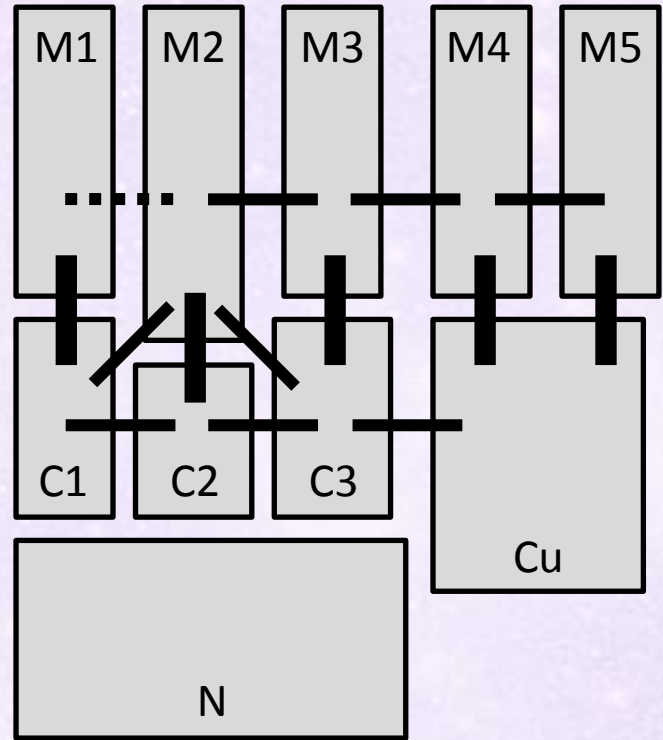


Mid foot injury – Lisfranc's injury



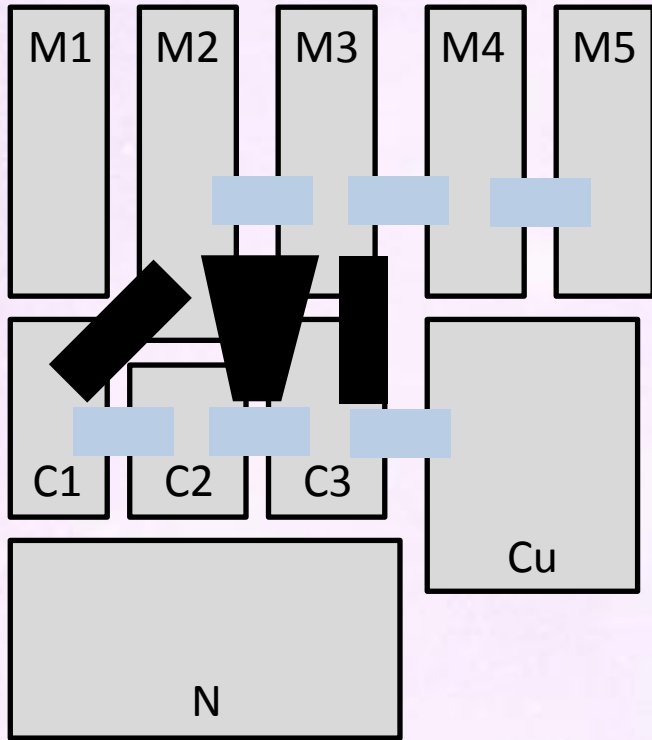


Simplified

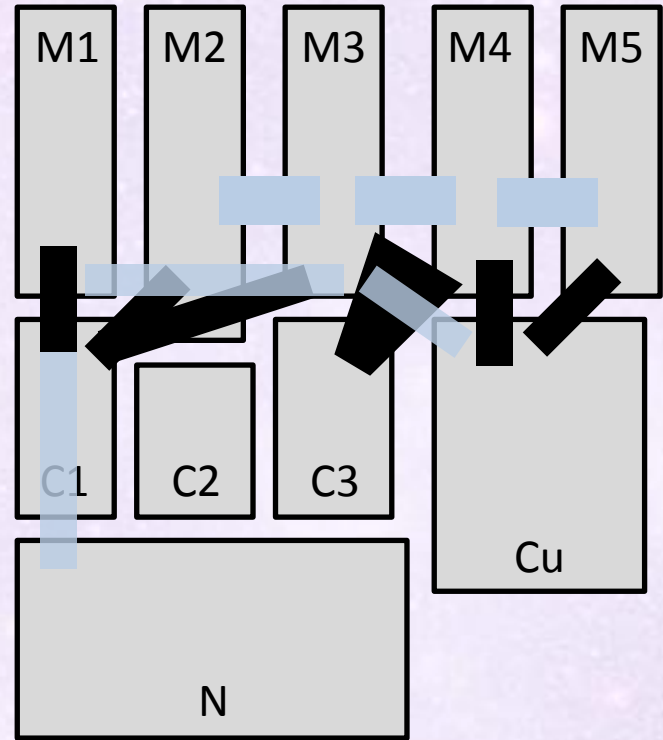


Dorsal

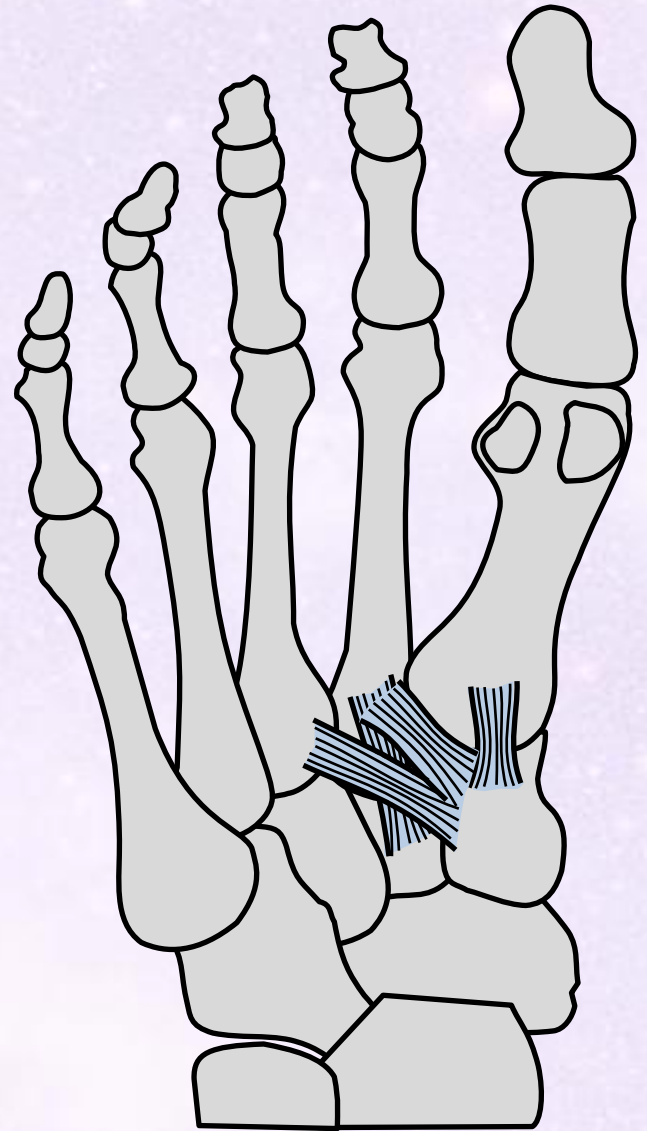
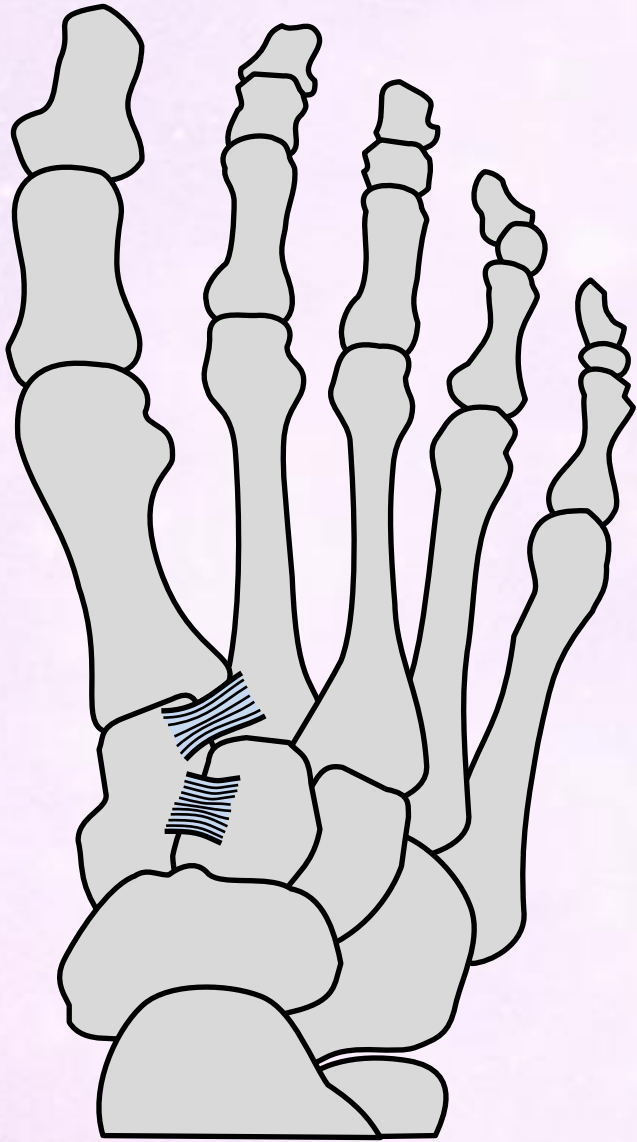
Dash line : occasionally identified



Interosseous

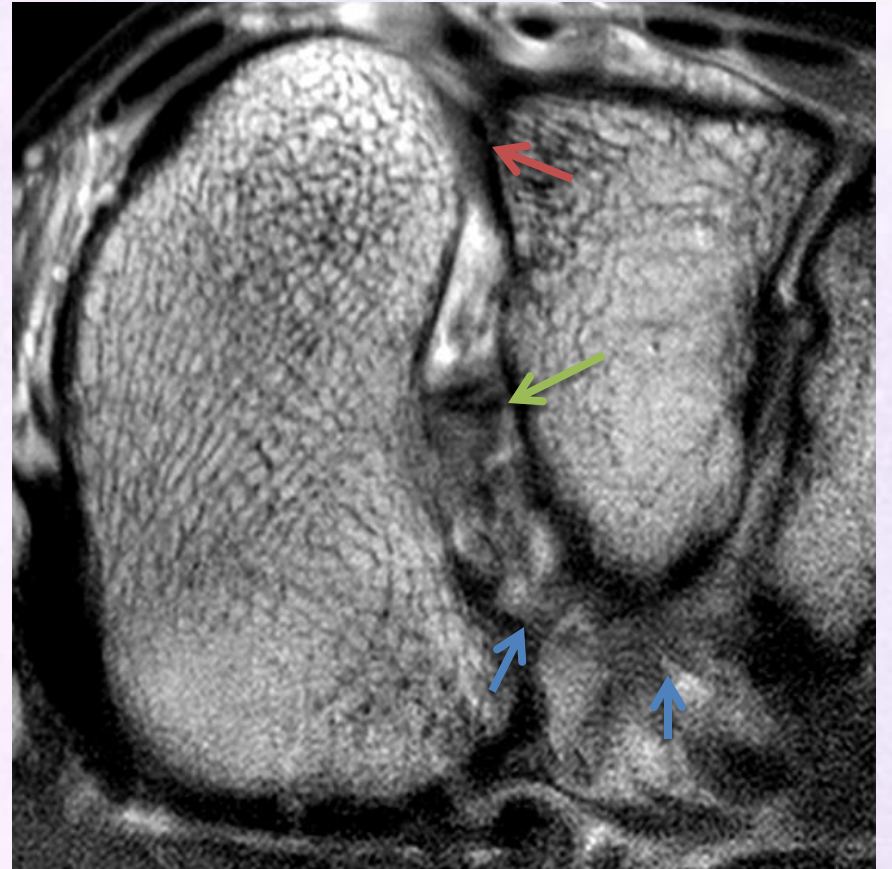
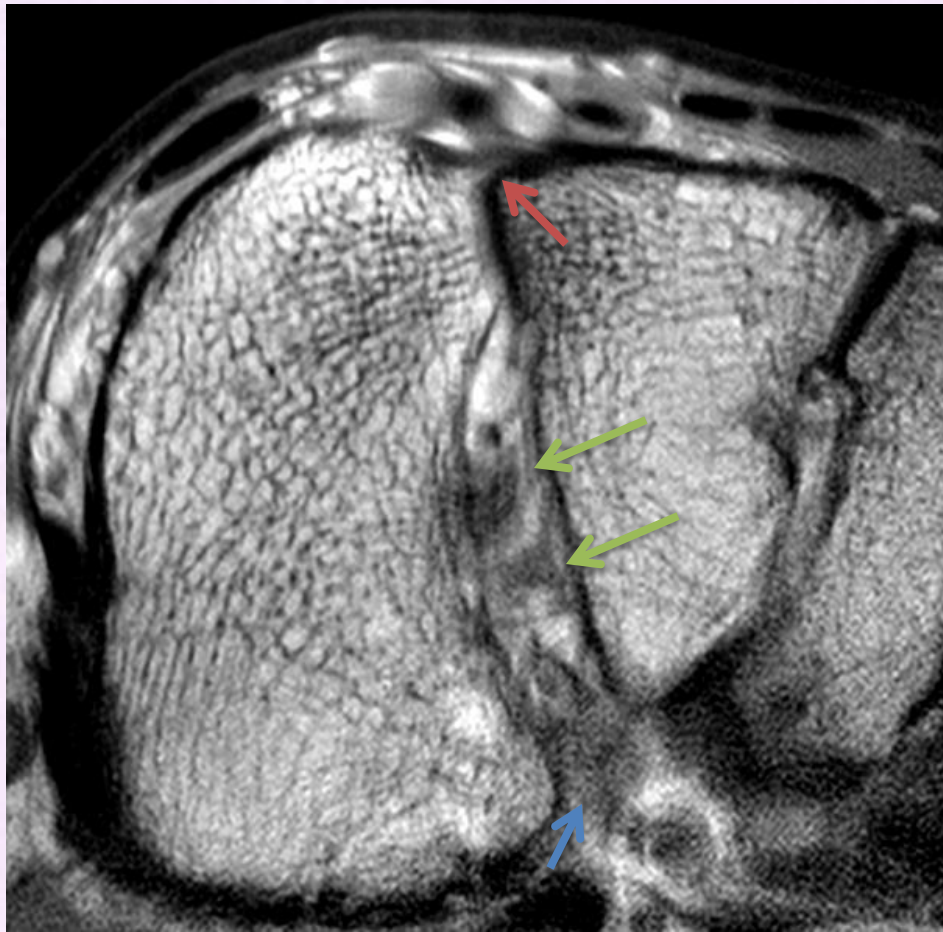


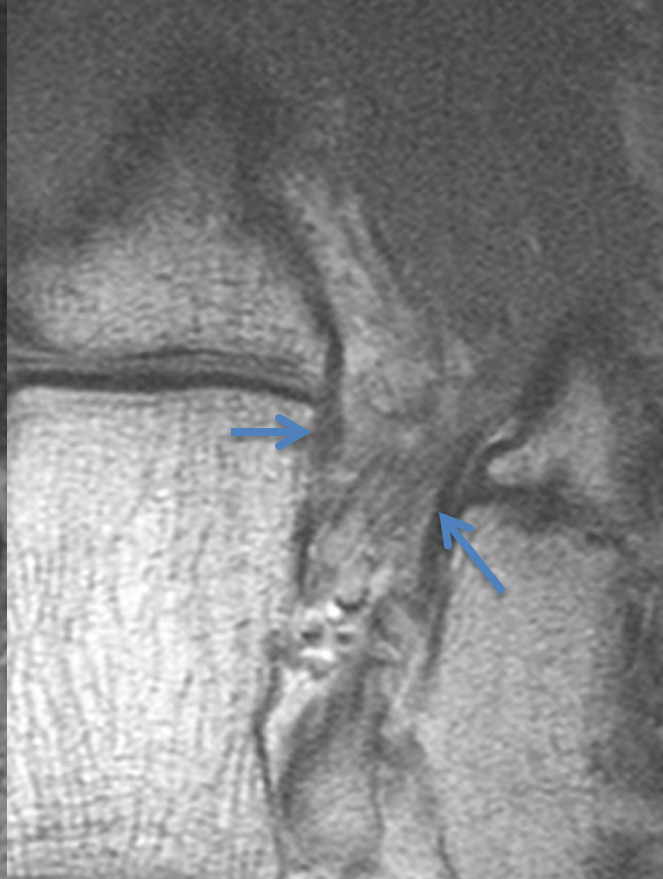
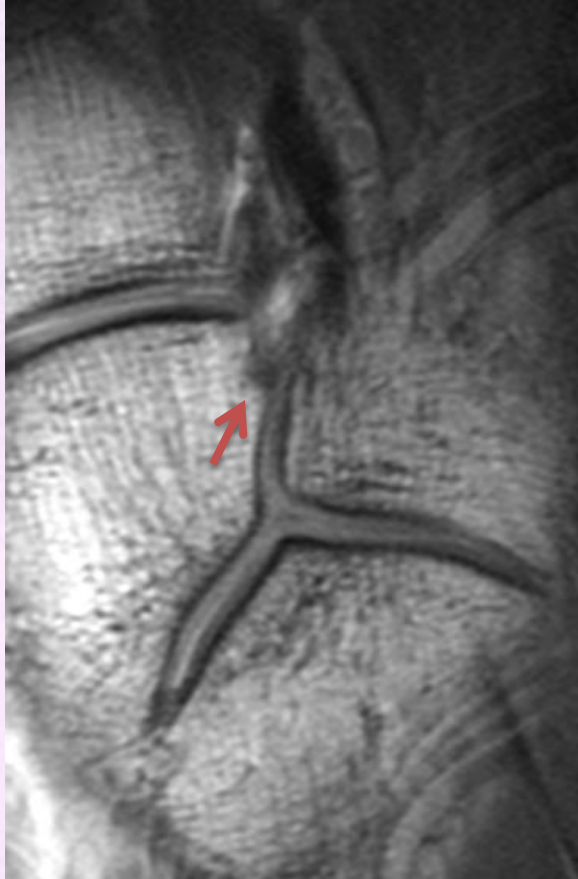
Plantar





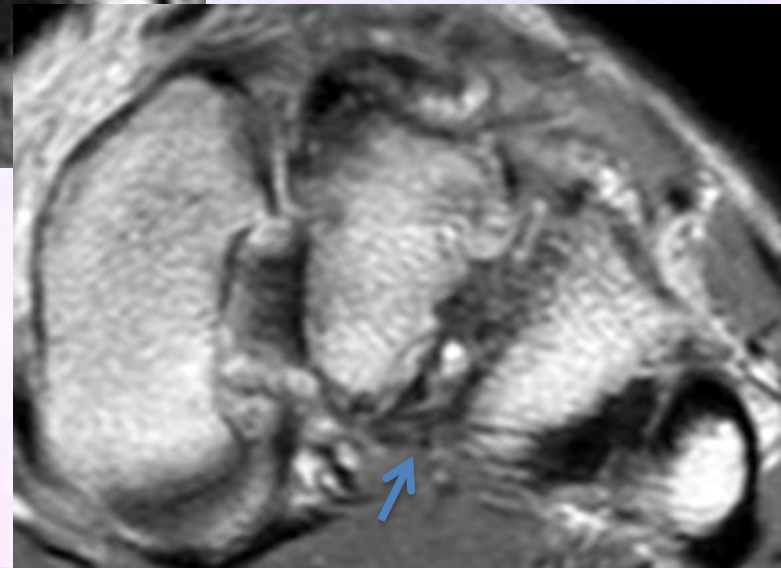
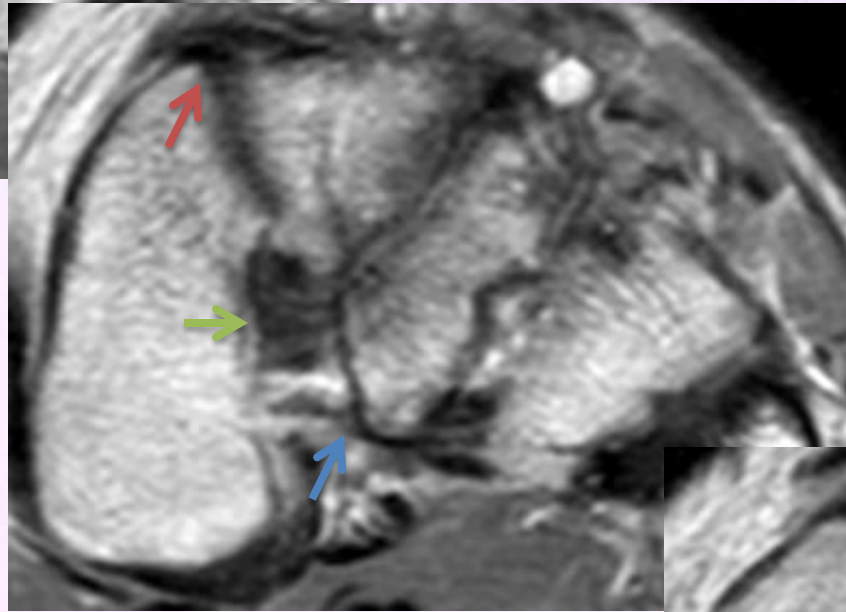
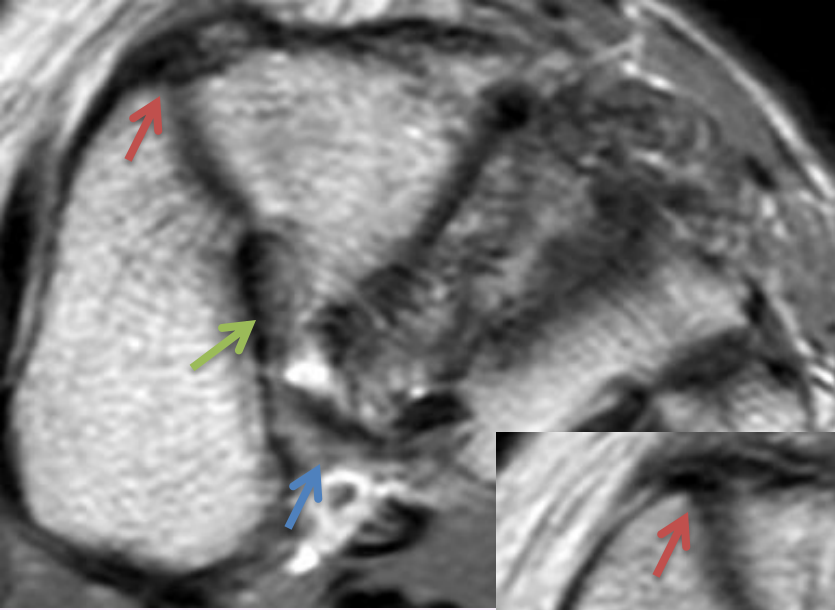
Axial



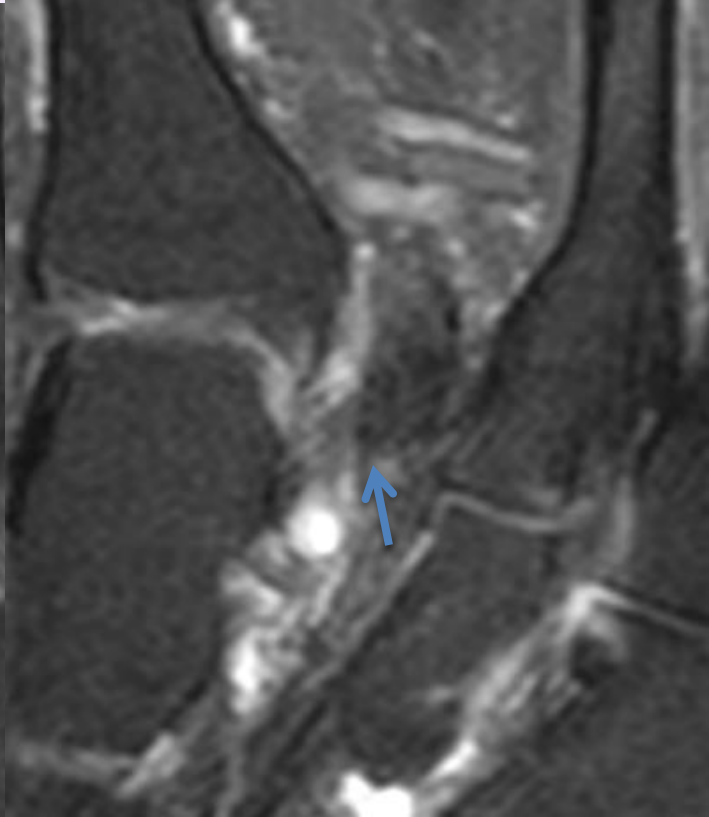
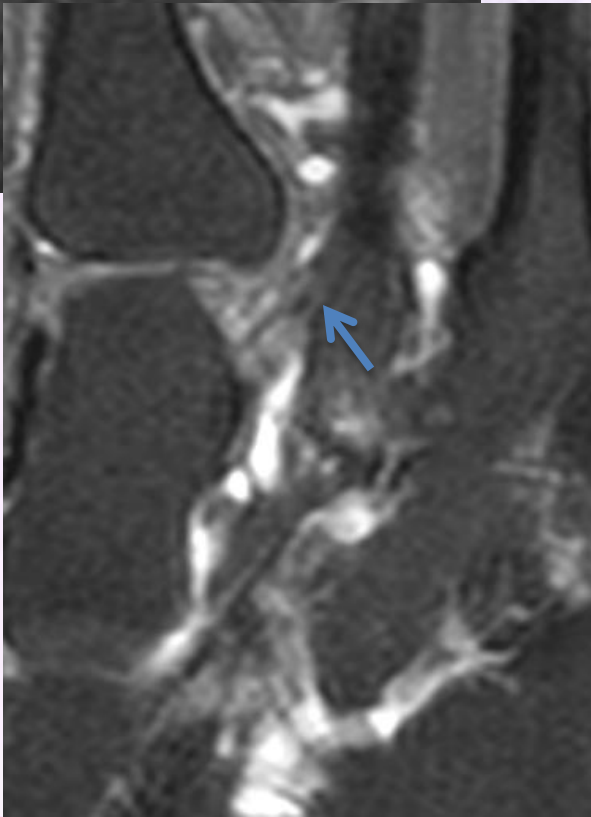
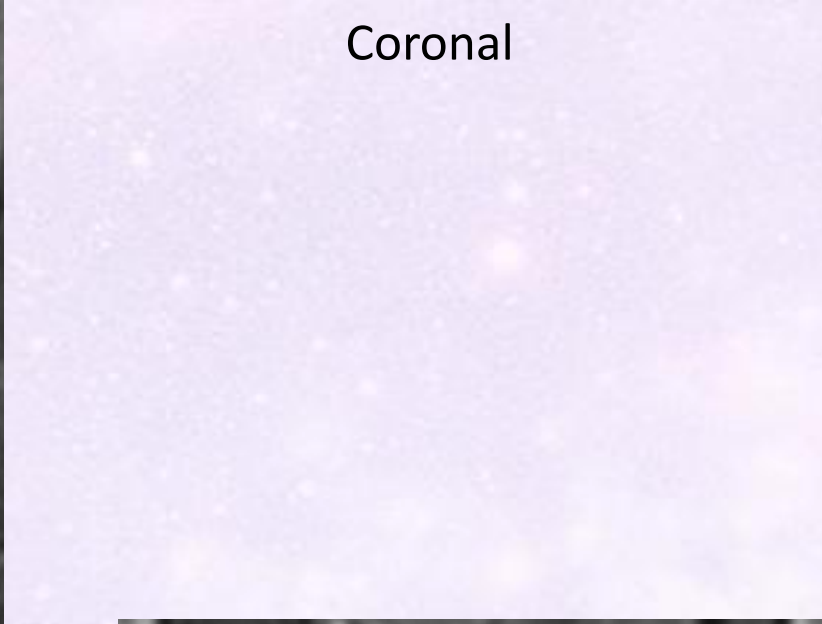
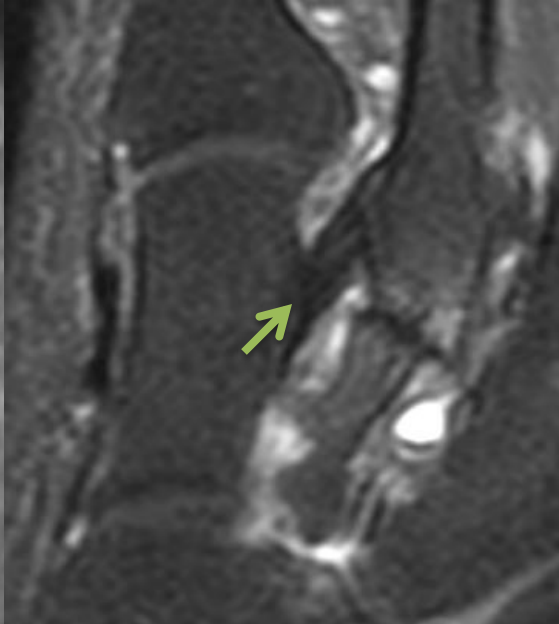


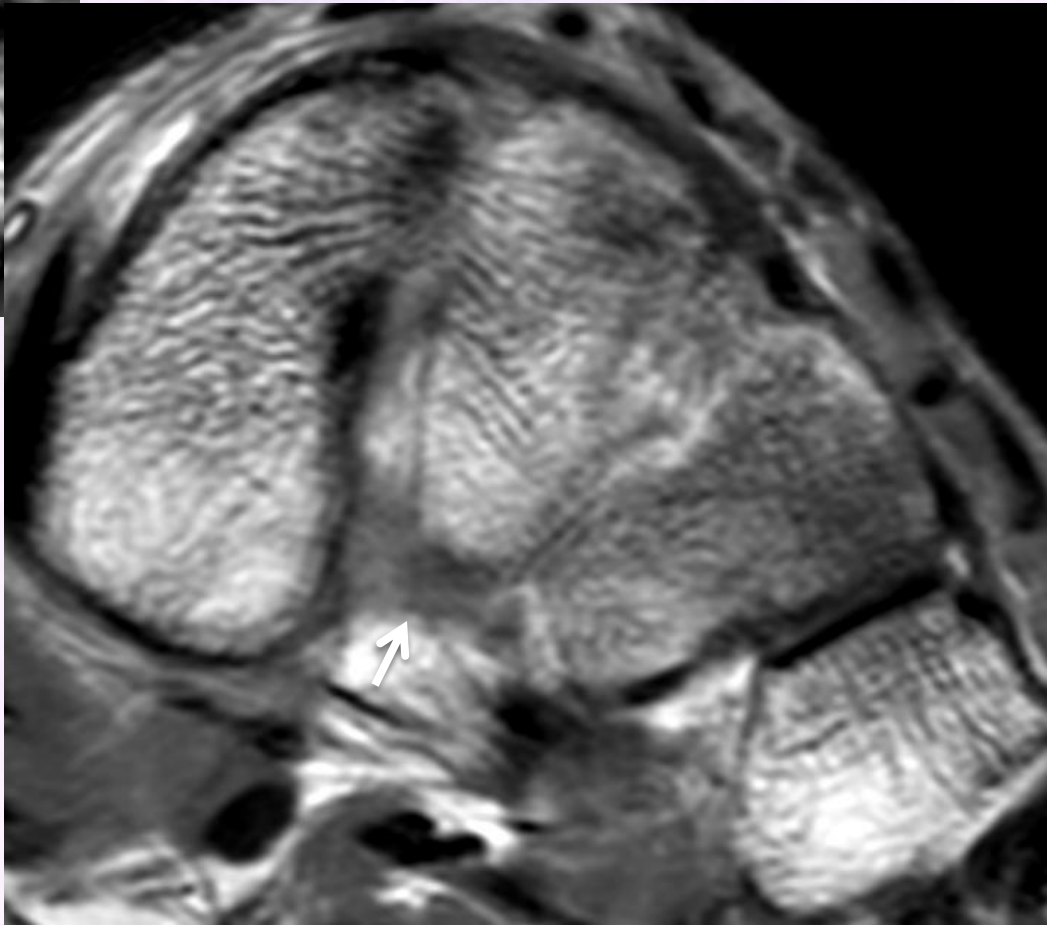
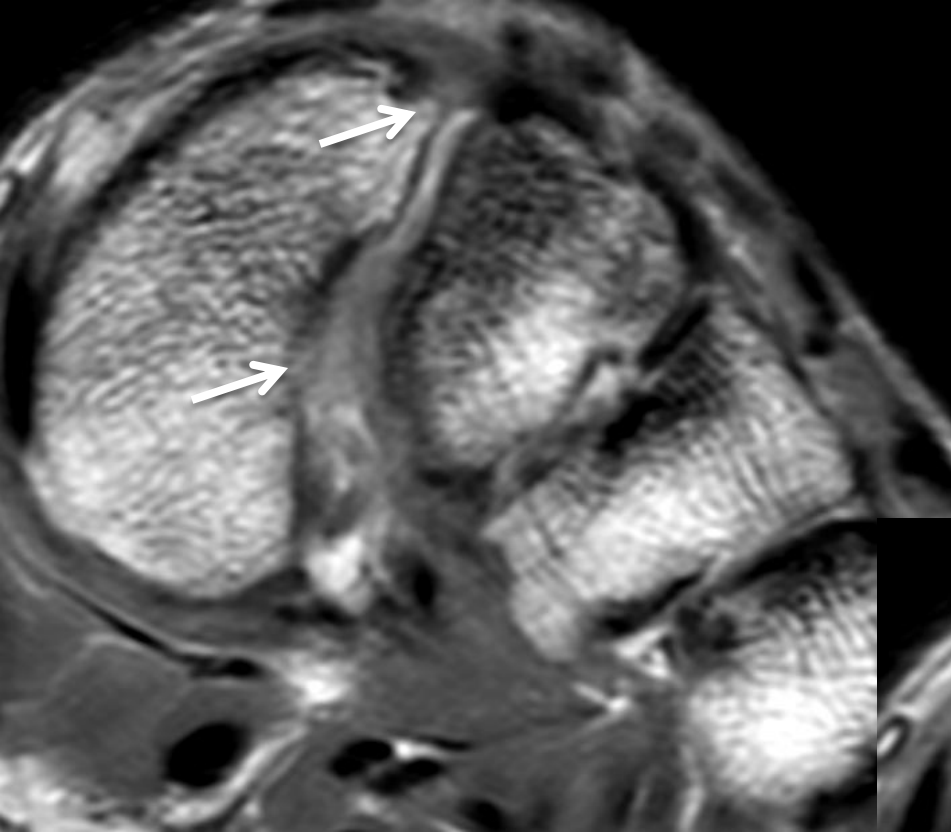
Coronal

Axial



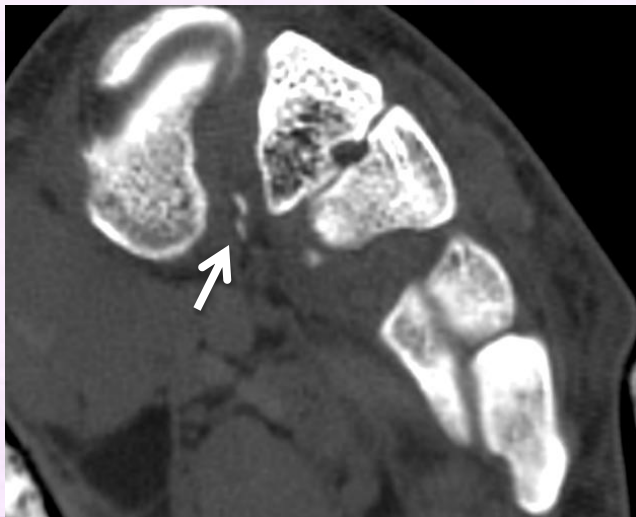
Coronal

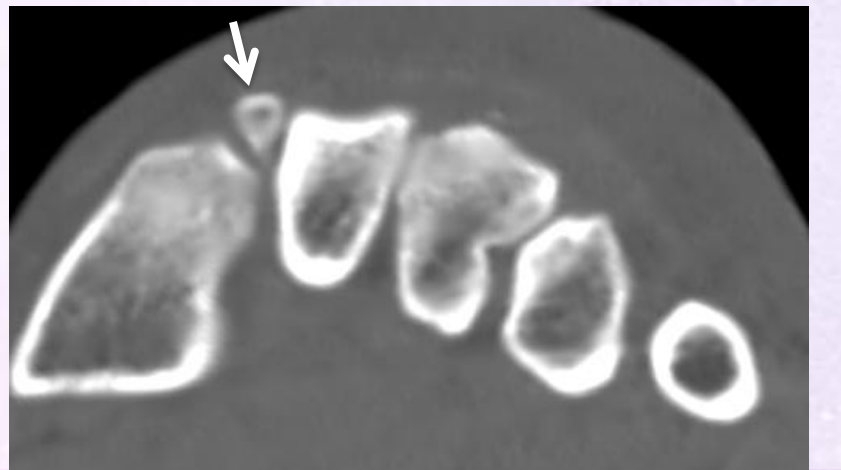






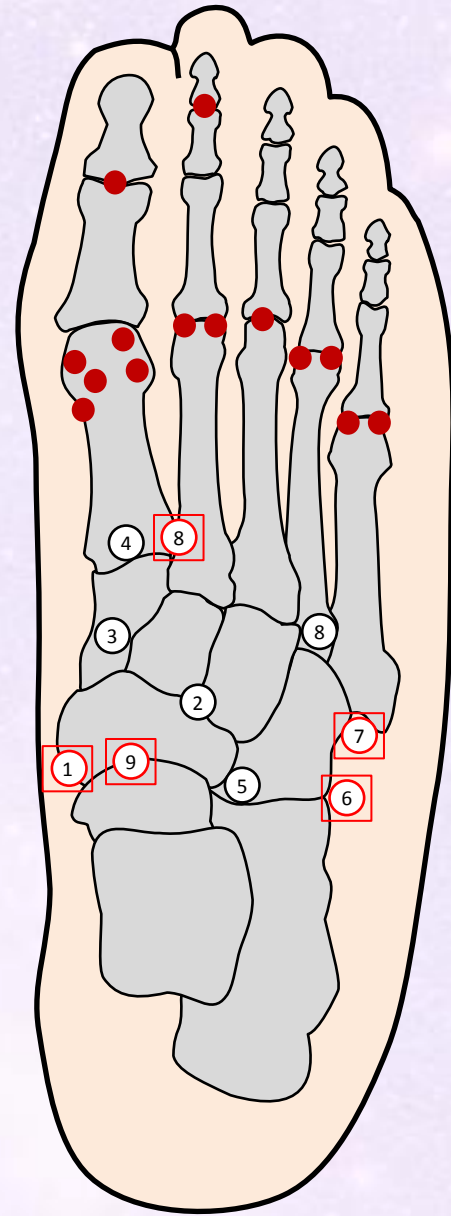
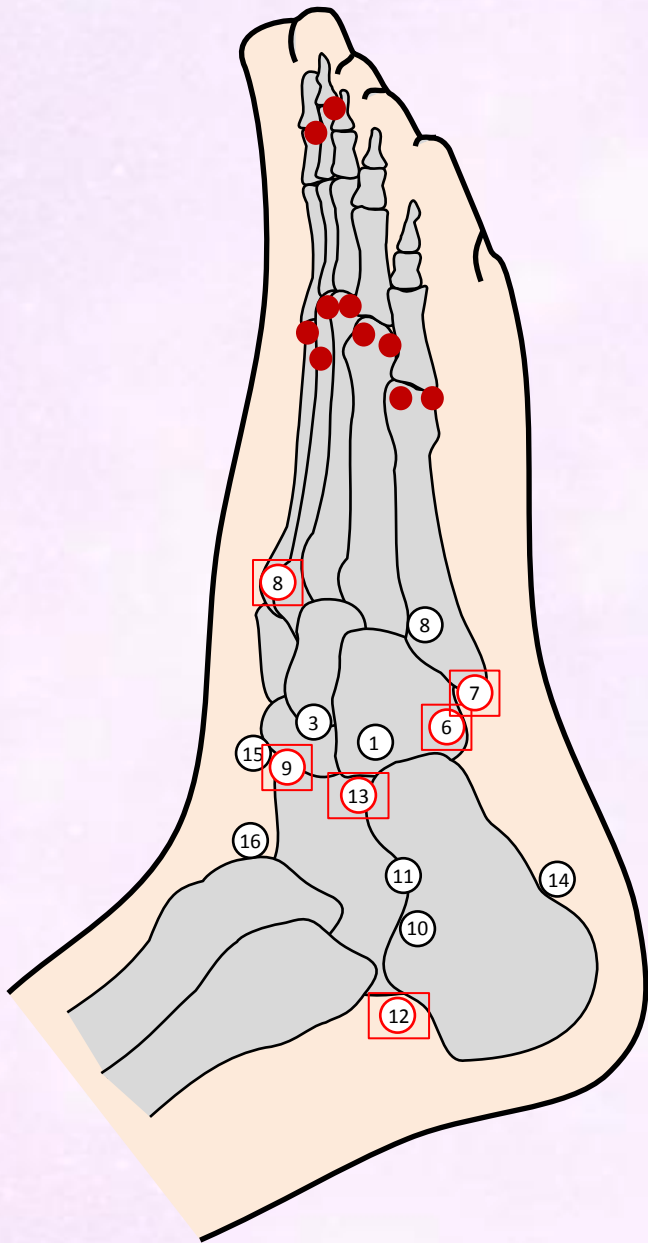
Fleck sign

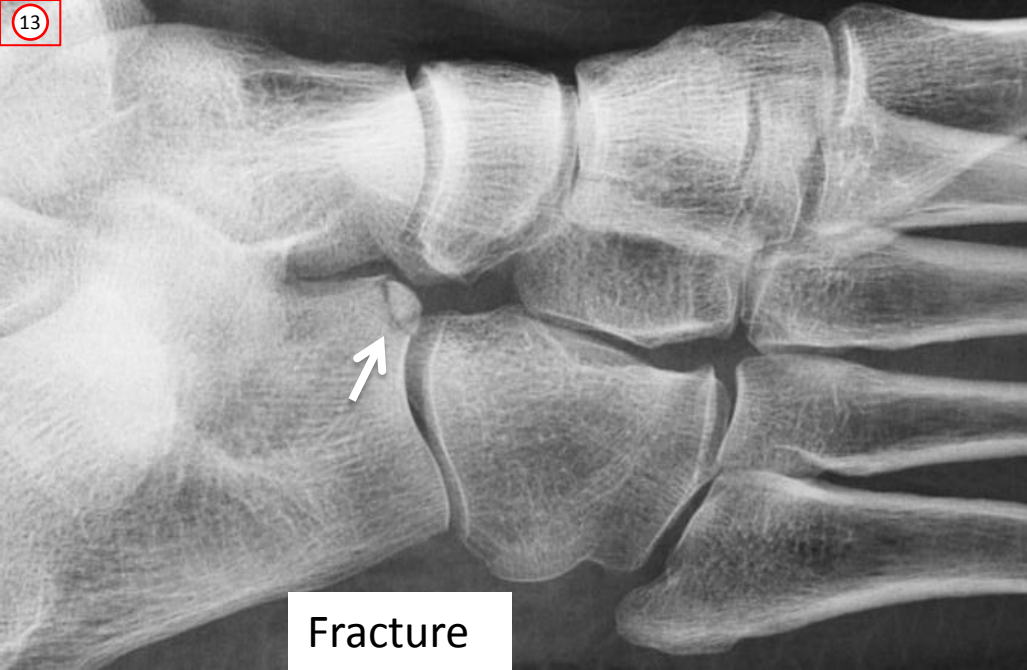


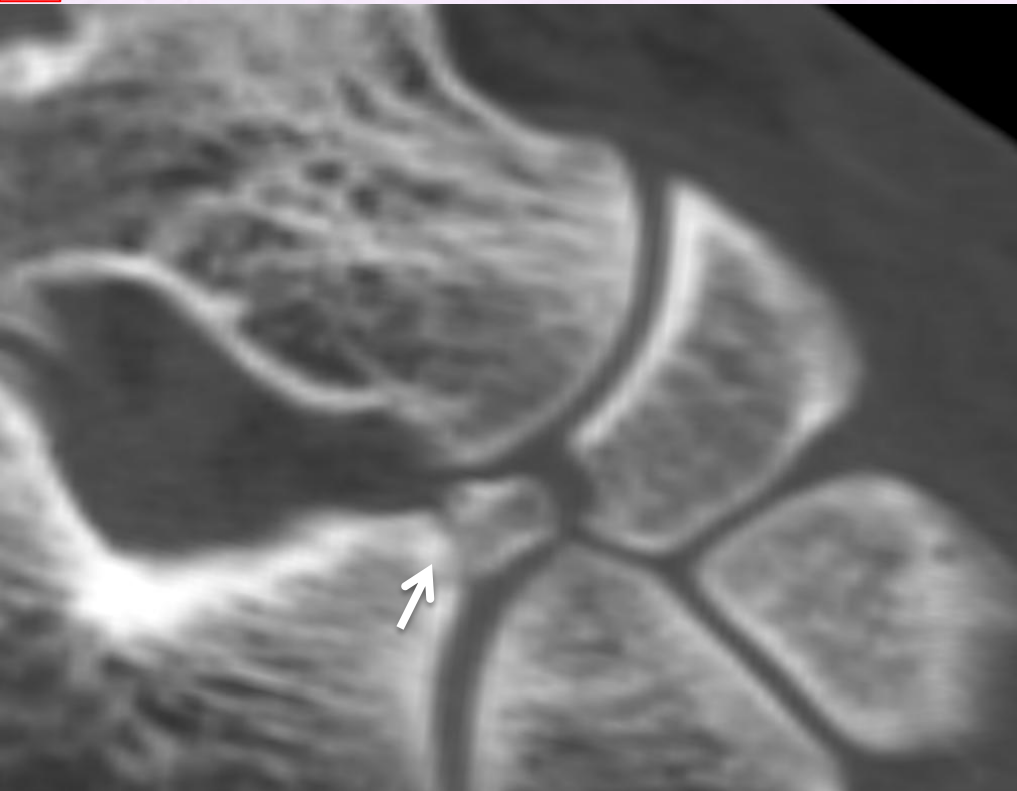


Os intermetatarsium

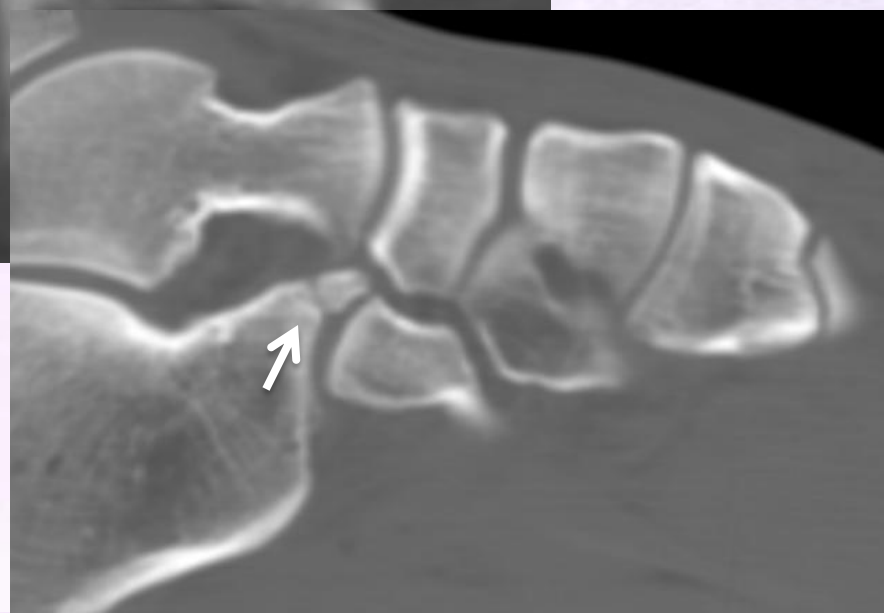
Other accessory ossicles

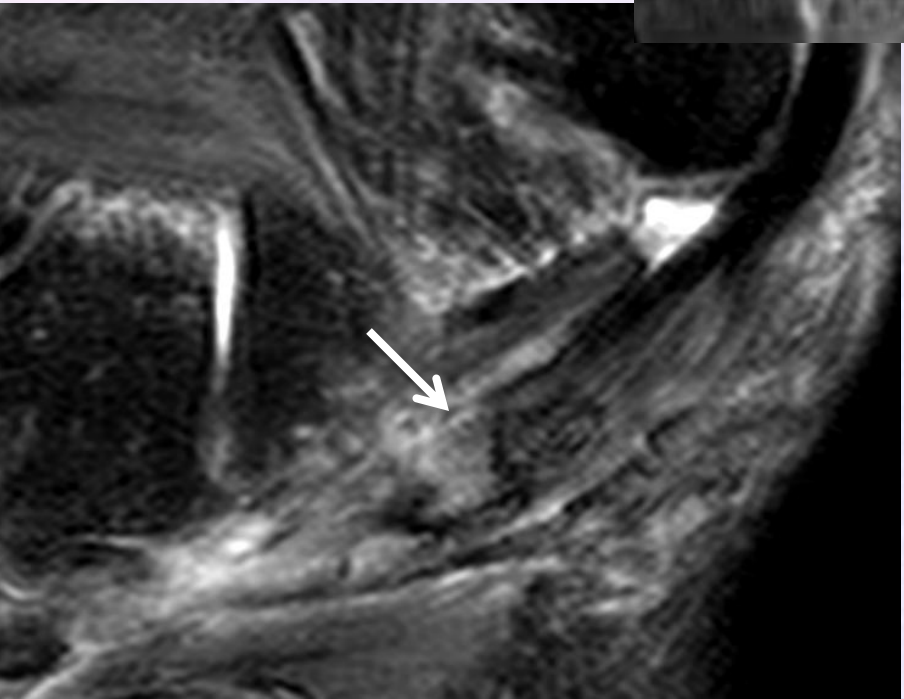
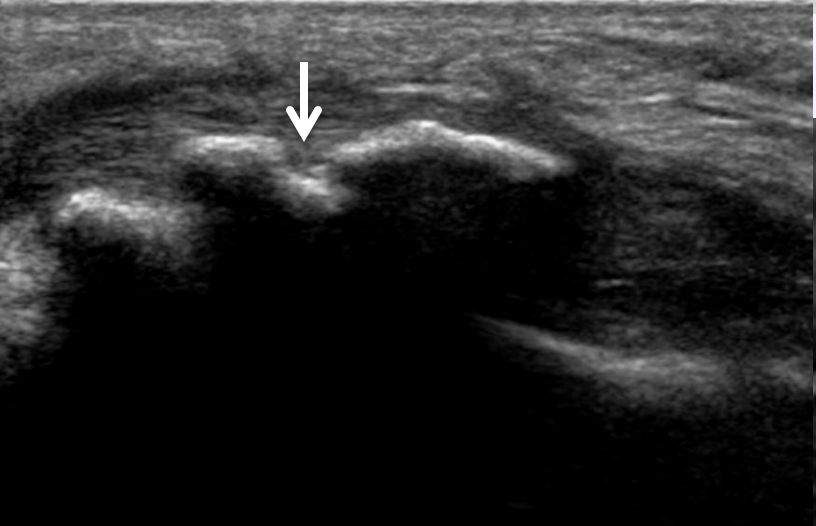
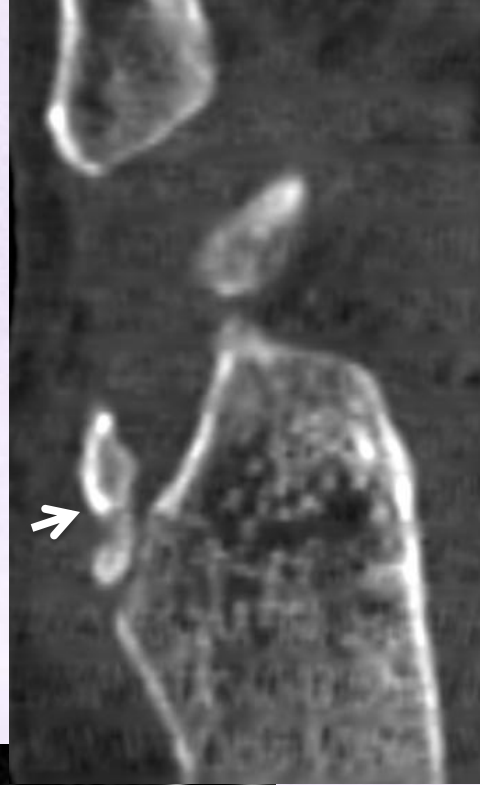




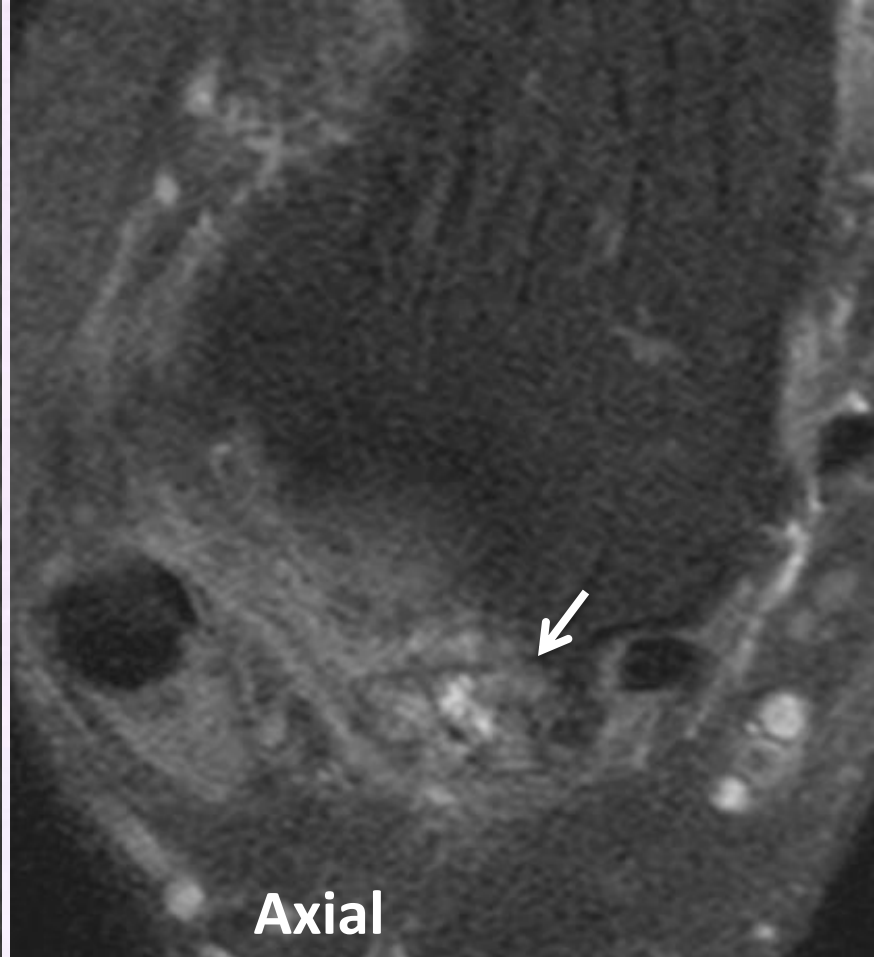


Os calcaneus secundarius
? Fracture





Os peroneum syndrome



Os trigonum syndrome

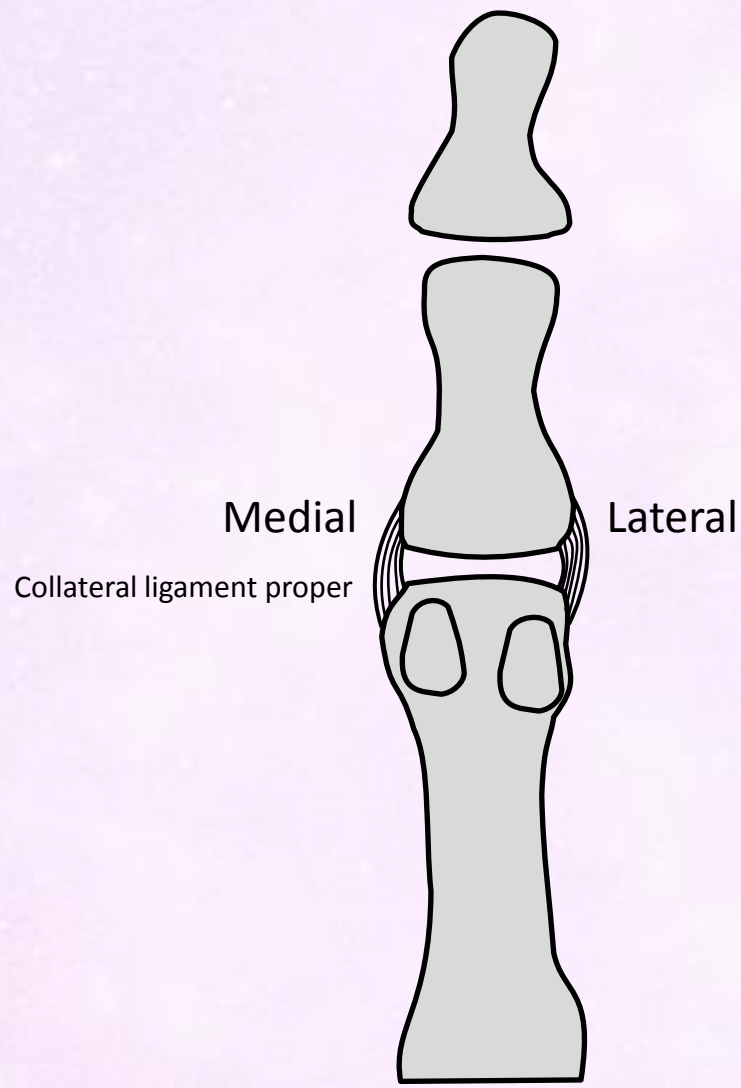
Metatarsalgia

Metatarsalgia

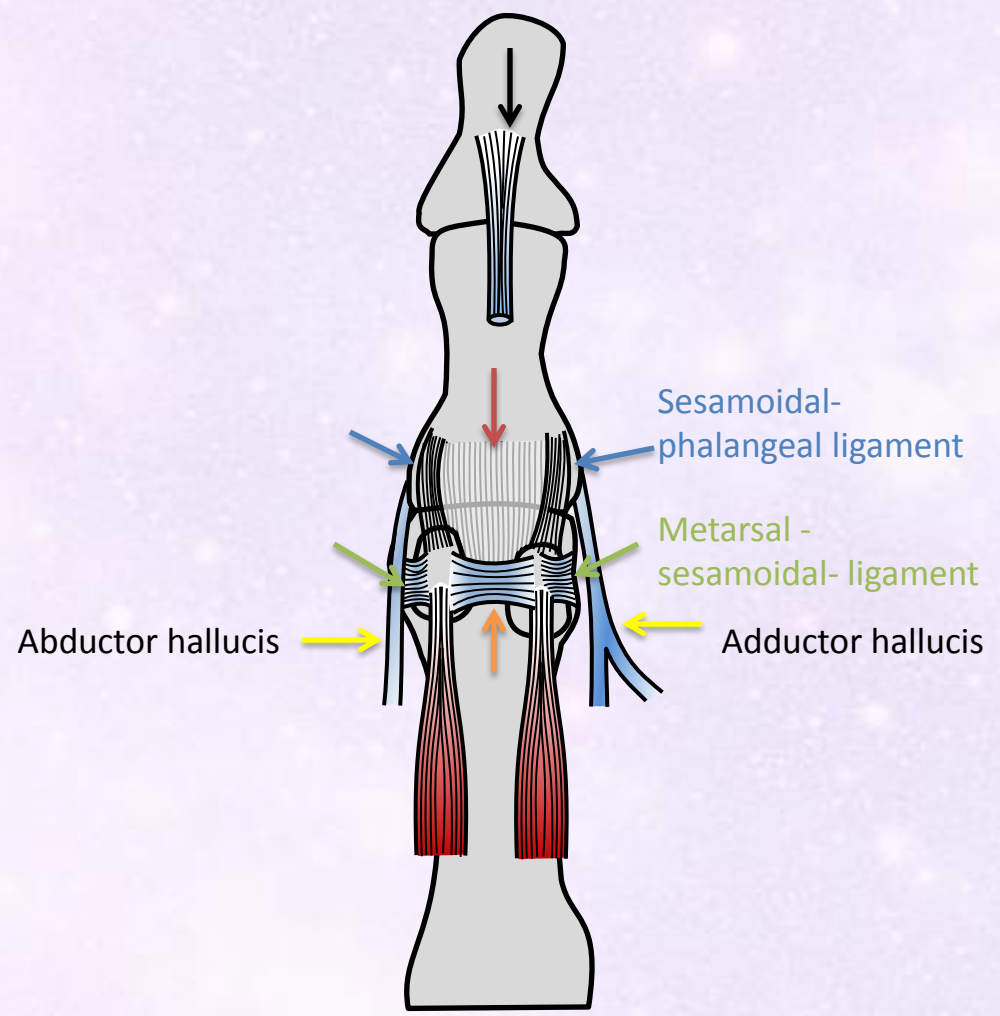
- Turf's toe (plantar plate injury)
- Seasmoid pathology
- Morton's neuroma (vs intermetatarsal bursitis)
- Stress fracture
- Freiberg's disease
- MTP joint disorders
- Tendon pathologies

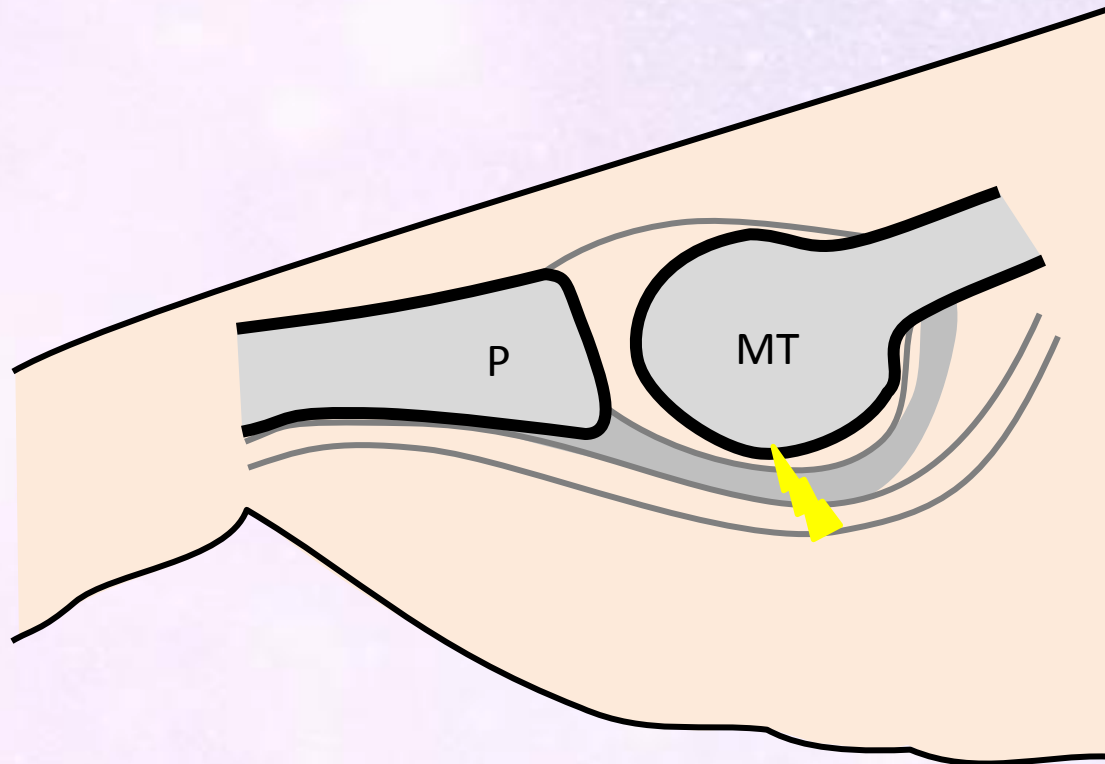
A. Turf toe

Big toe



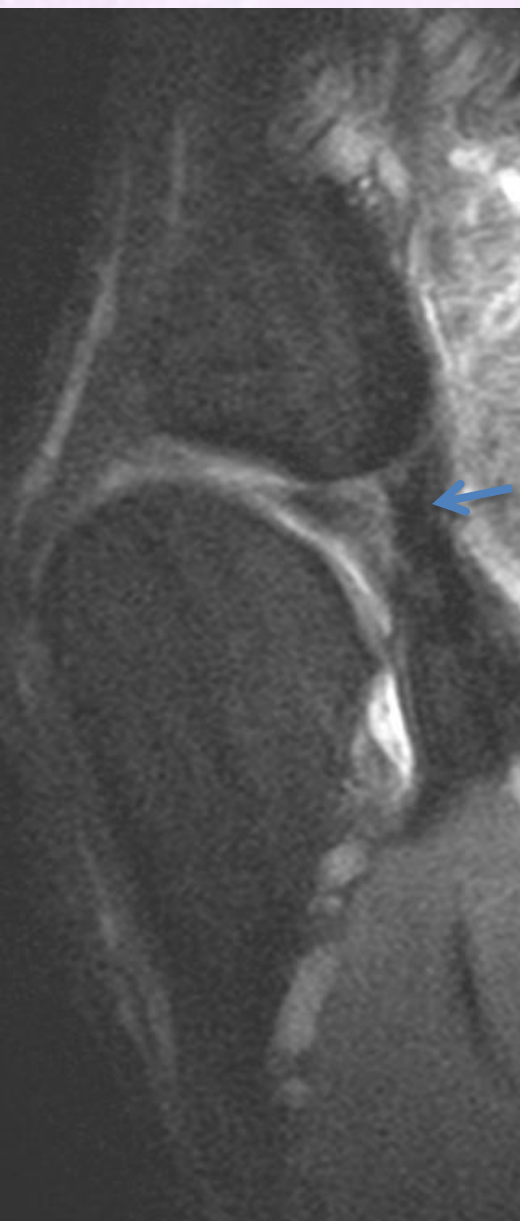
Plantar aspect



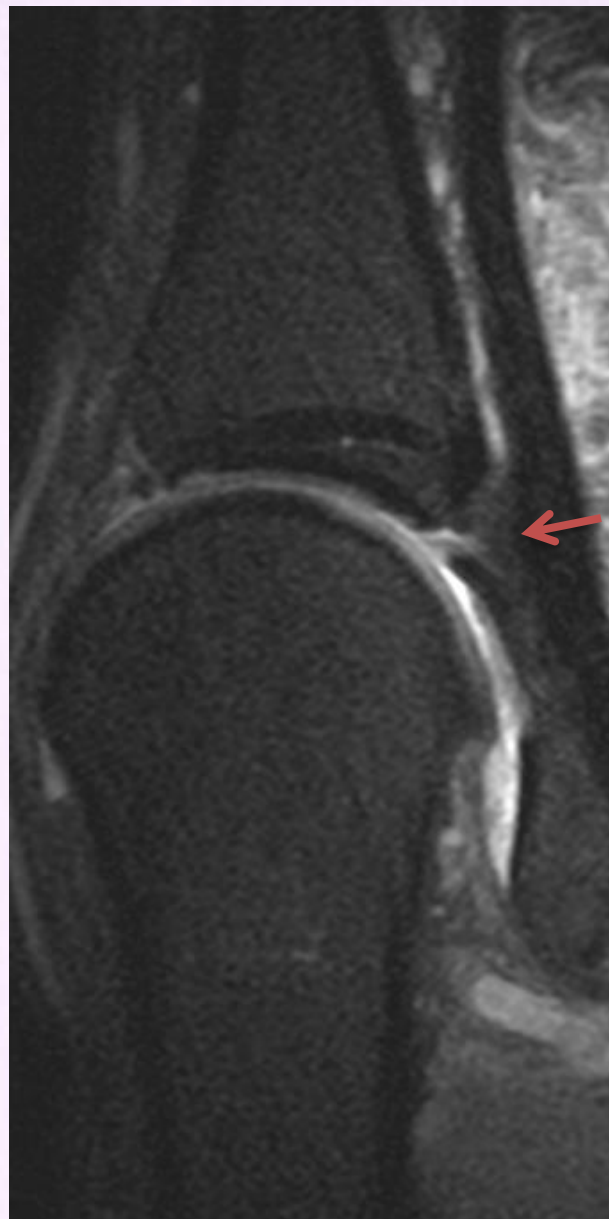


Lesser metatarsals

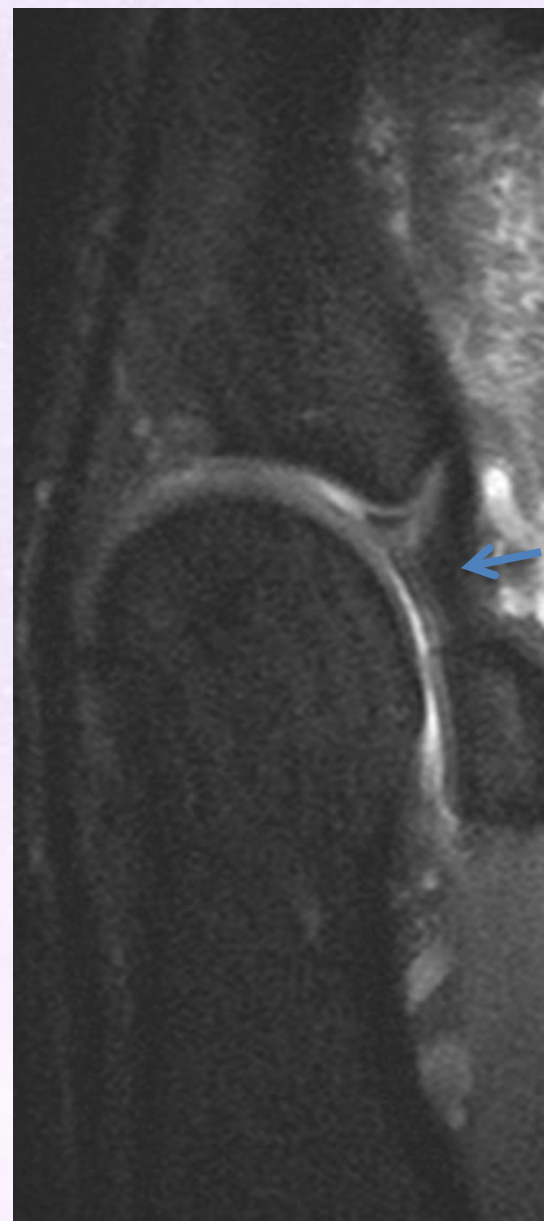
Sagittal – normal anatomy



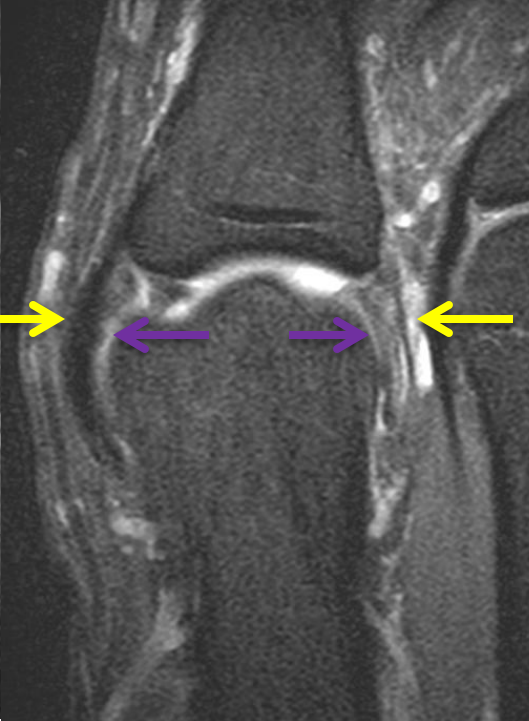
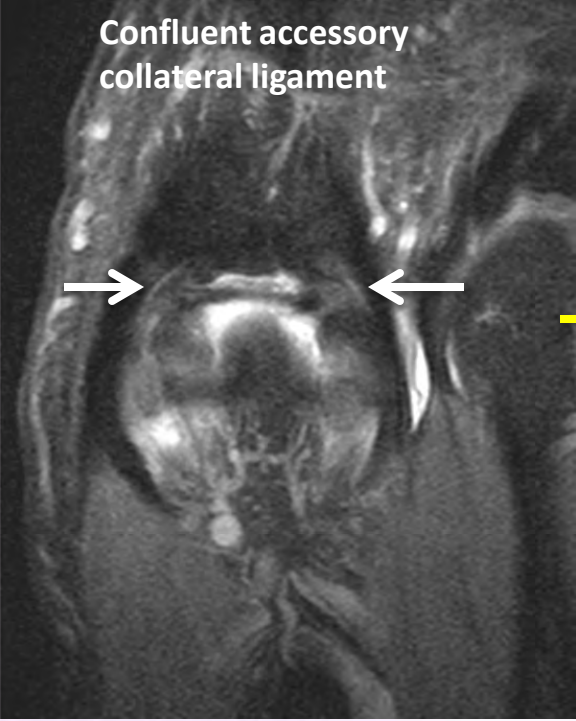
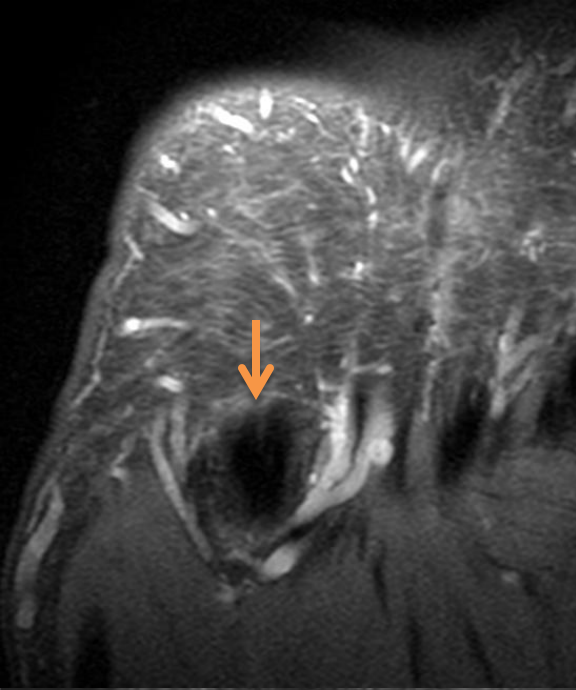
Lateral



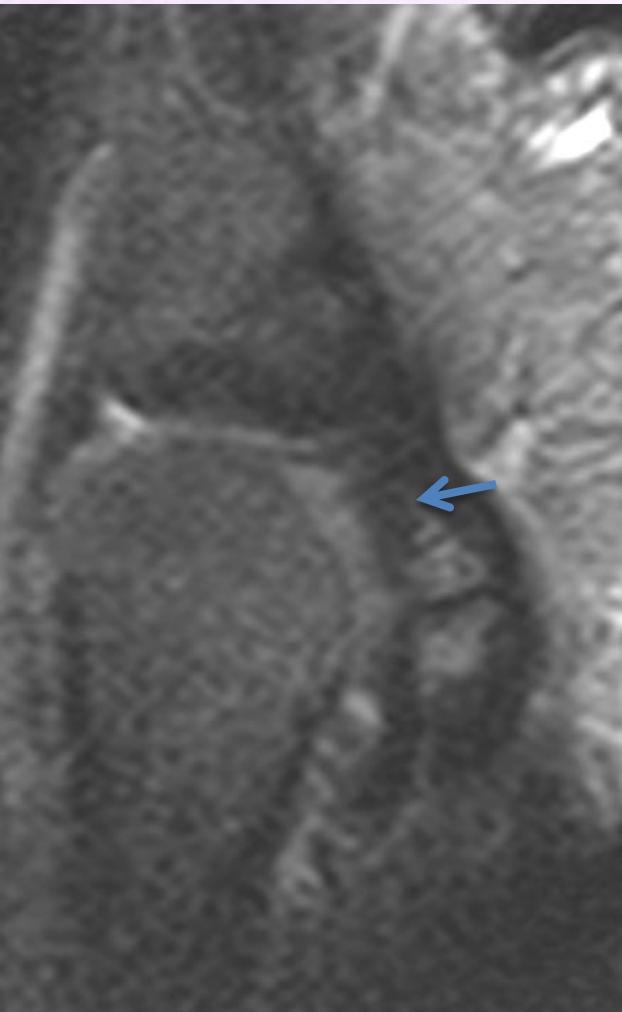
Central



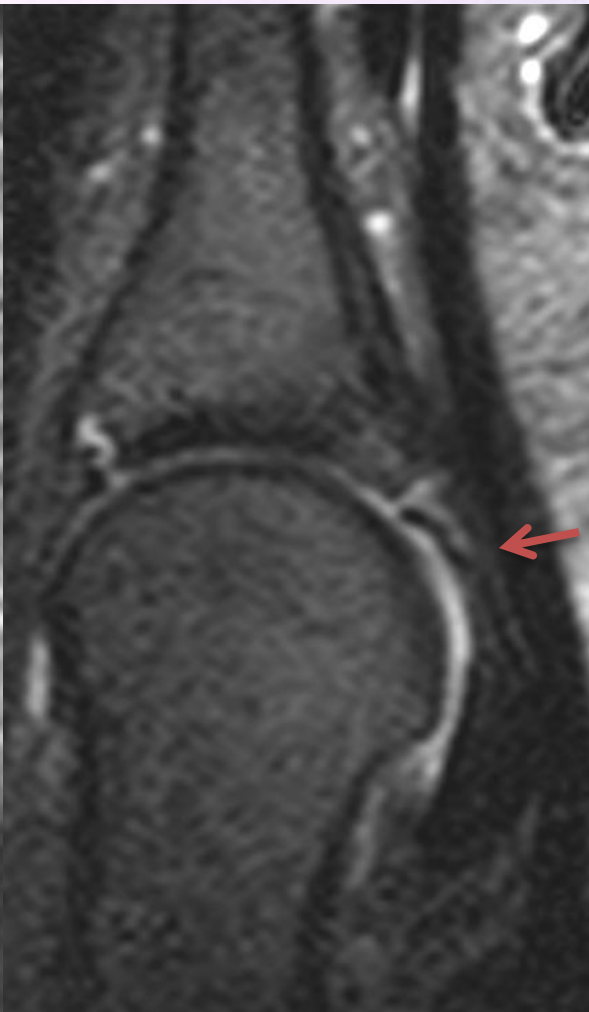
Lateral



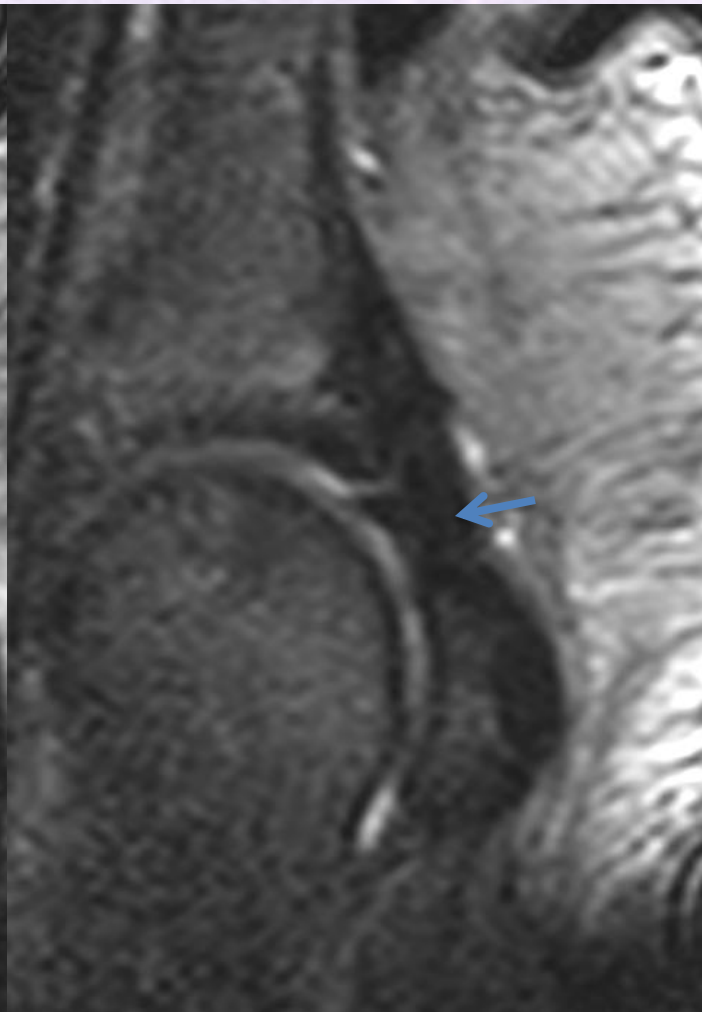
Axial – normal anatomy



Lateral

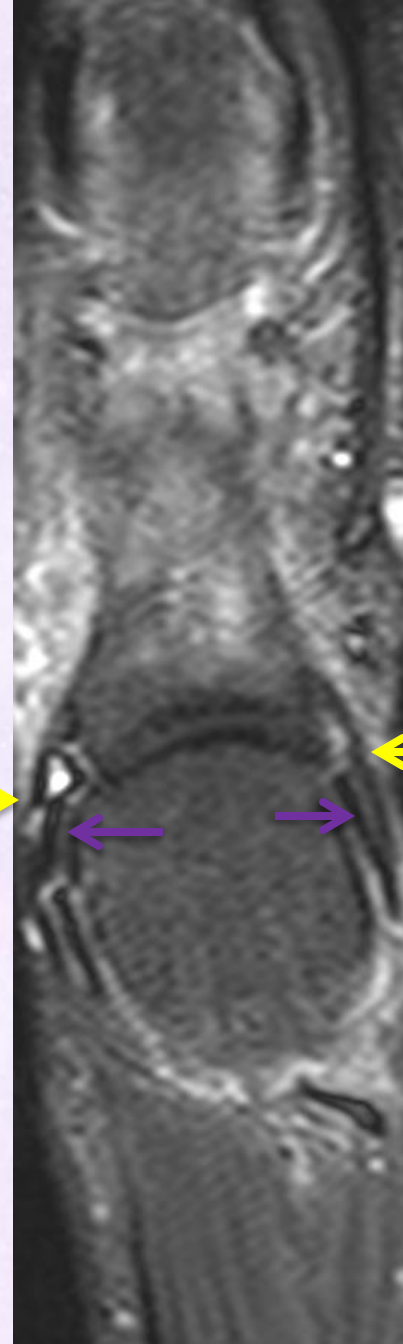
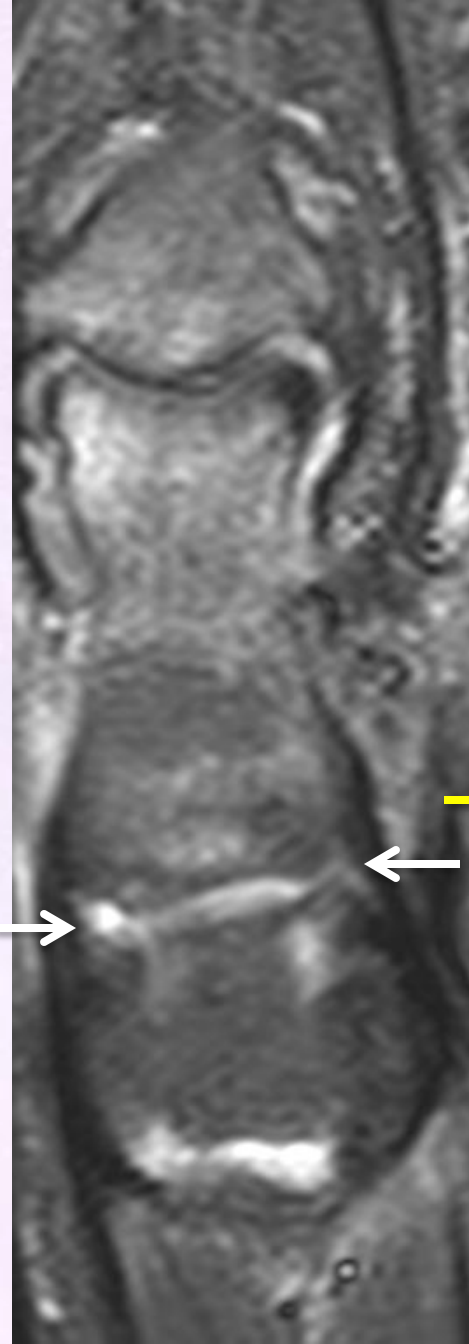
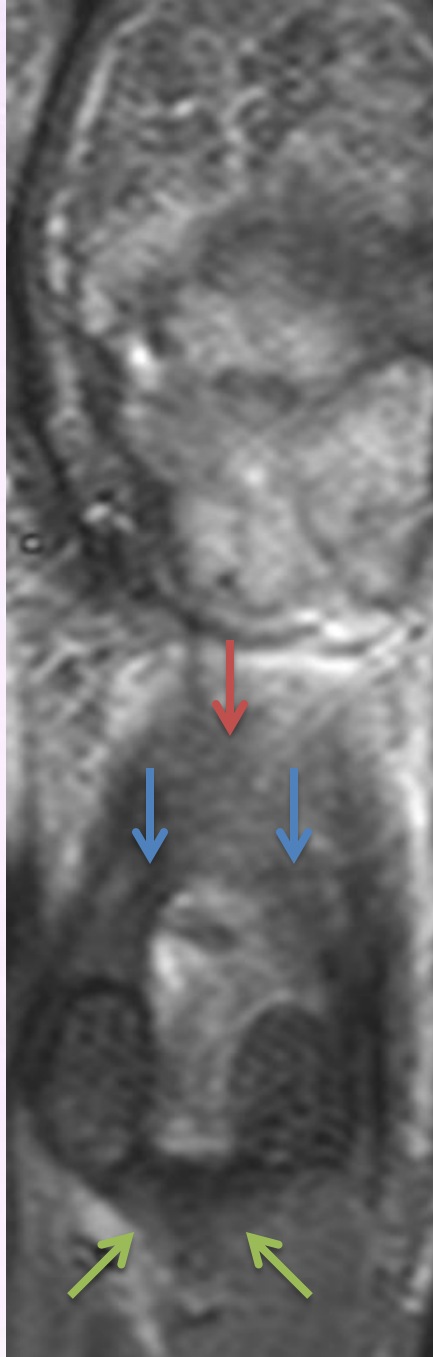
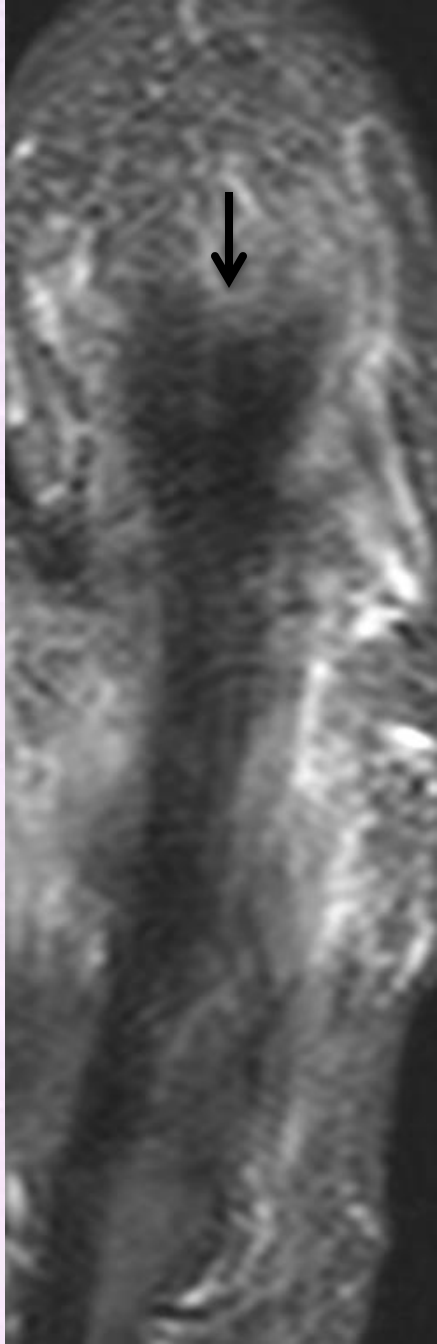


Central



Lateral

Sagittal – normal anatomy

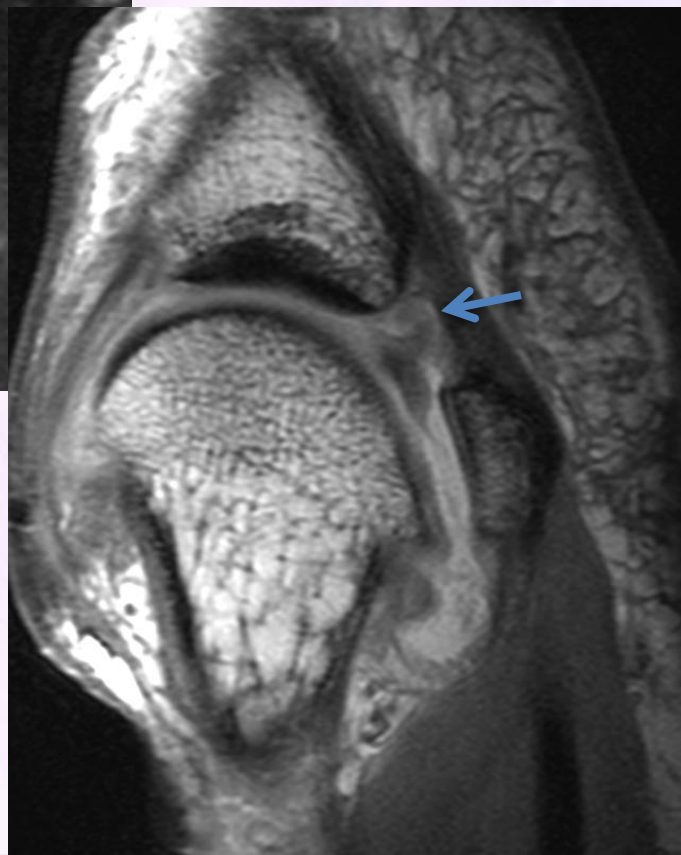


Axial – normal anatomy

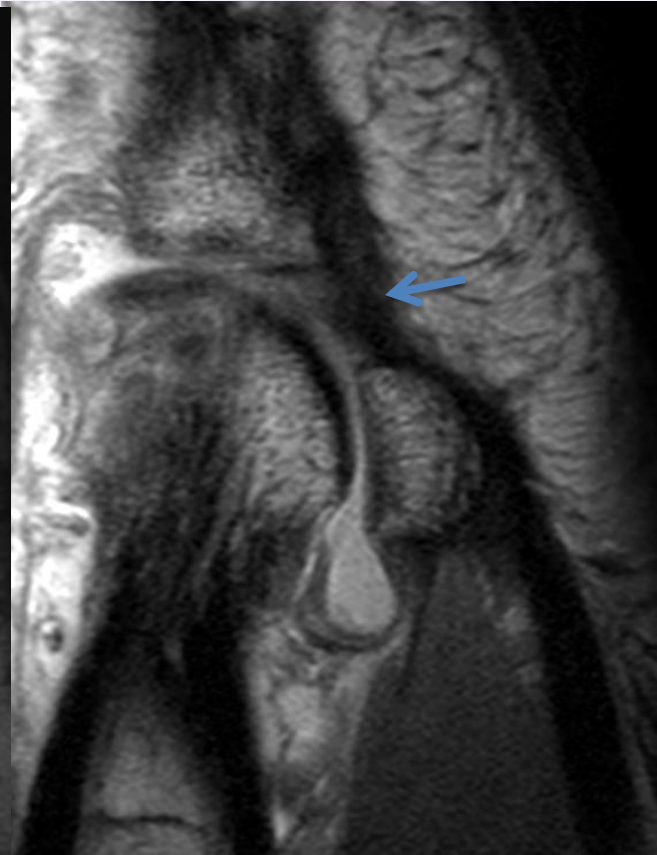
Turf's toe



Medial

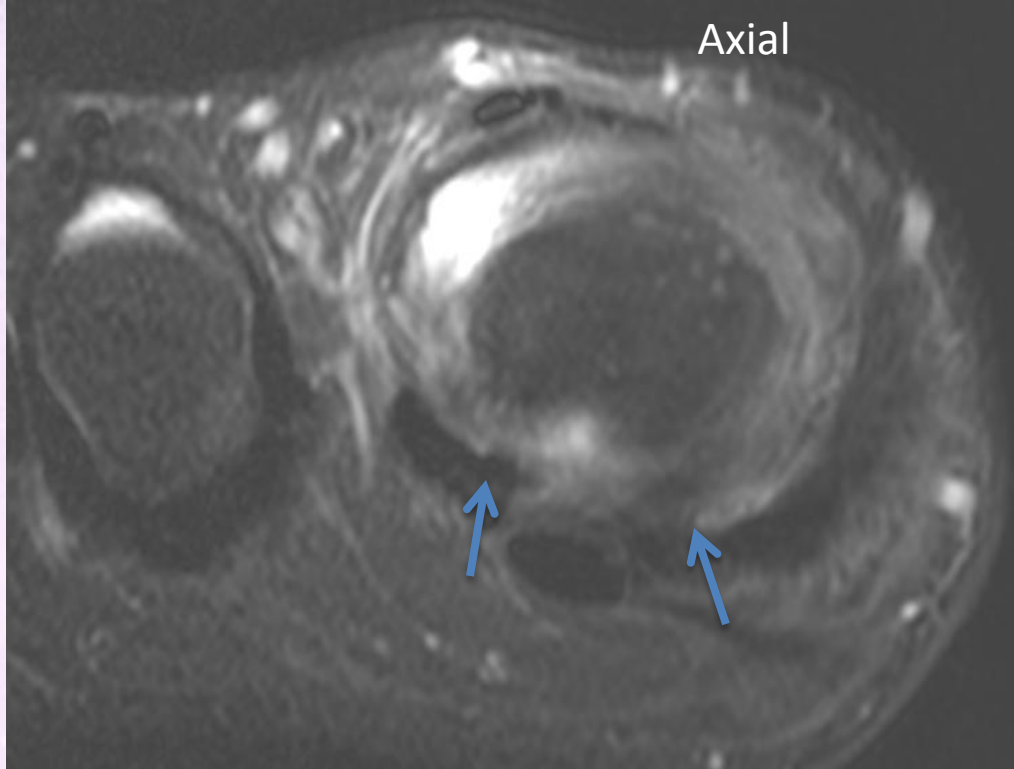


Central



Lateral

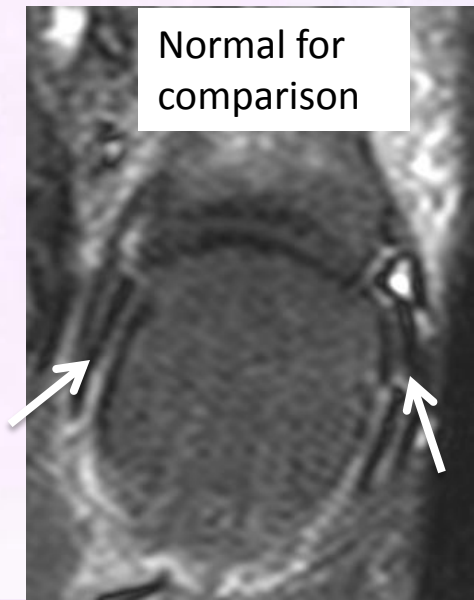
Axial



Coronal



Normal for
comparison



Turf's toe

Checklist for reading MR images of patient with turf's toe

- 1) Sesamoidal-phalangeal (SP) ligaments (medial and lateral)
- 2) Metatarsal-sesamoid (MT-S) ligaments (medial and lateral)
- 3) Inter-sesamoid (IS) ligament
- 4) Collateral ligaments proper (medial and lateral)
- 5) Accessory collateral ligaments to sesamoid (plantar medial and plantar lateral capsule)
- 6) Tendinous insertion and confluences with plantar capsule (flexor hallucis brevis, adductor and abductor hallucis, extensor hood) / plantar capsule
- 7) Sesamoids (medial and lateral)
- 8) Cartilage
- 9) Alignment

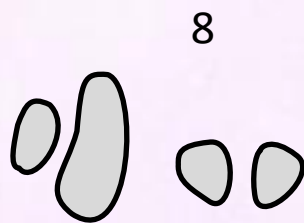
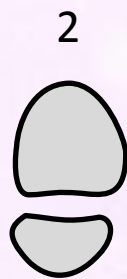
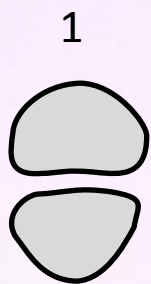
B. Seasmoid bone pathology

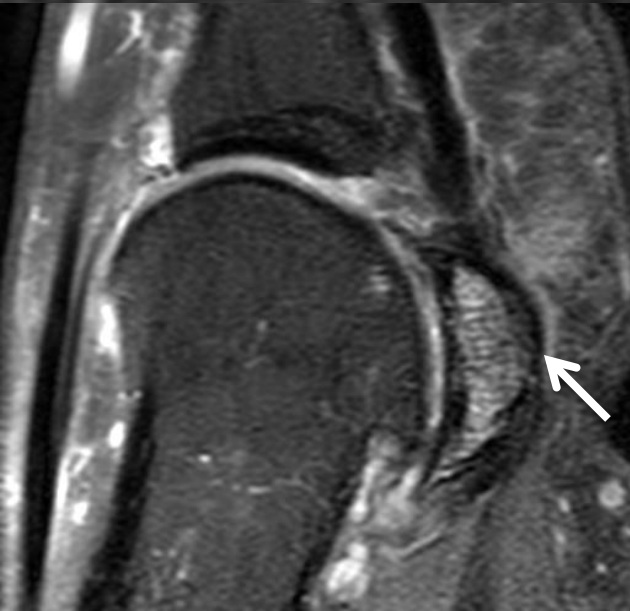
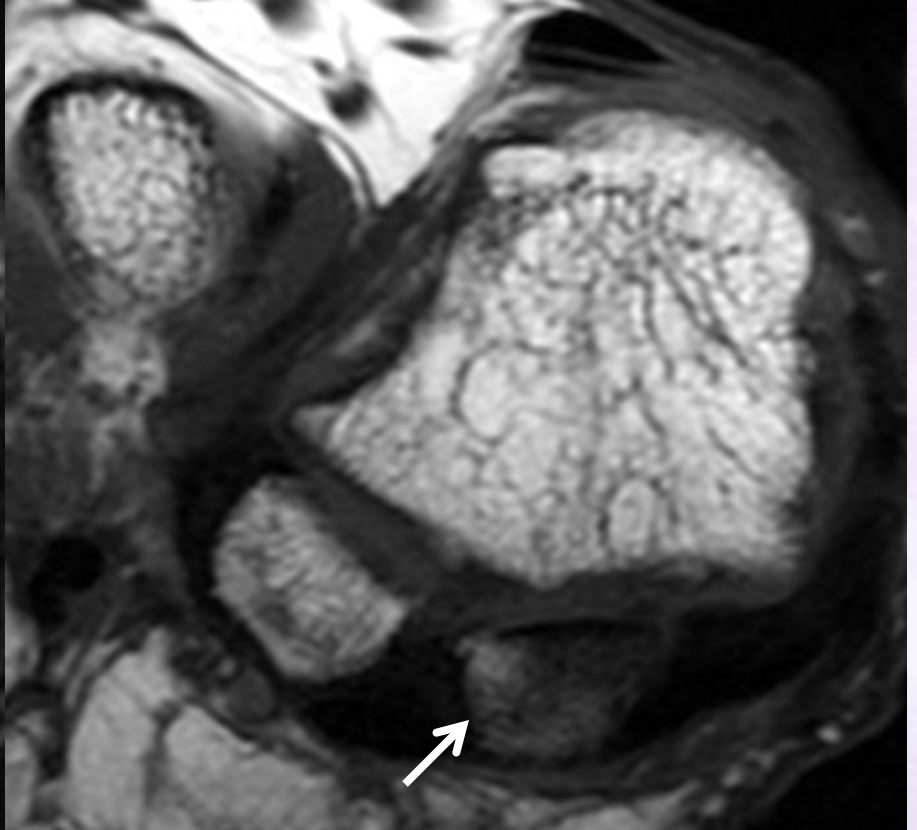
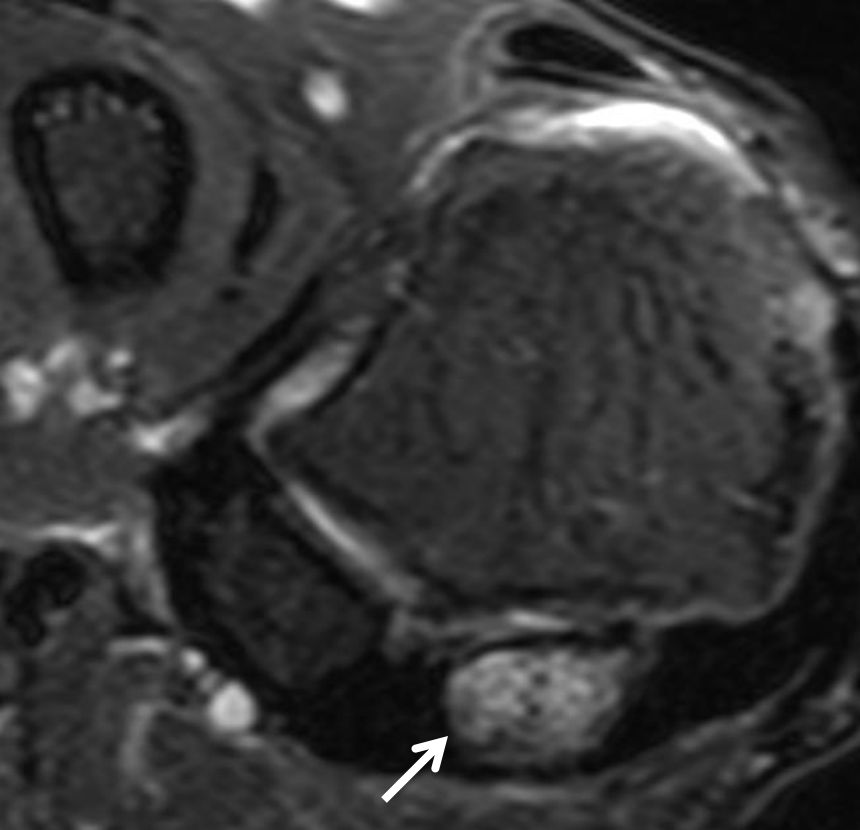
Medial



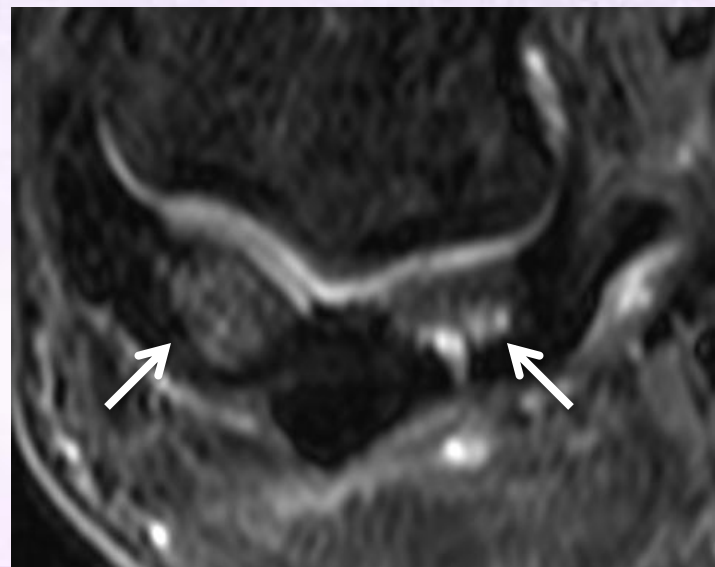
Medial

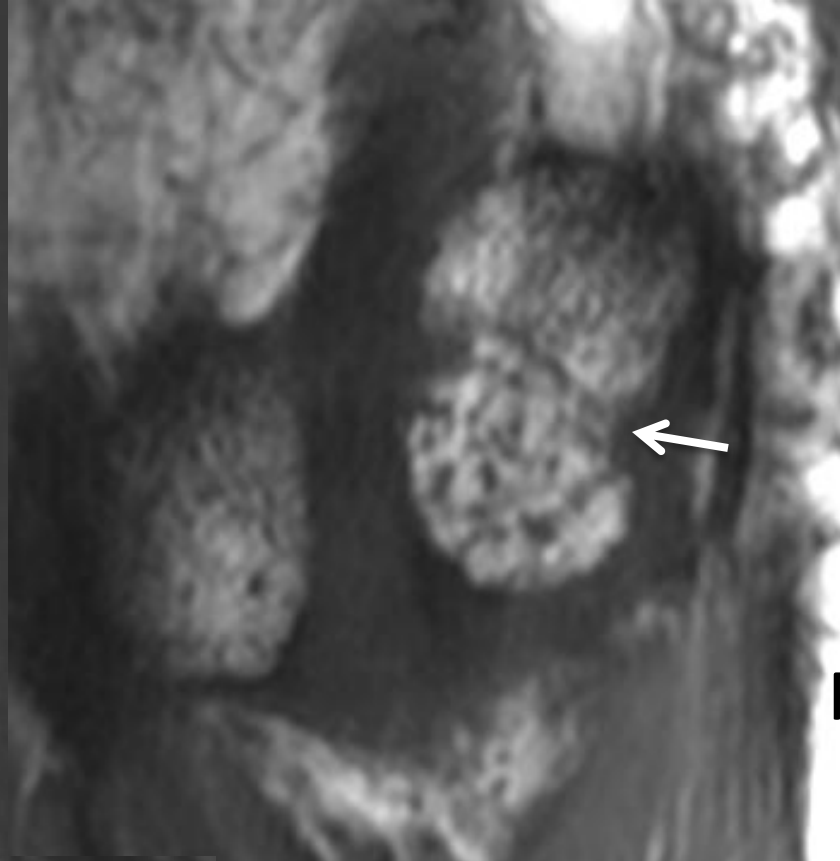




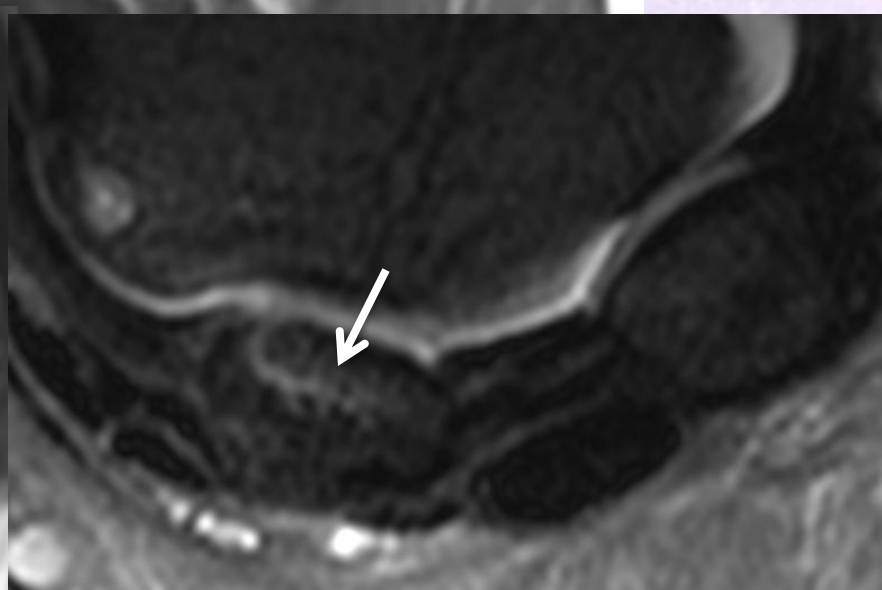
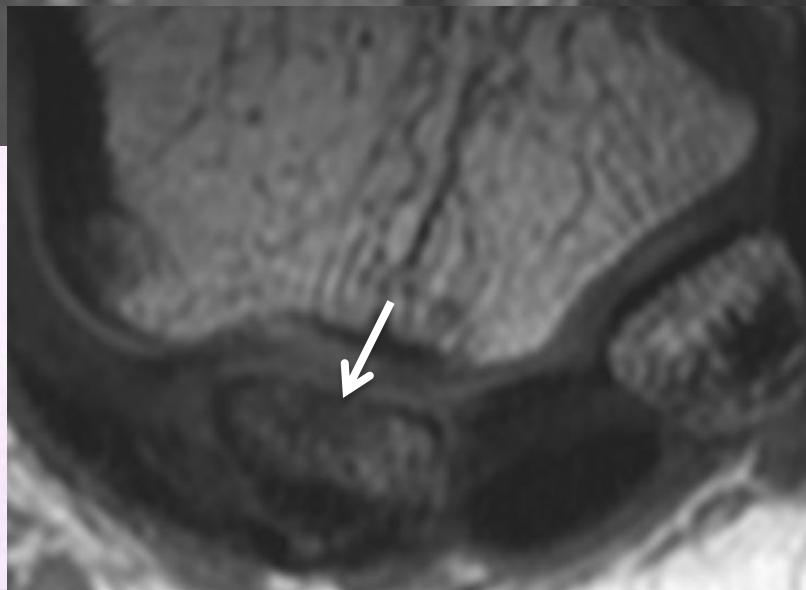


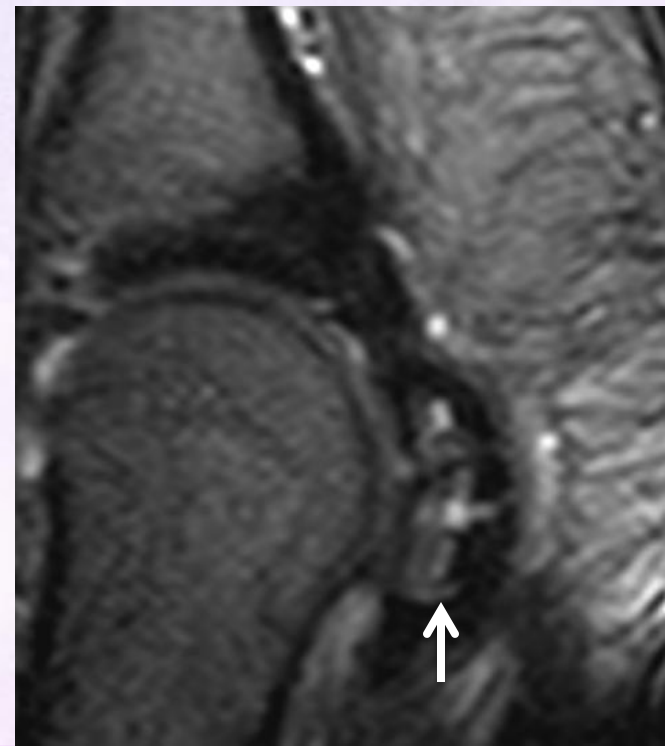
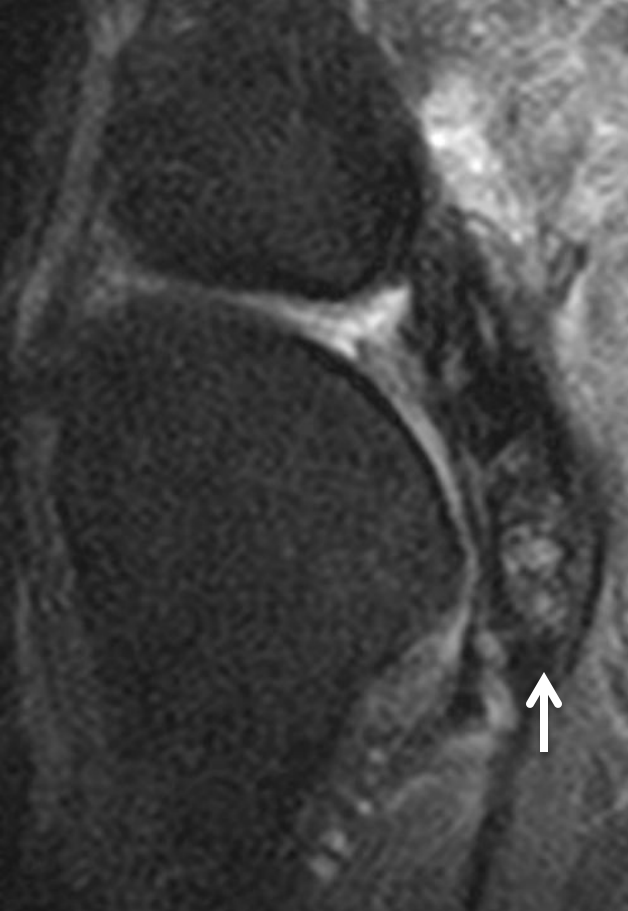
Sesamoiditis



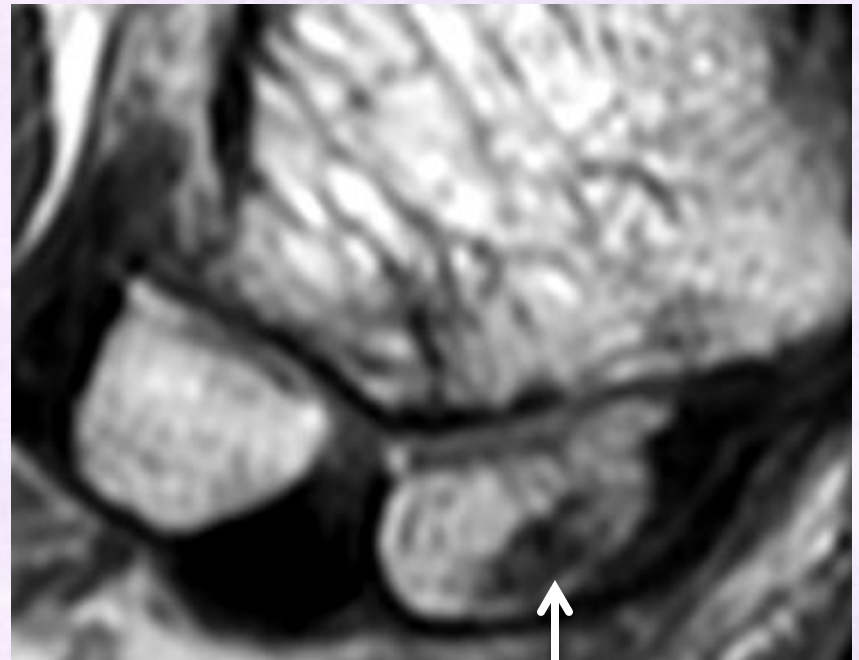
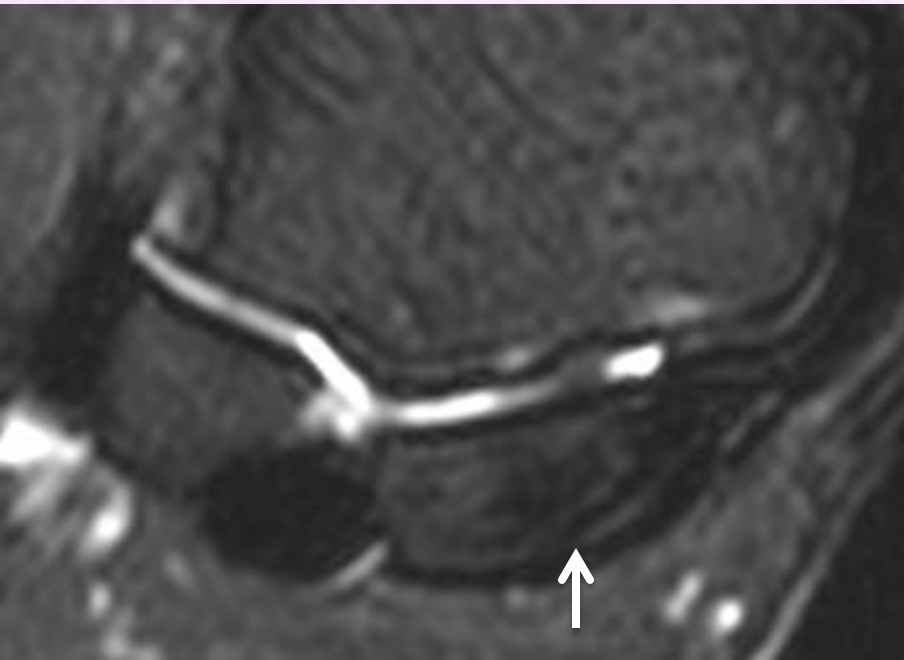


Fracture

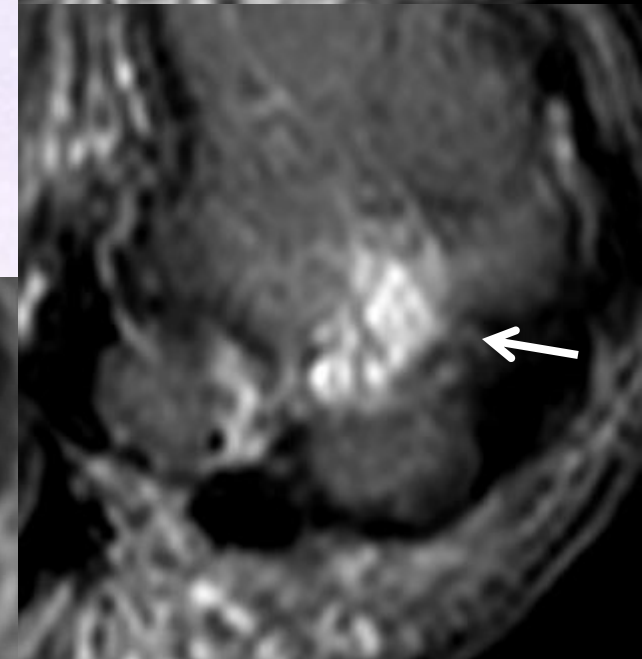
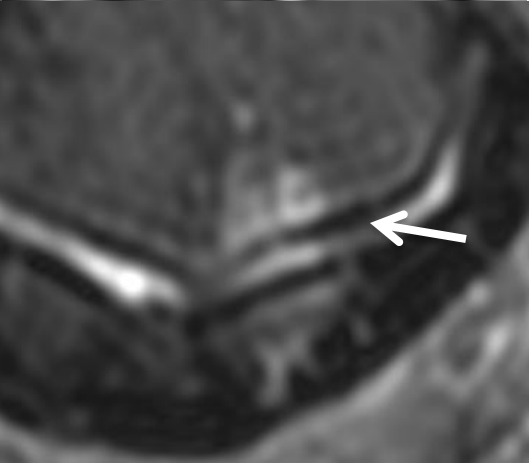
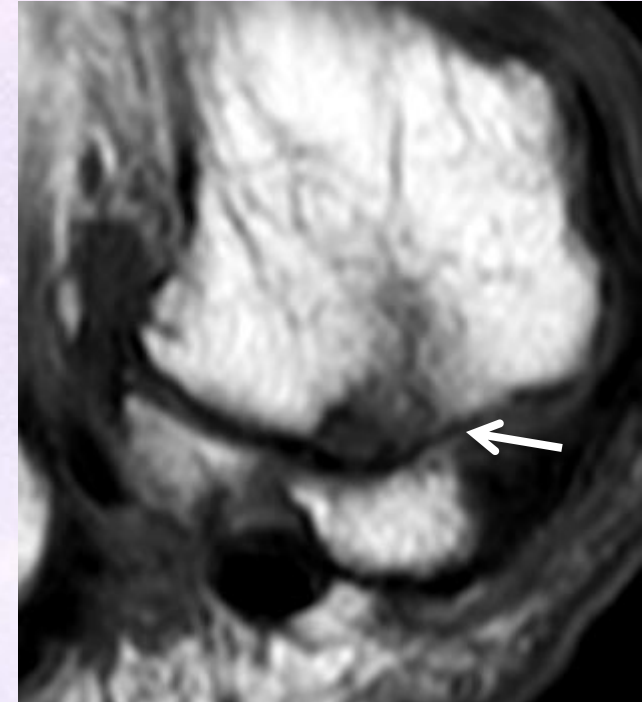
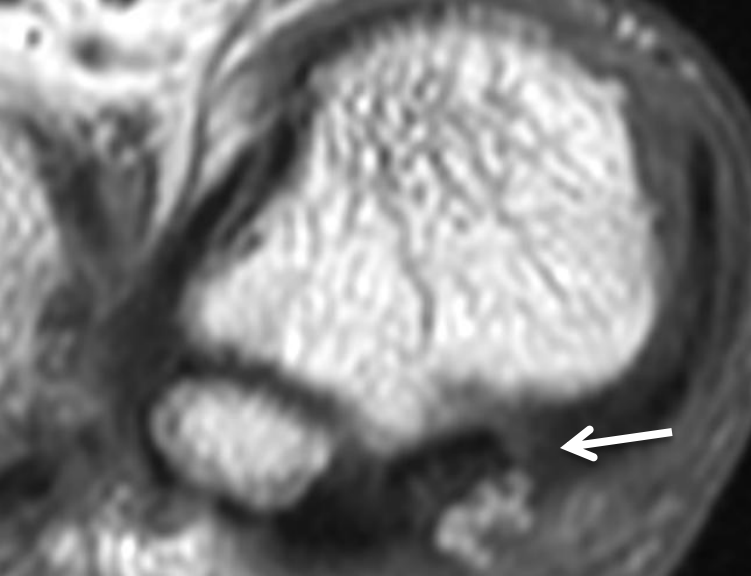




Avascular
necrosis

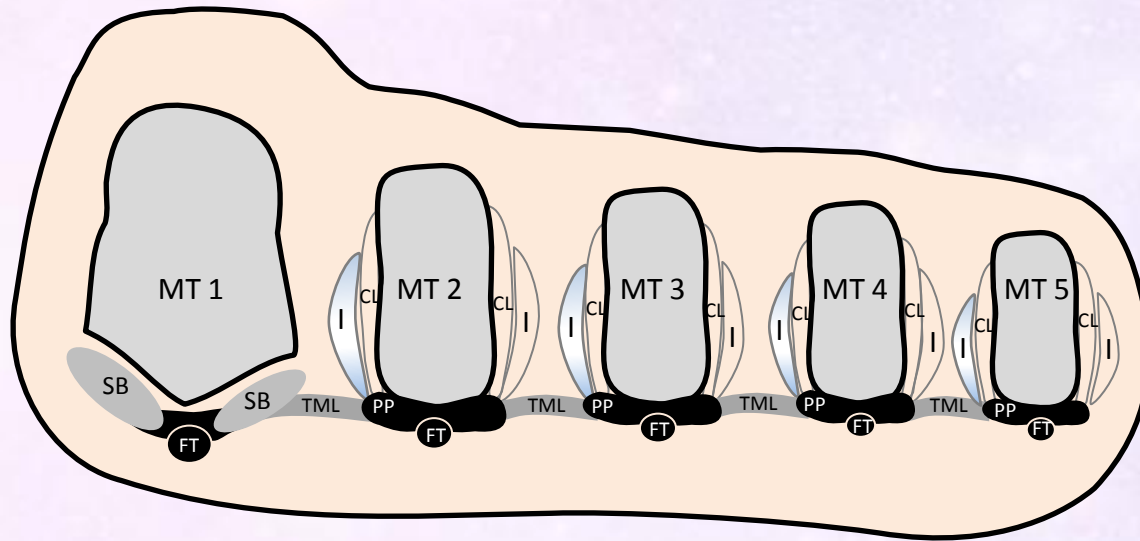


Sclerosis

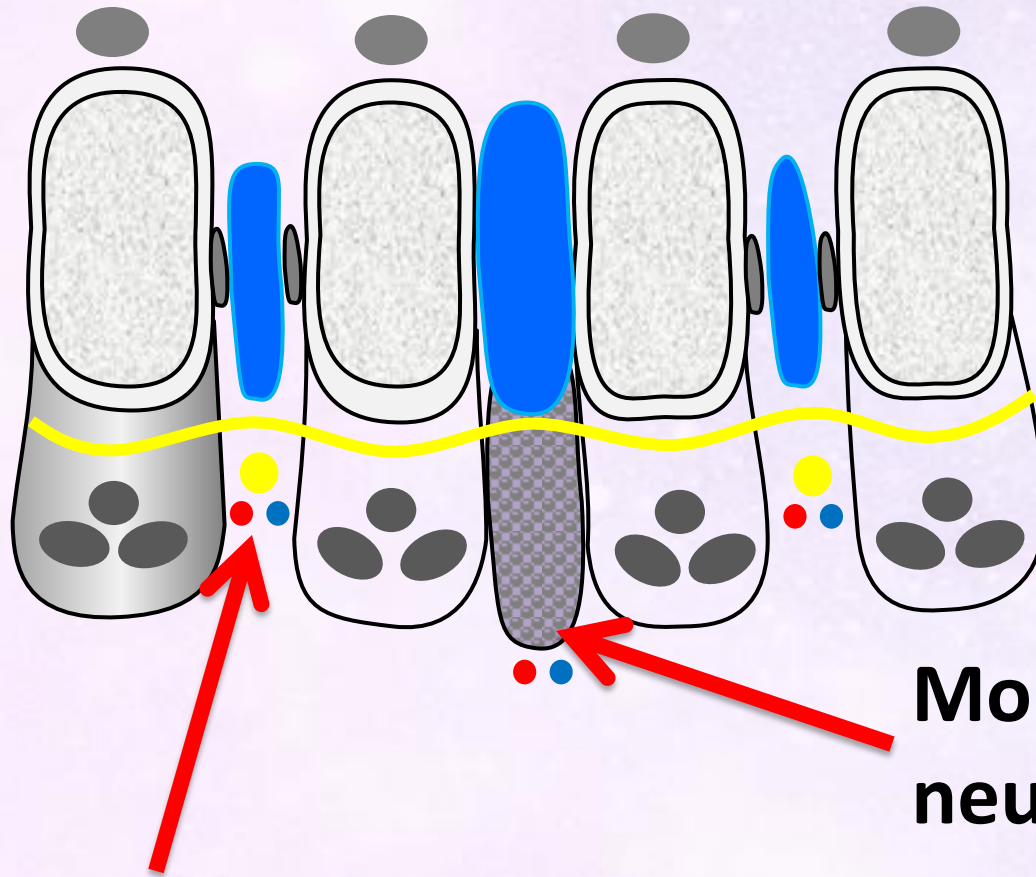


Degeneration

C. Morton's neuroma

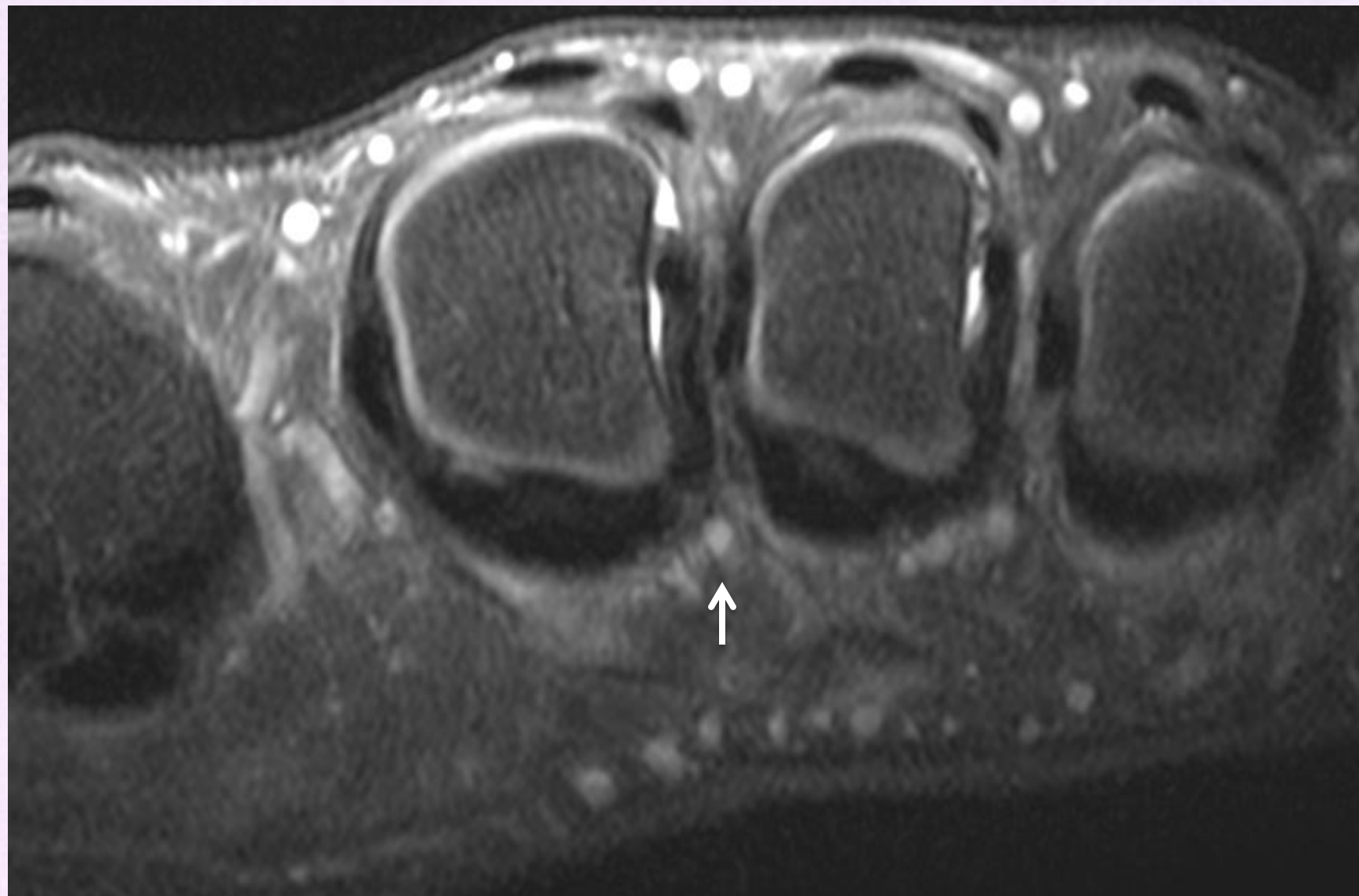


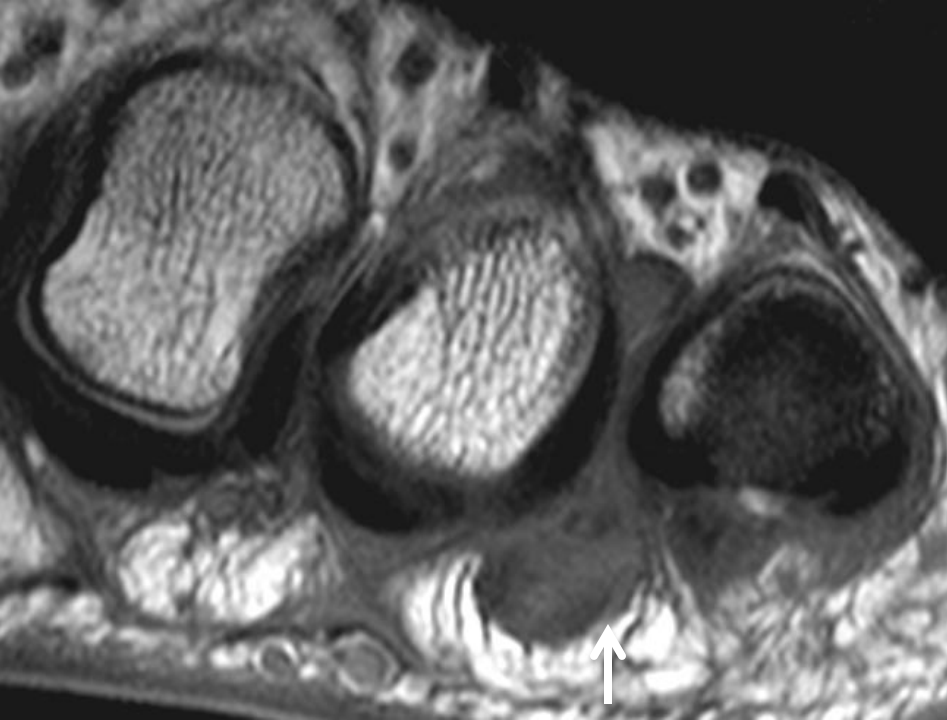
Forefoot - Anatomy



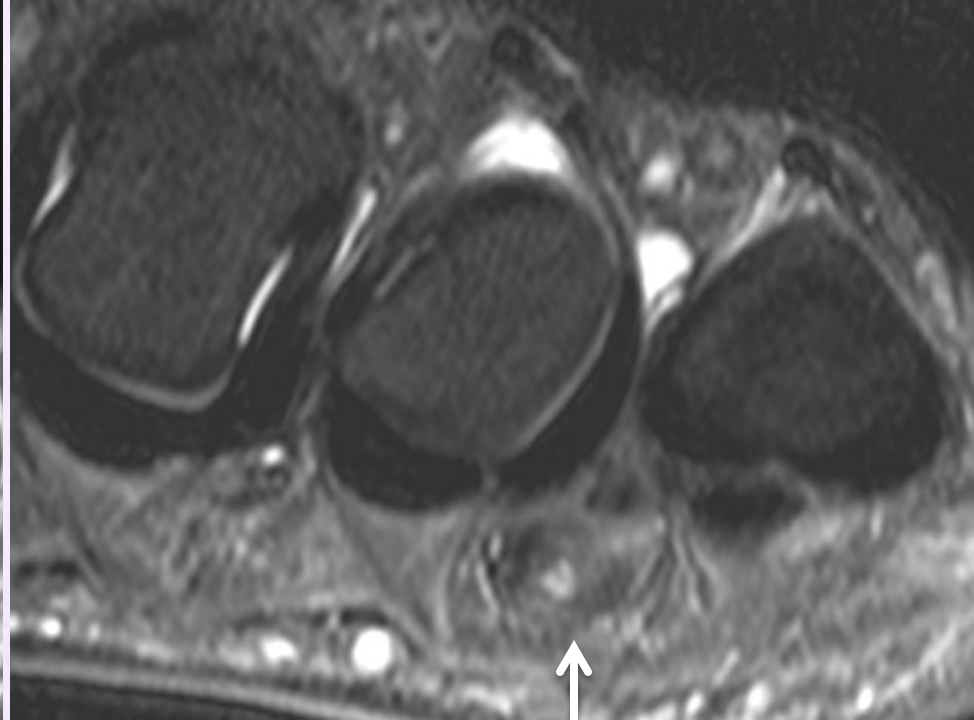
**Morton's
neuroma**

Normal plantar digital nerve 1-2mm diameter

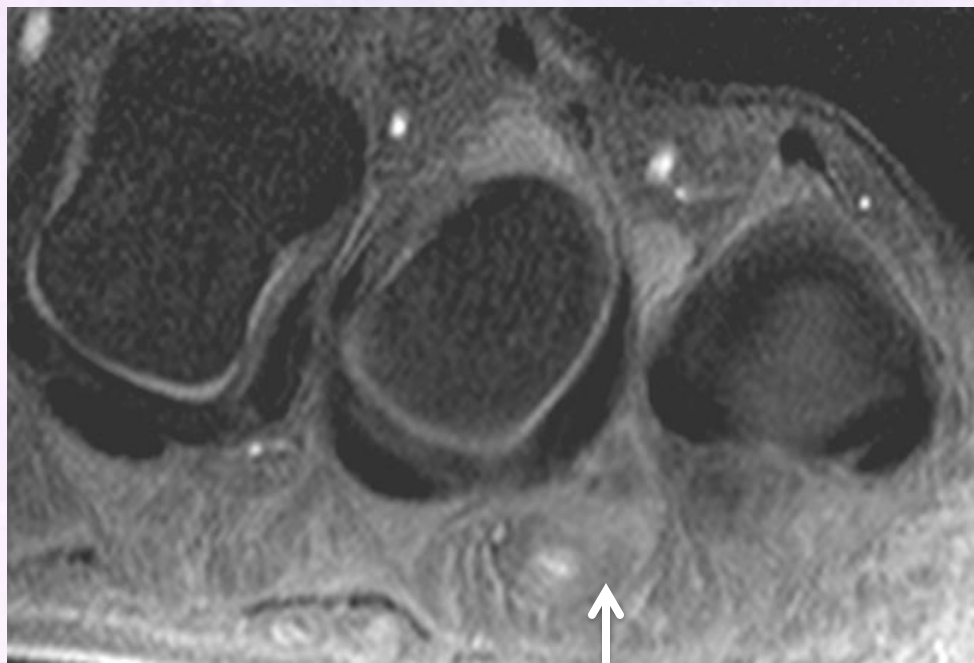


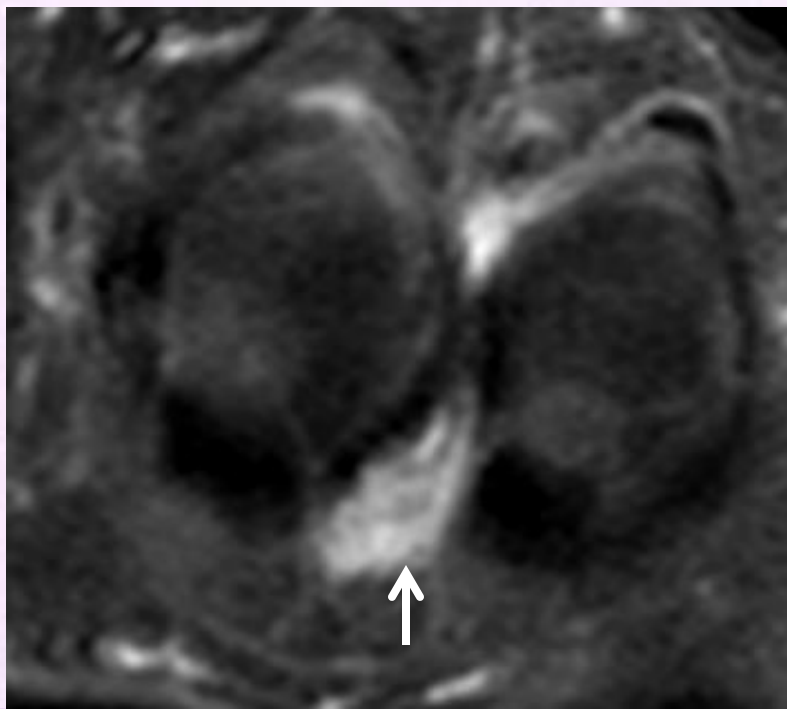
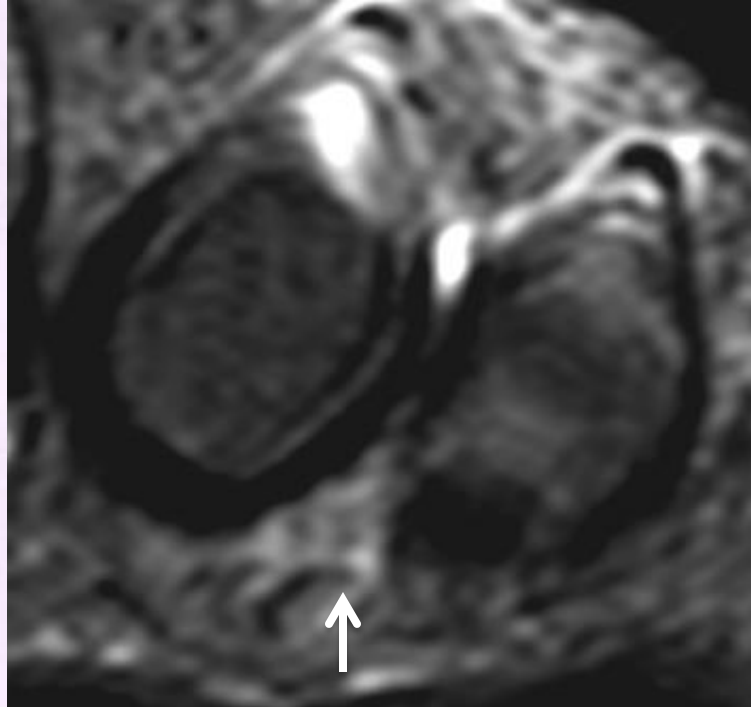
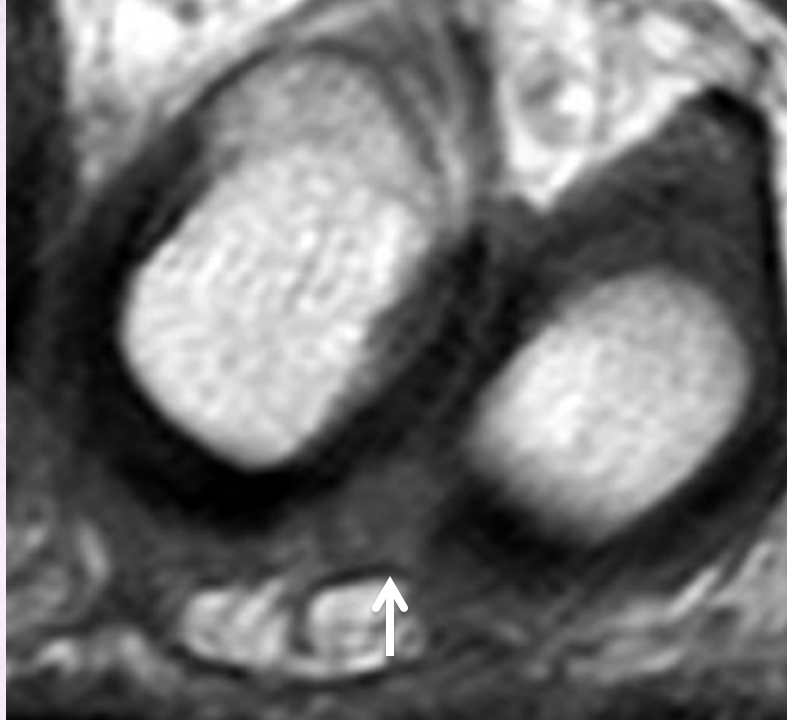


Morton's neuroma

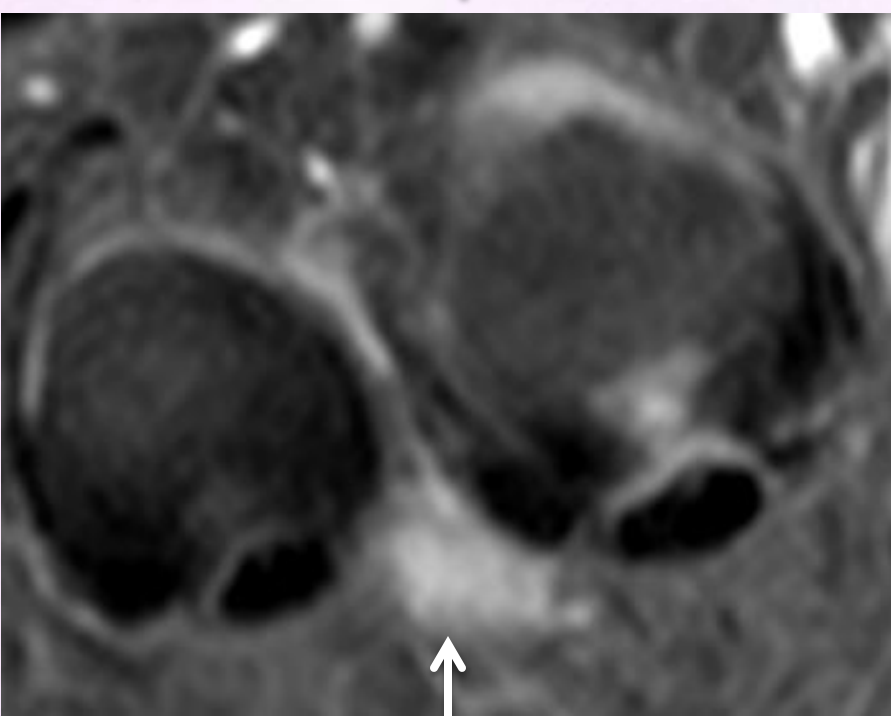
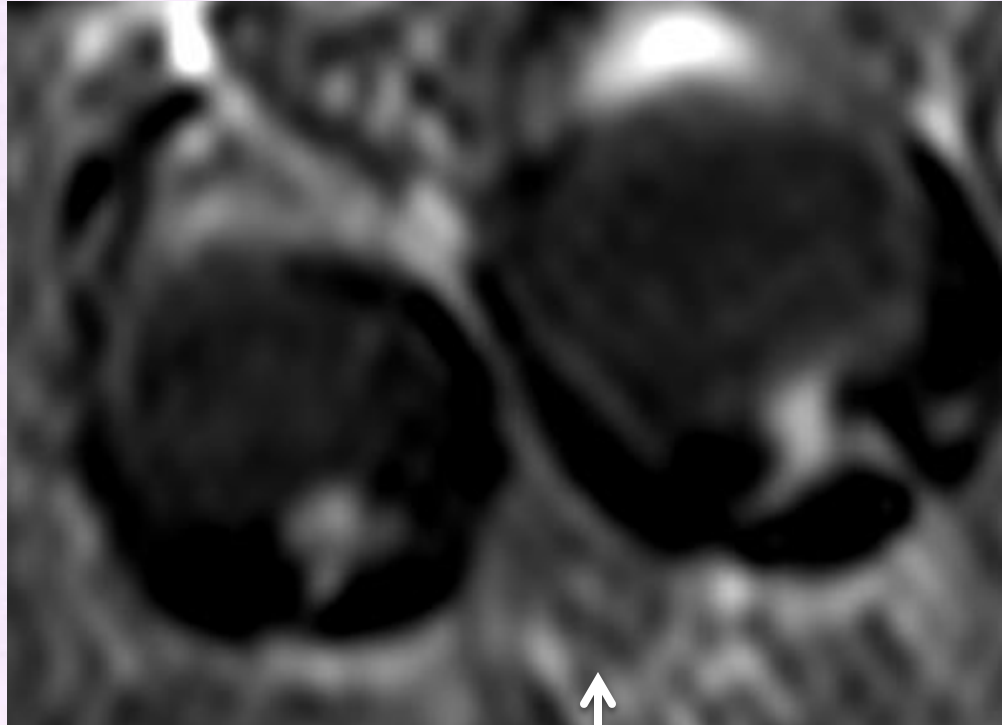
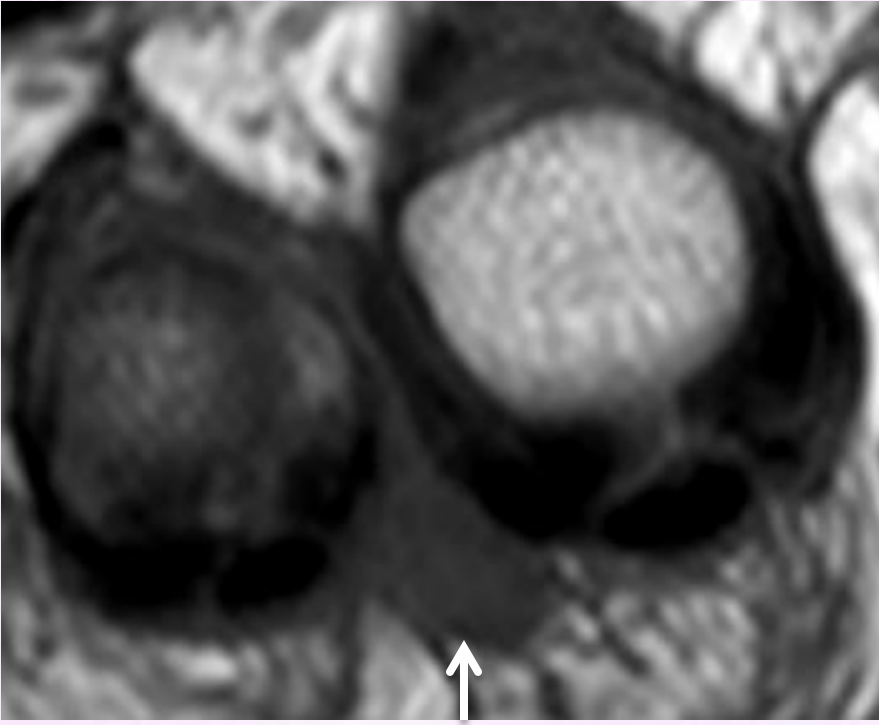


Poor enhancement



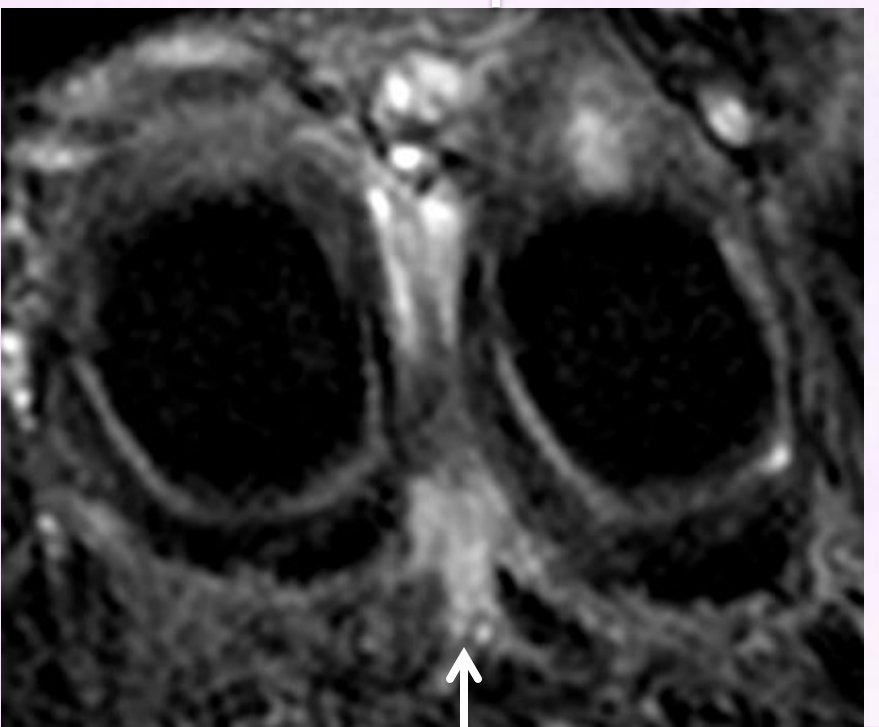
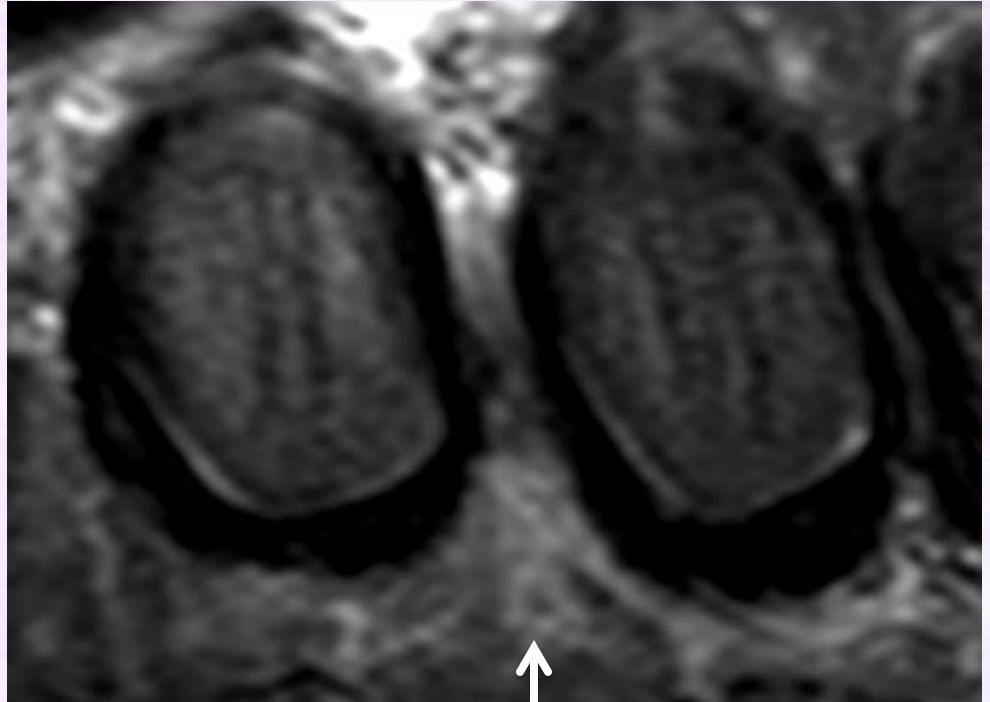
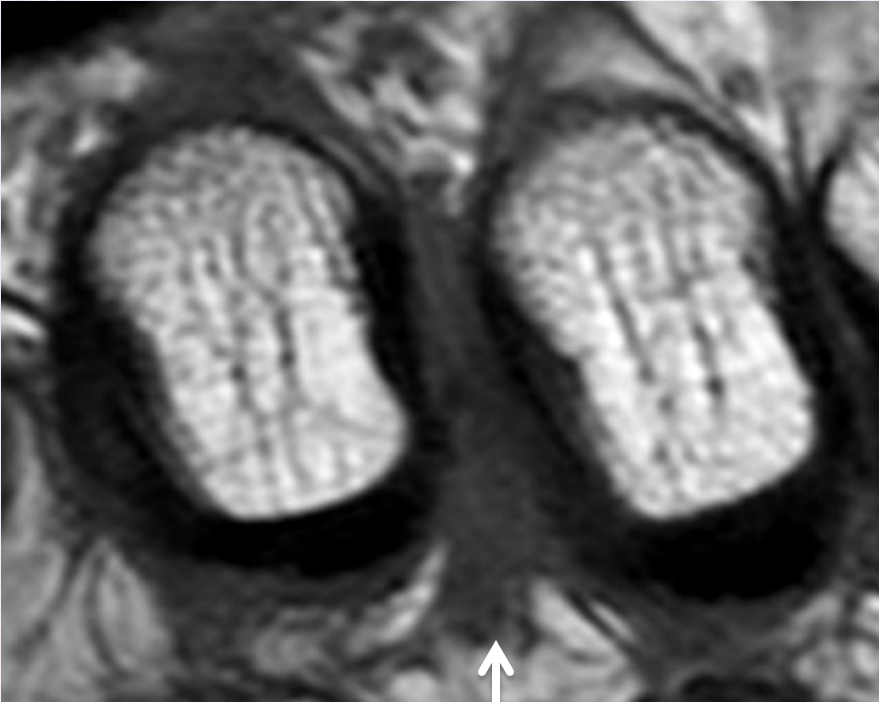


Morton's neuroma



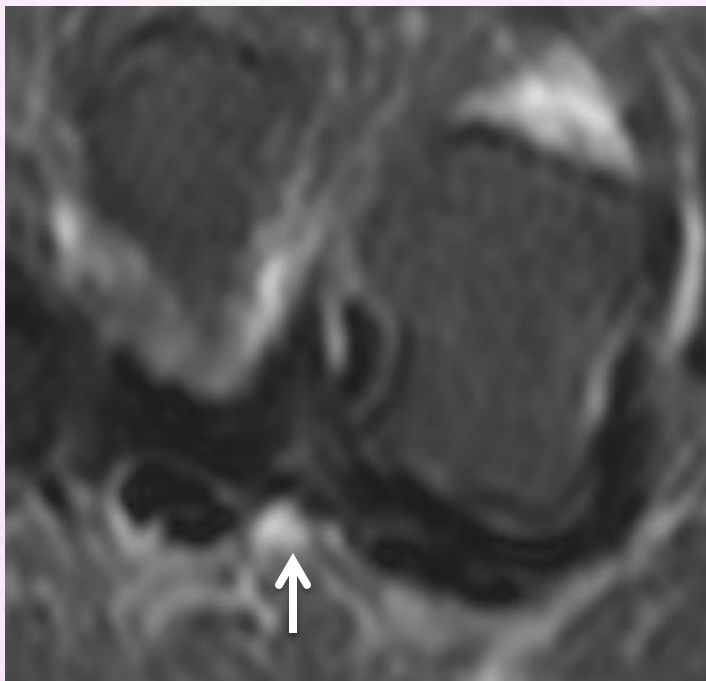
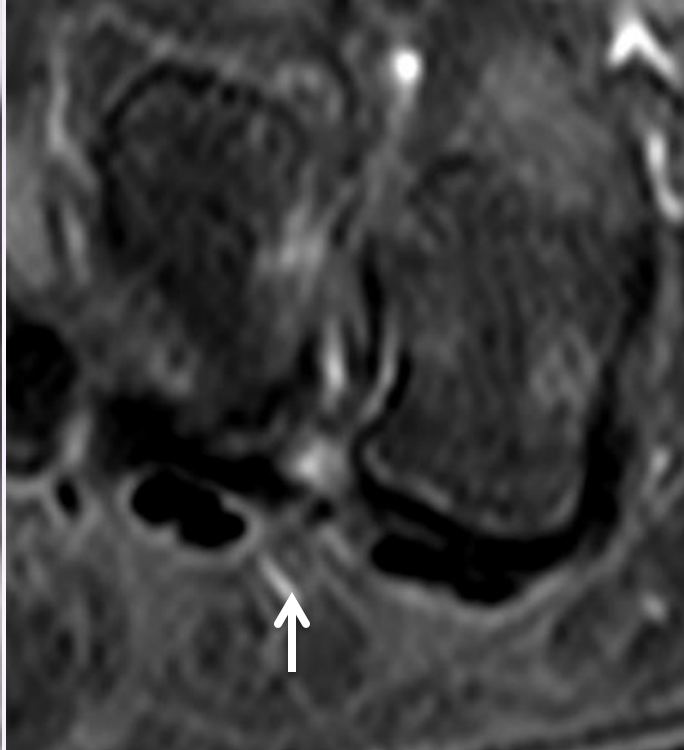
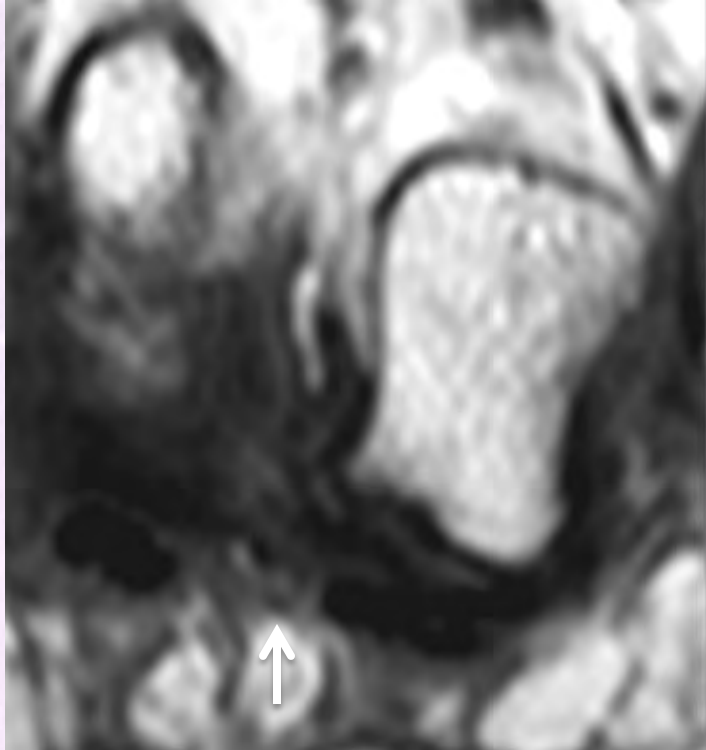
Morton's neuroma

Good enhancement

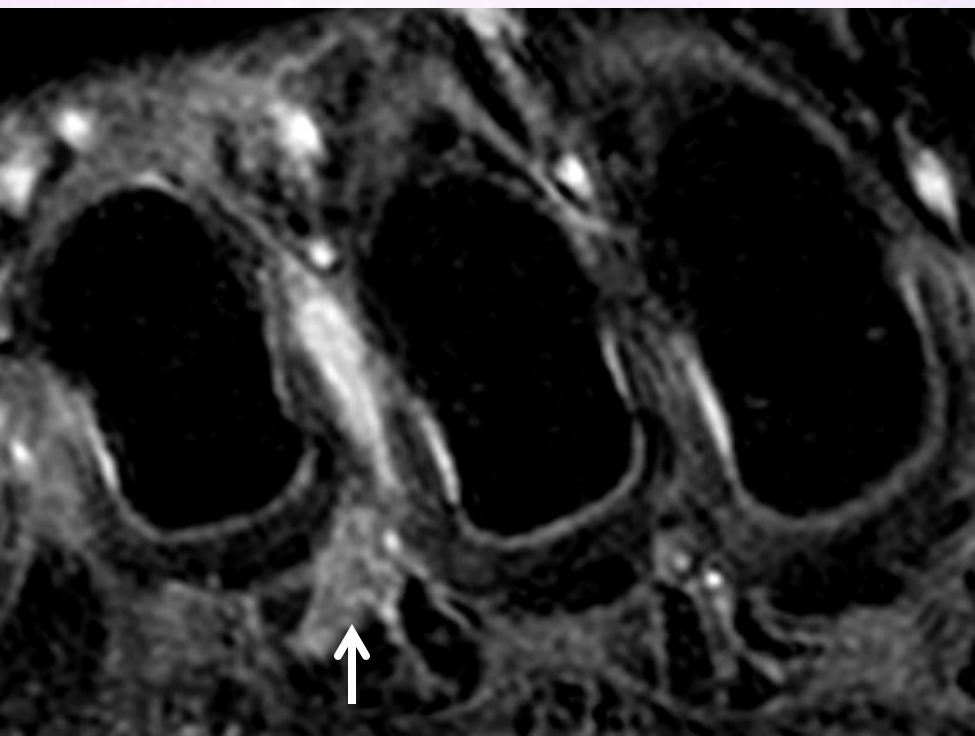
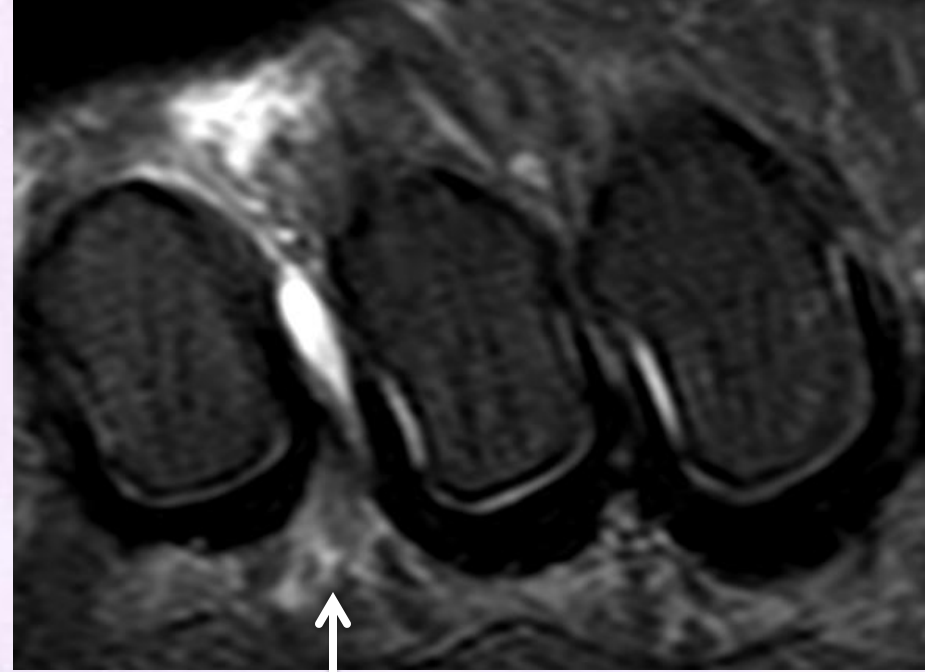
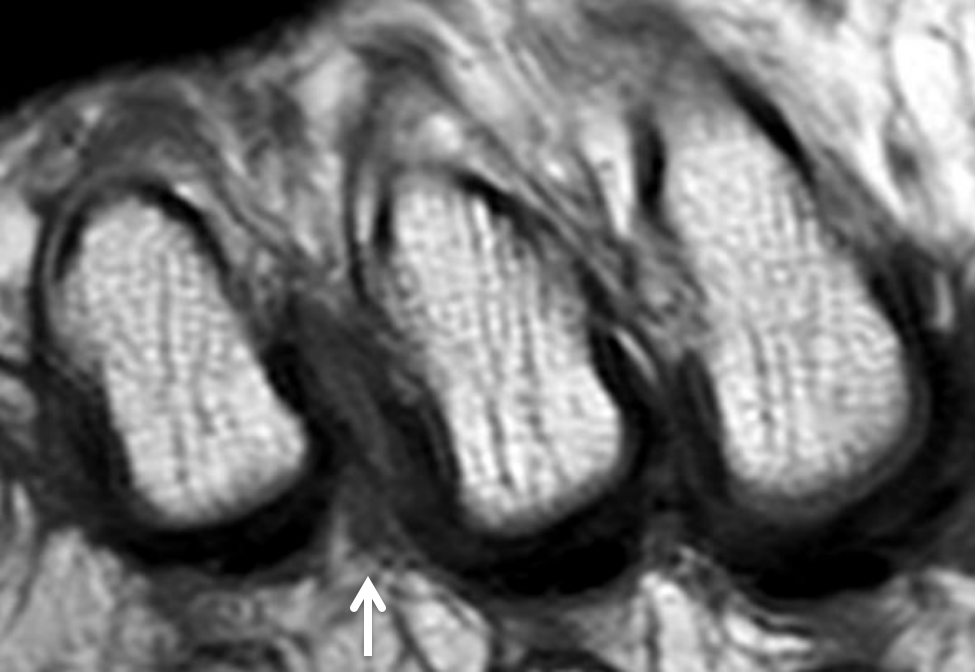


Morton's neuroma

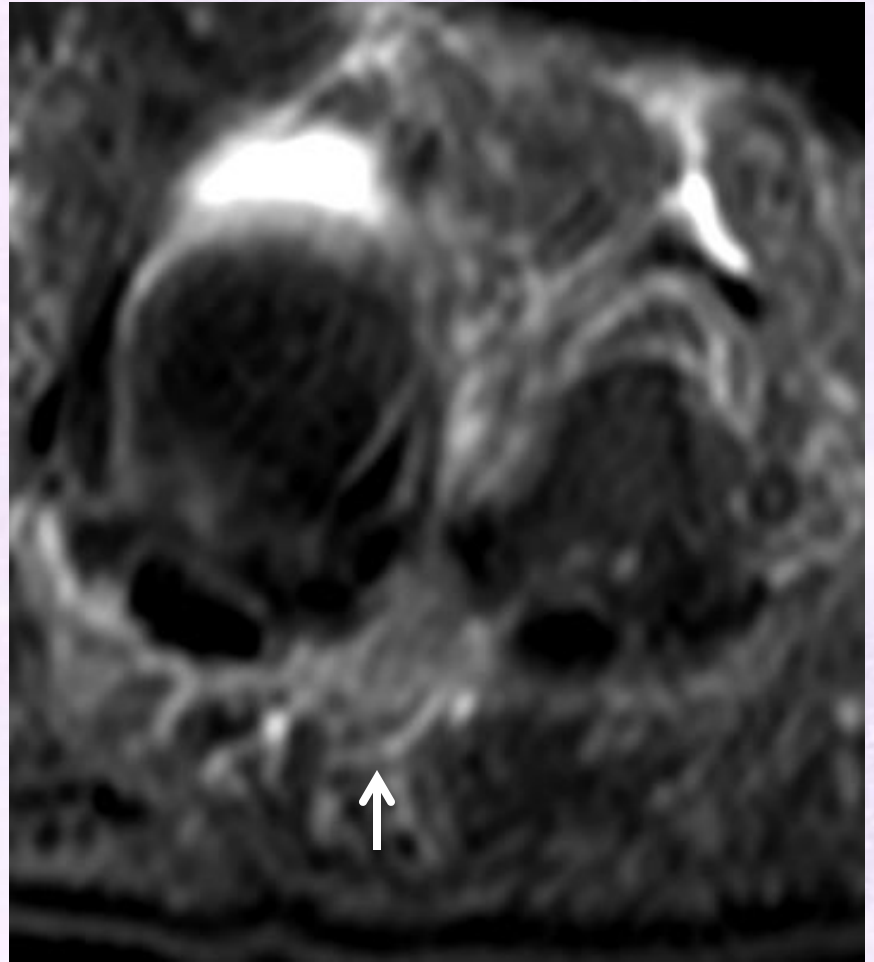
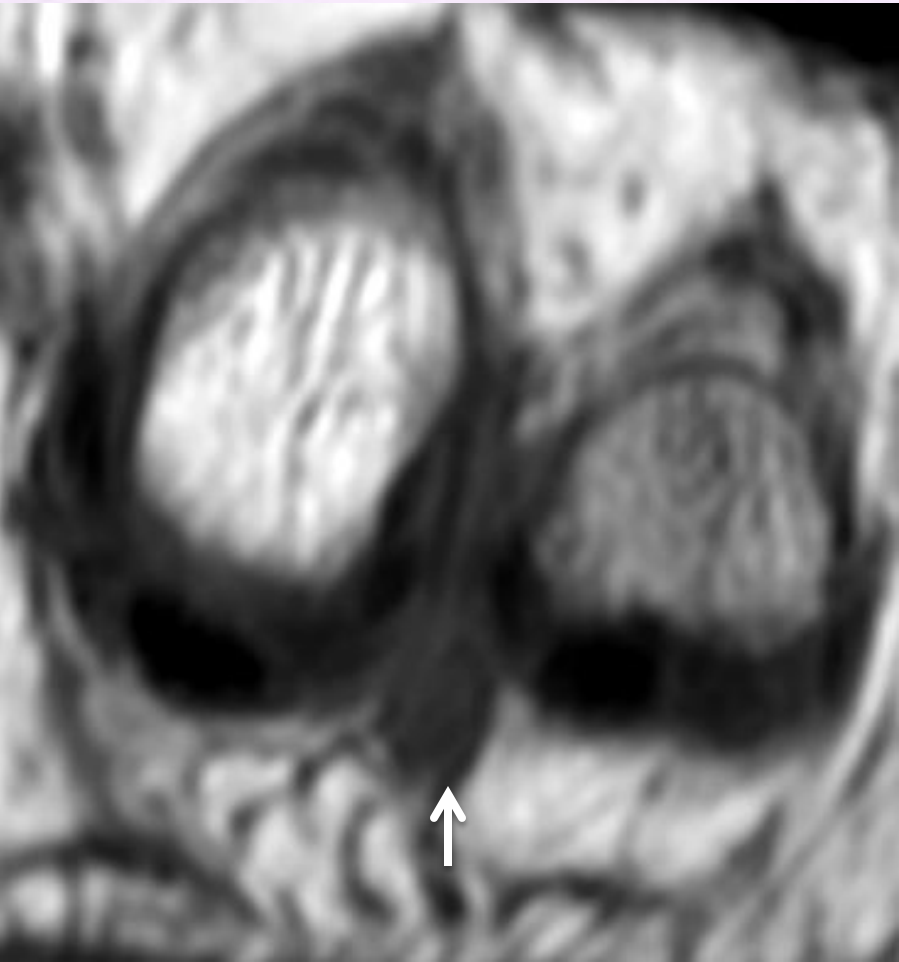
Good enhancement



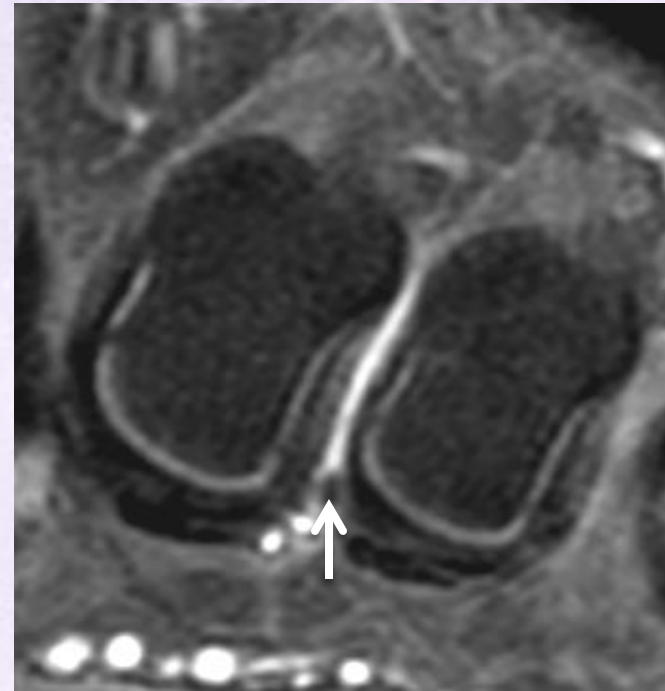
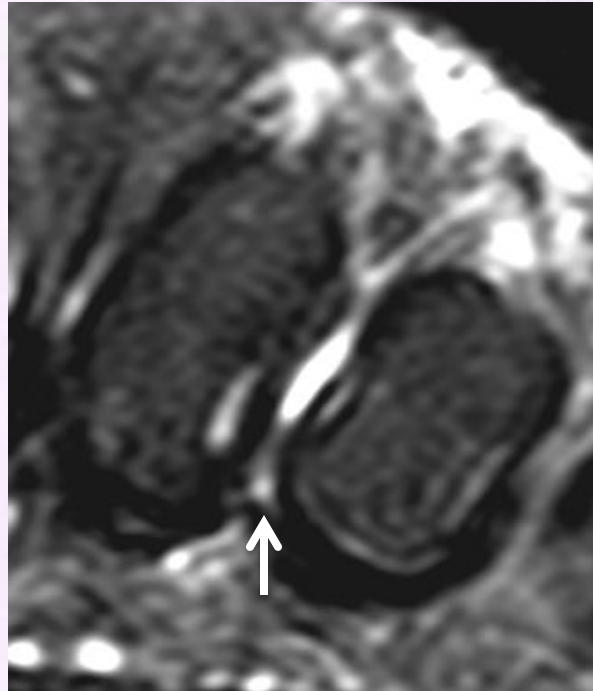
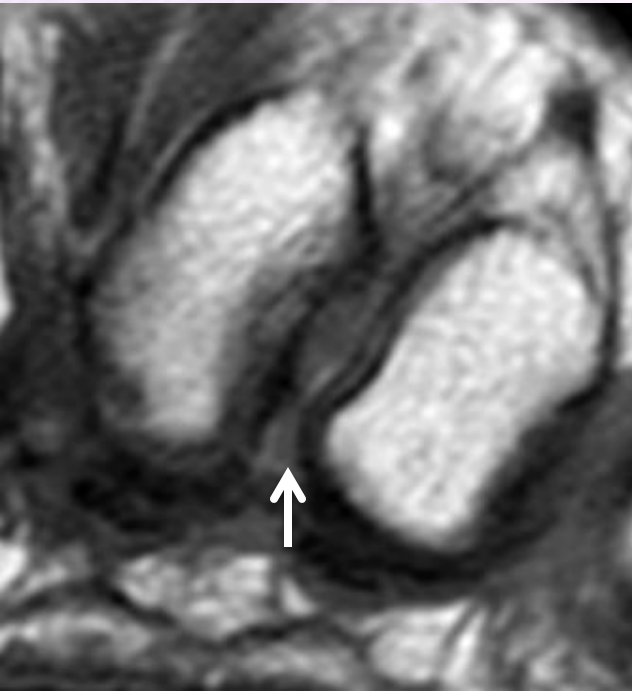
Morton's neuroma - equivocal



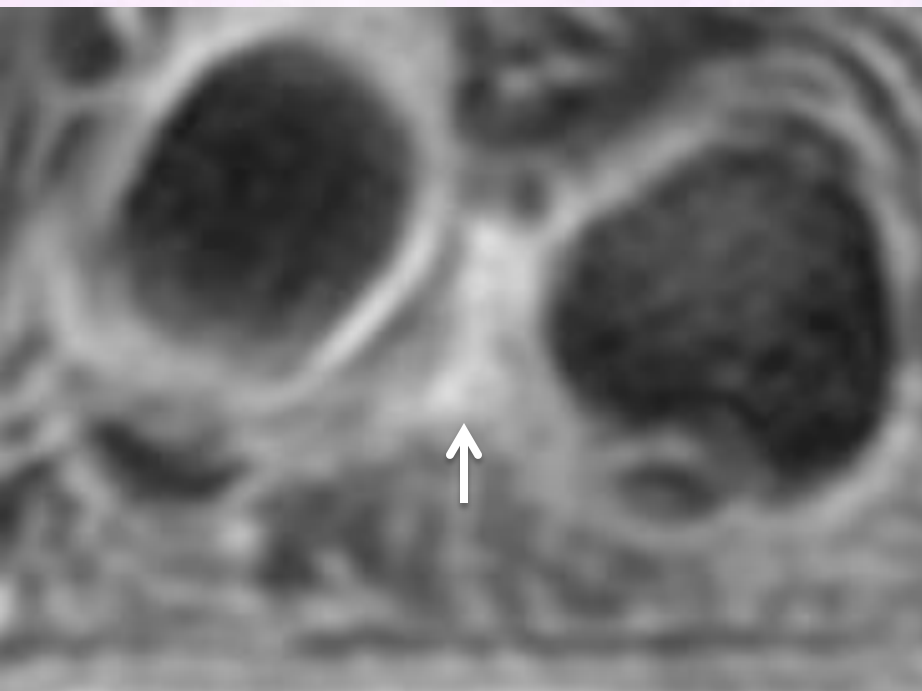
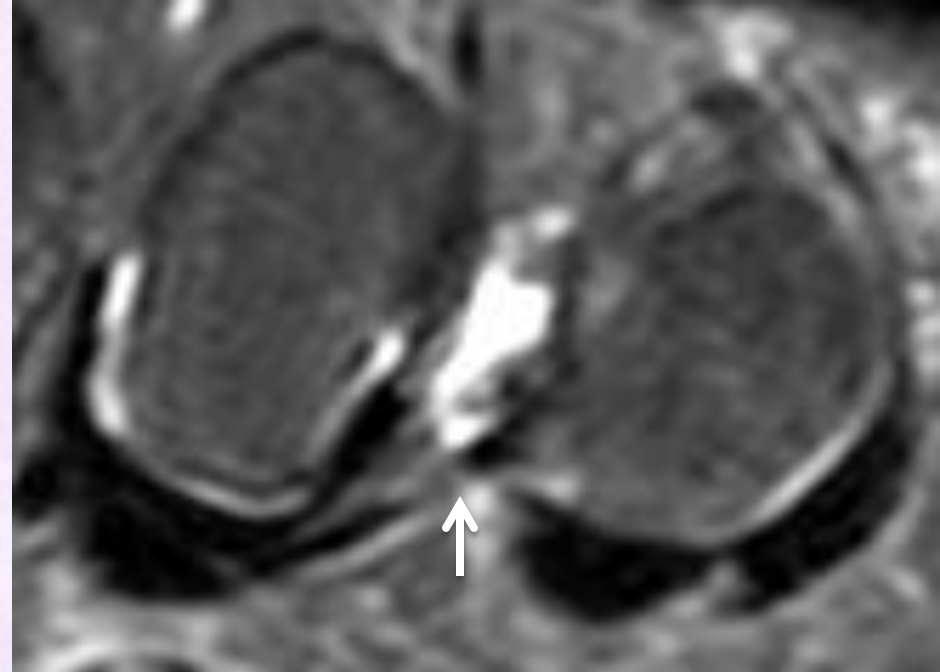
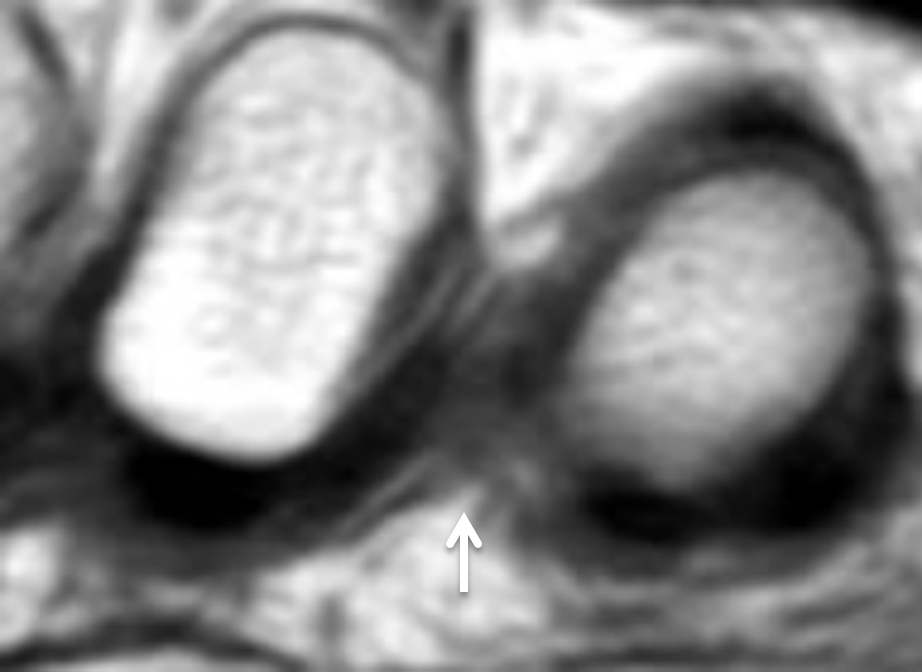
Morton's neuroma – equivocal
probably not



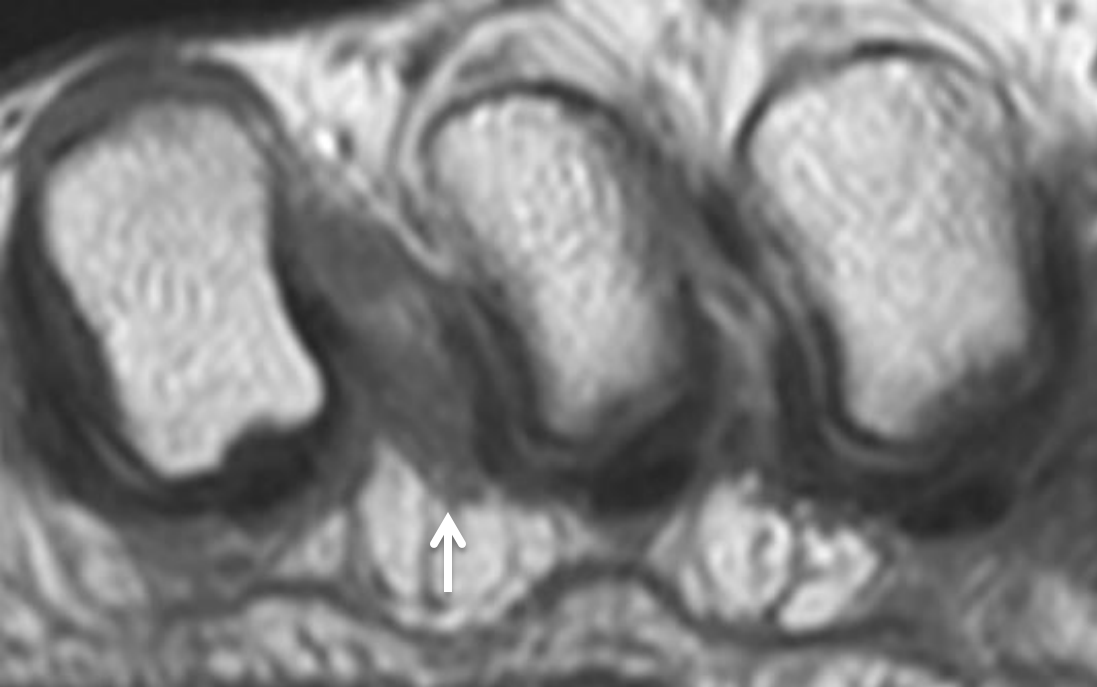
Morton's neuroma



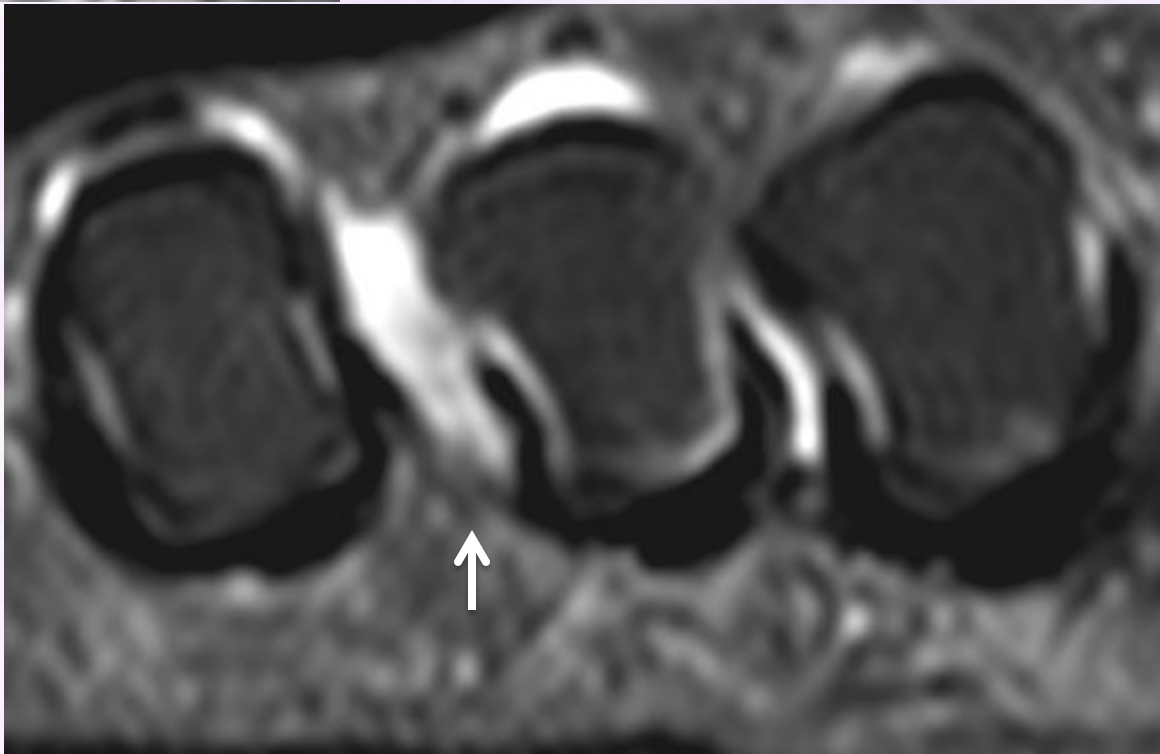
Intermetatarsal bursitis

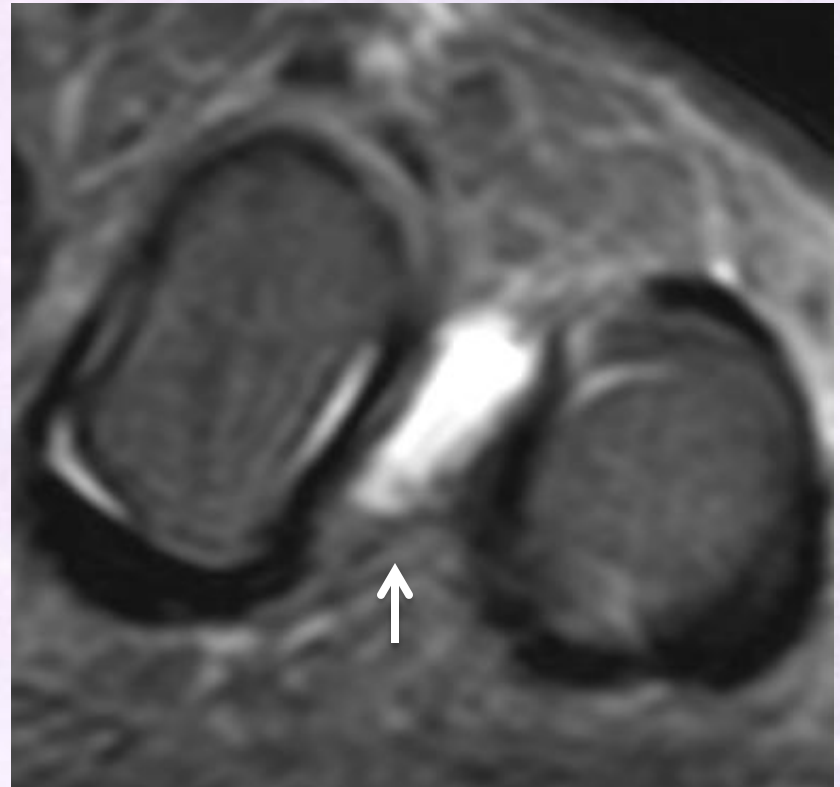
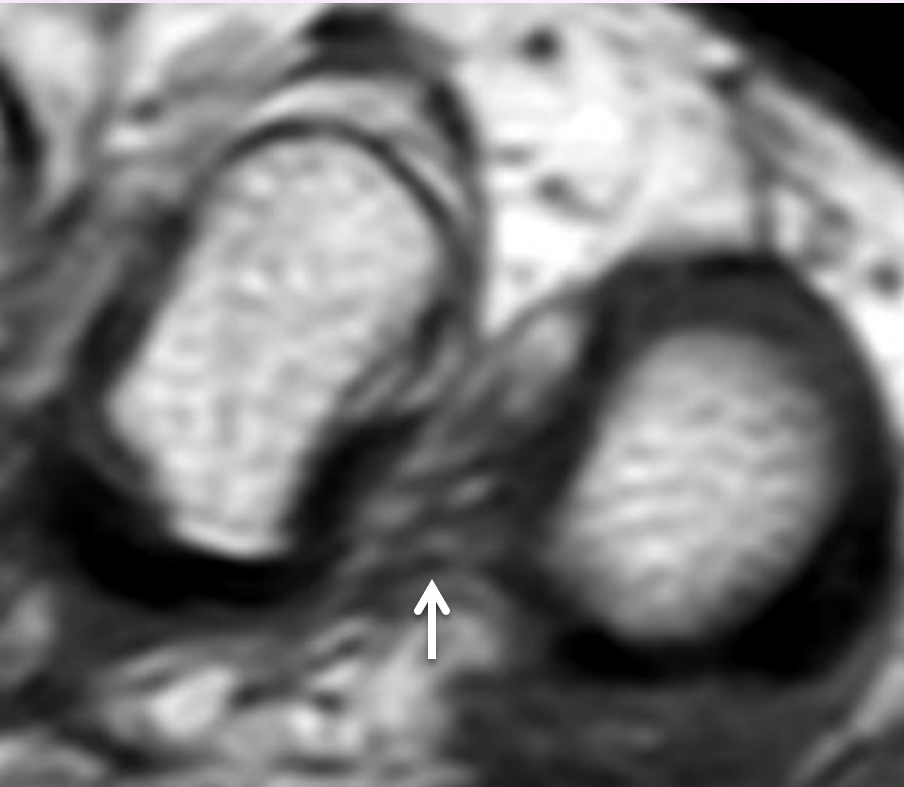


Intermetatarsal bursitis

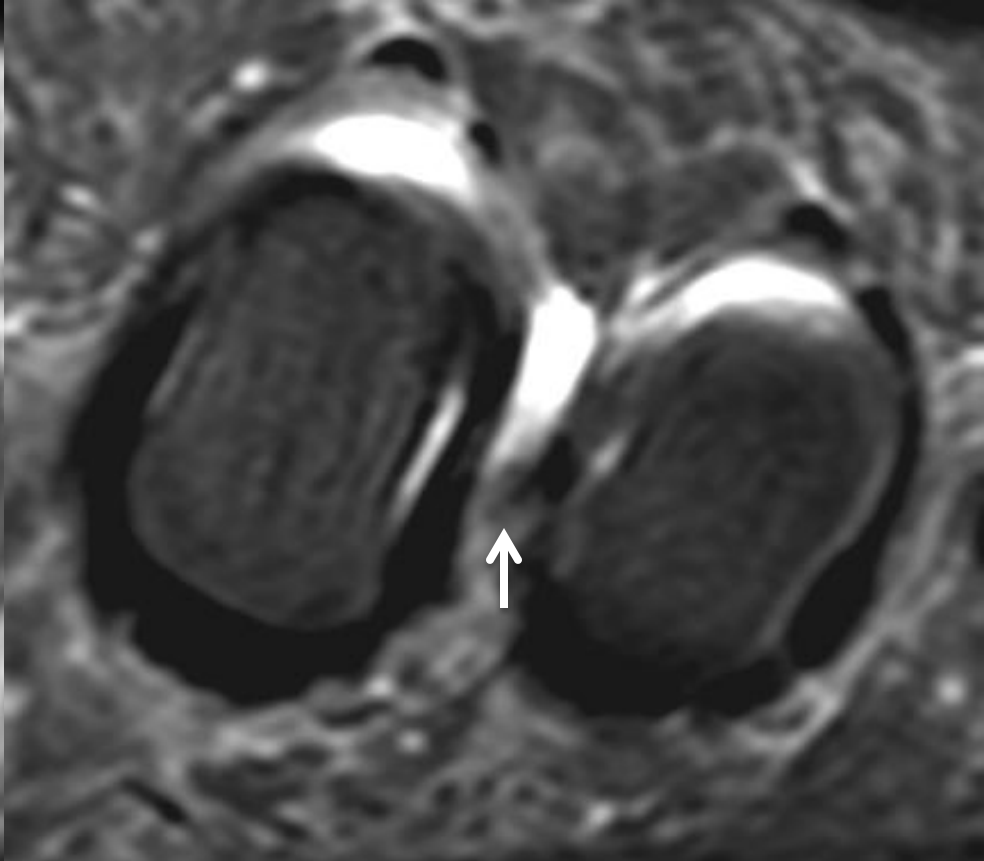
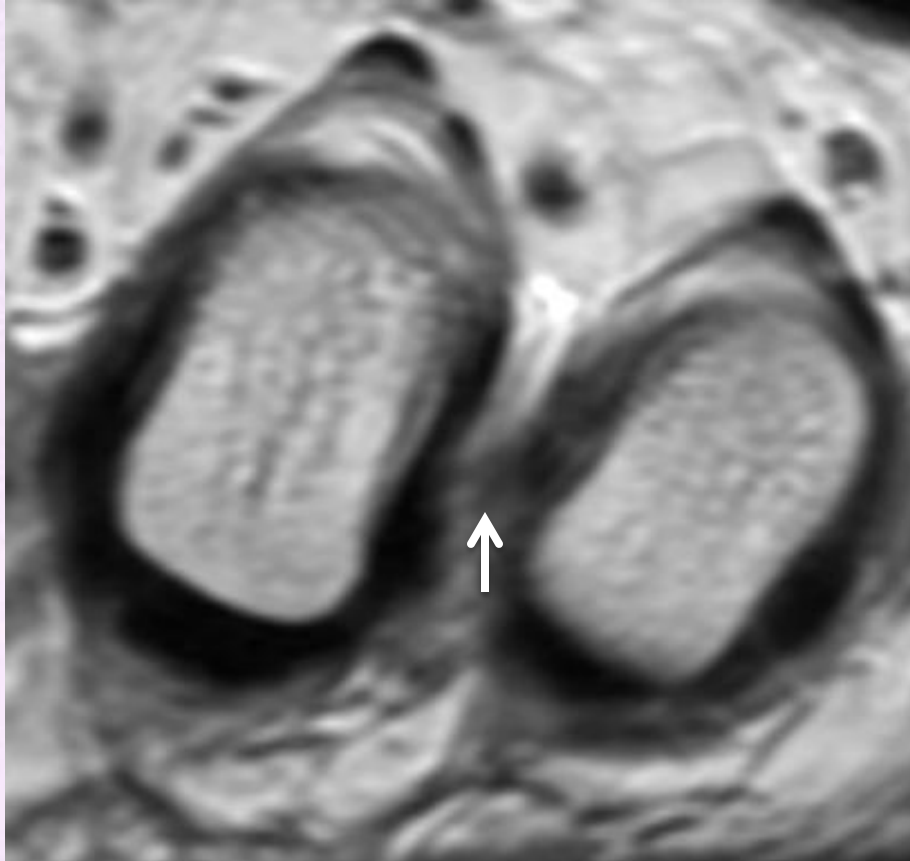


Intermetatarsal bursitis

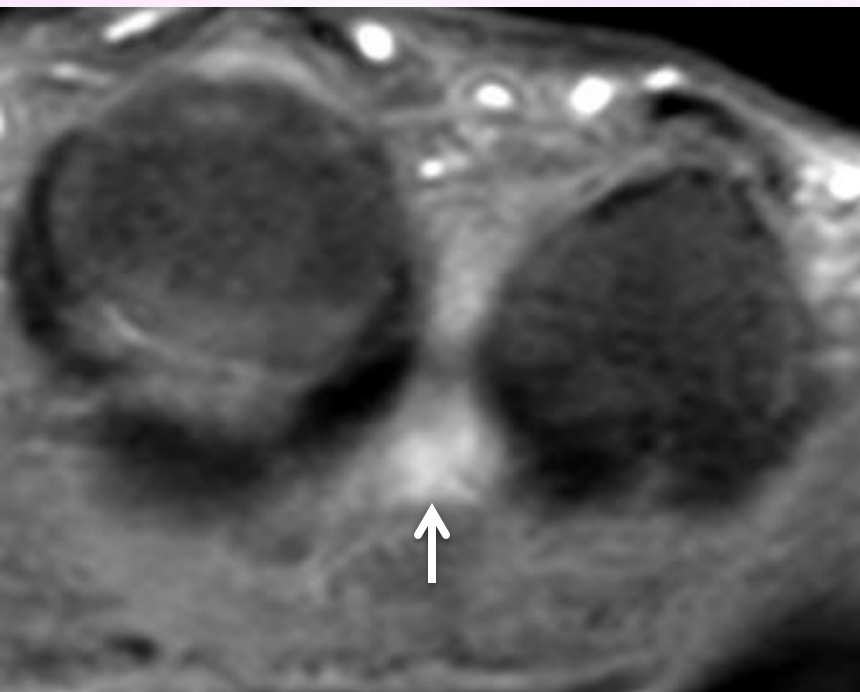
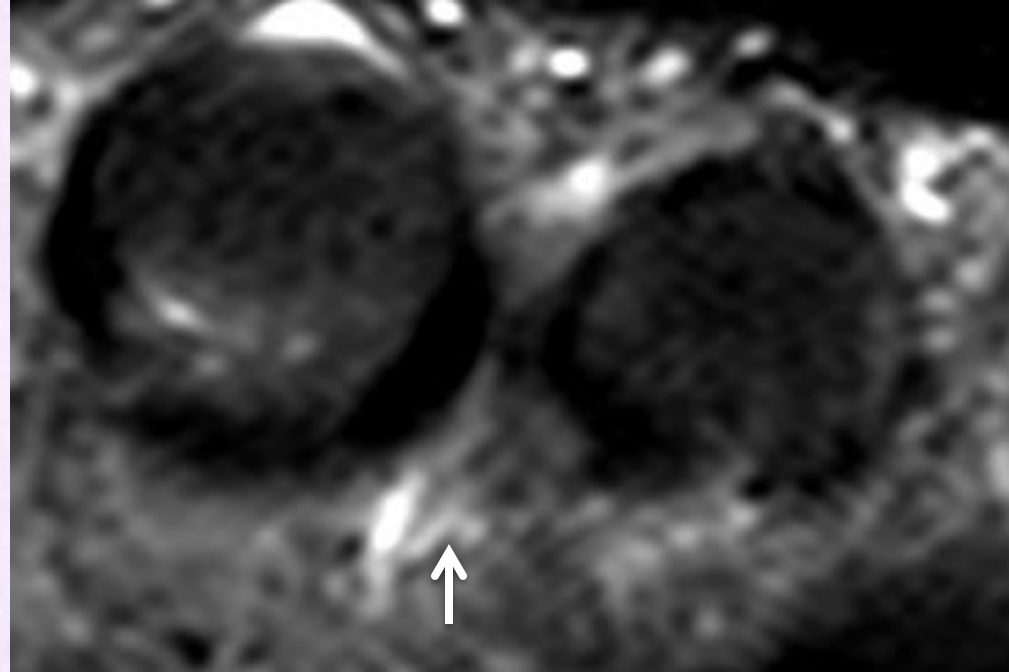
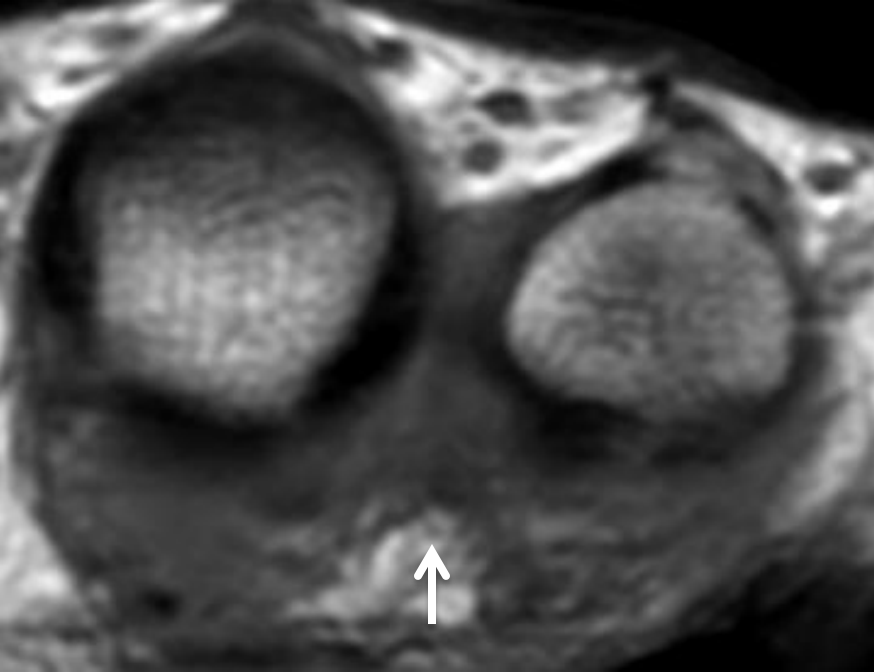




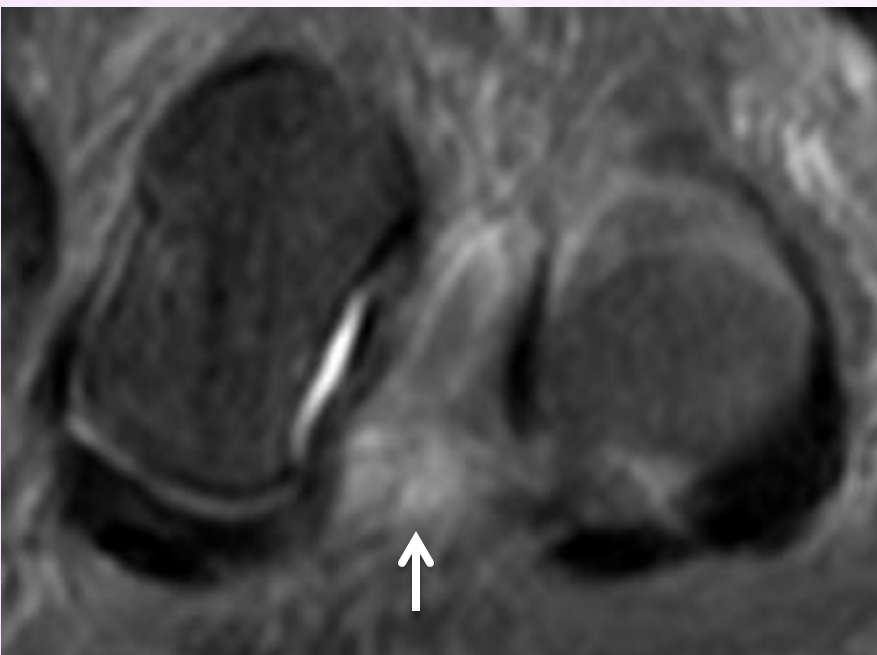
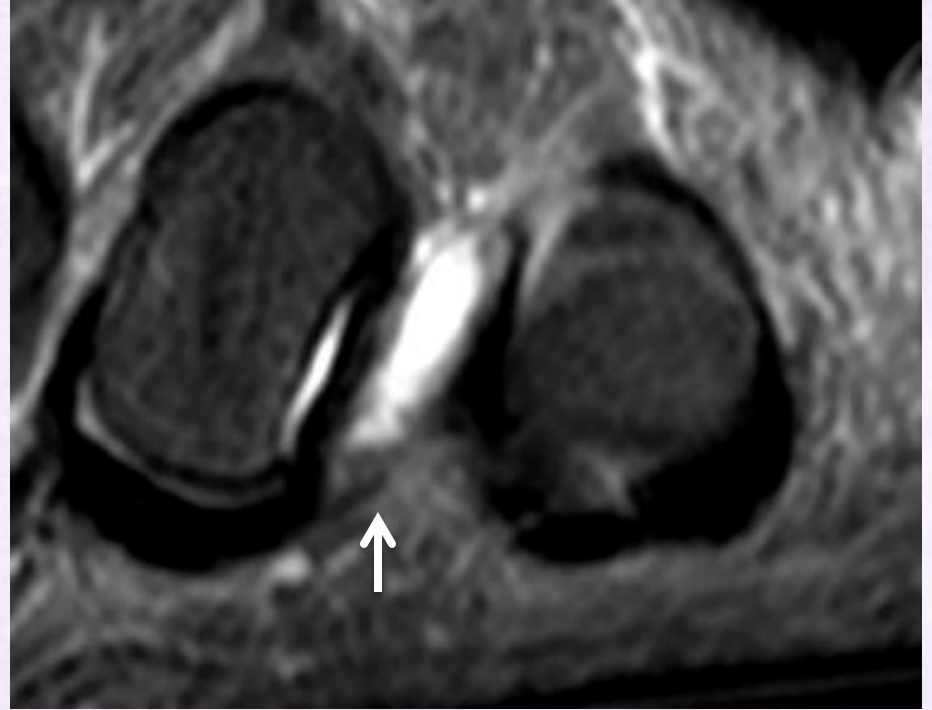
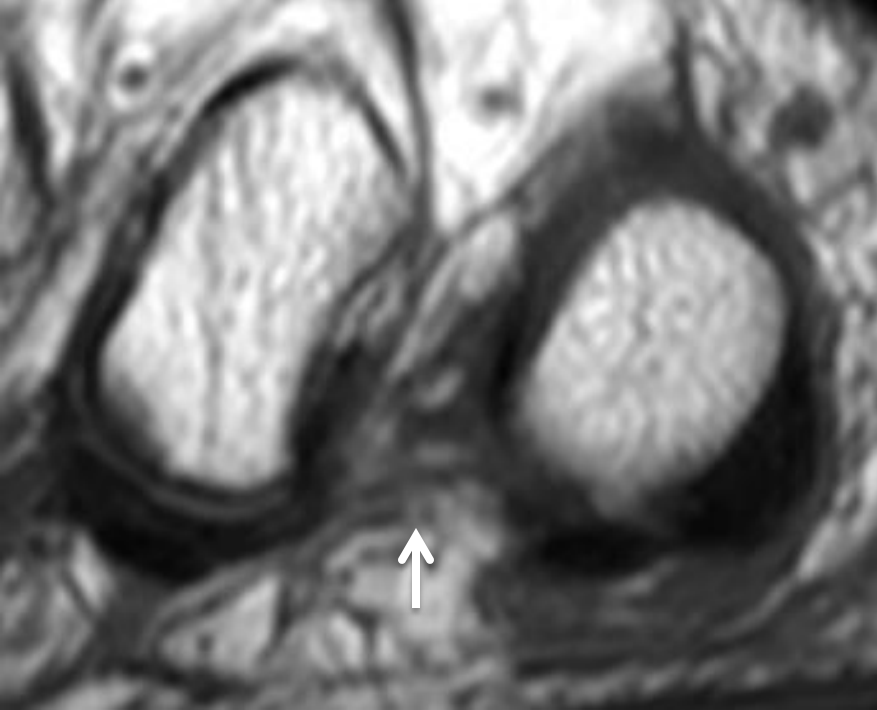
Intermetatarsal bursitis



Intermetatarsal bursitis

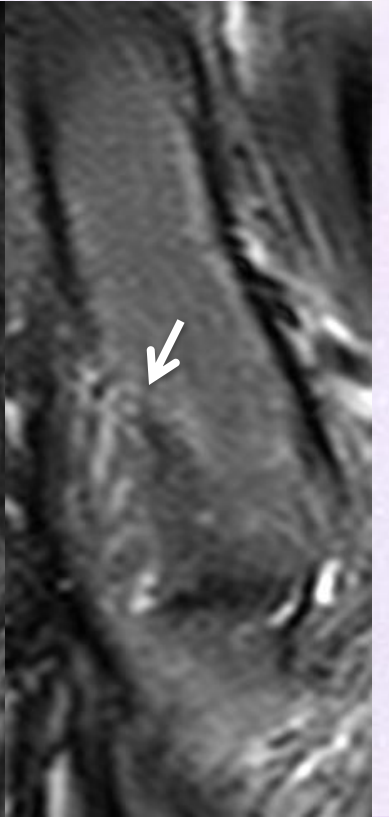
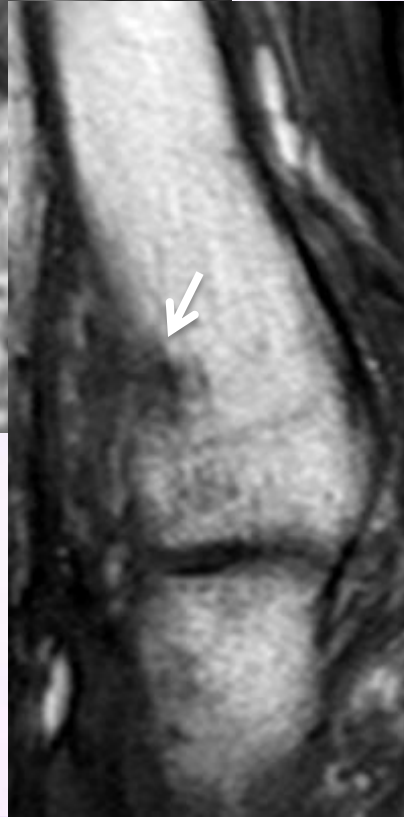


Bursitis + Morton's neuroma ?

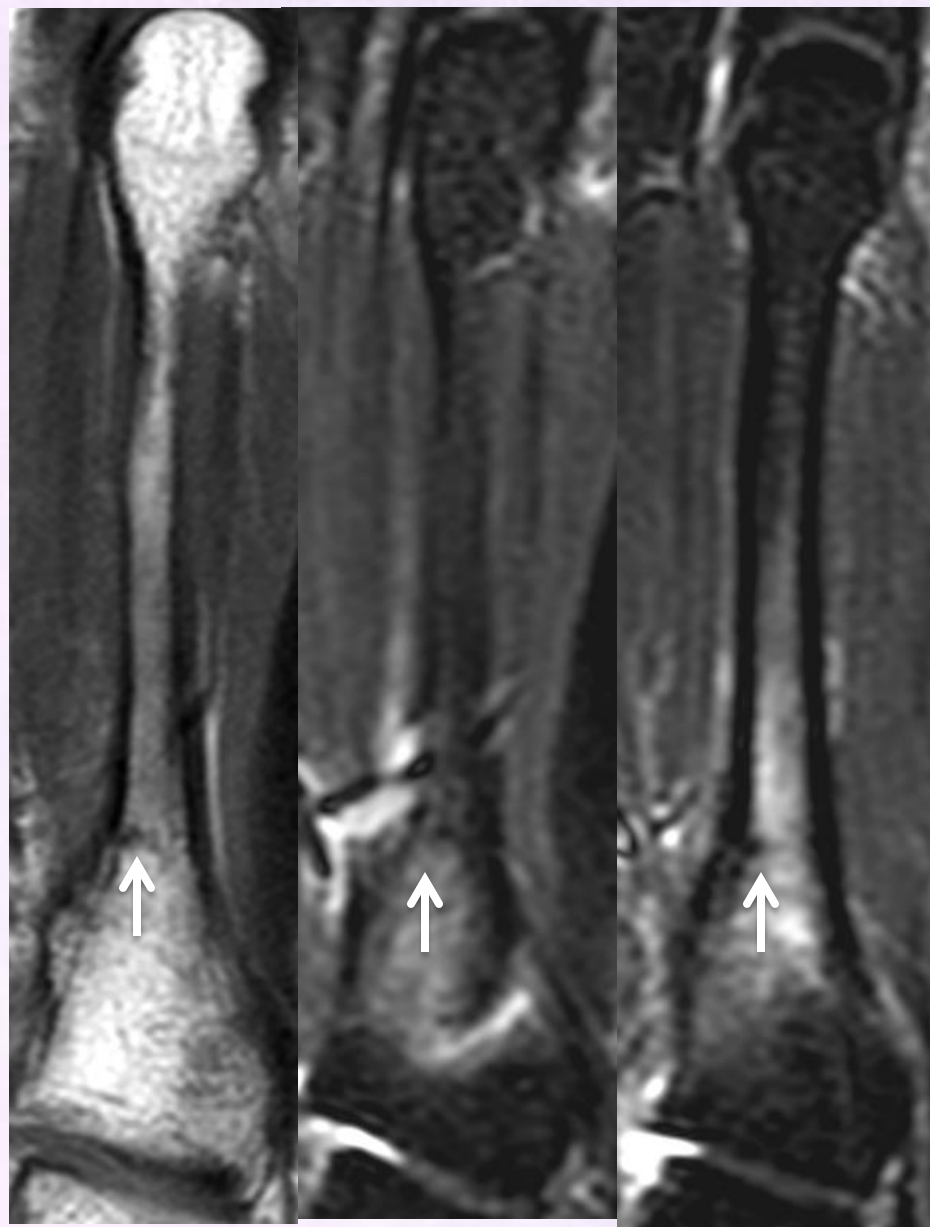
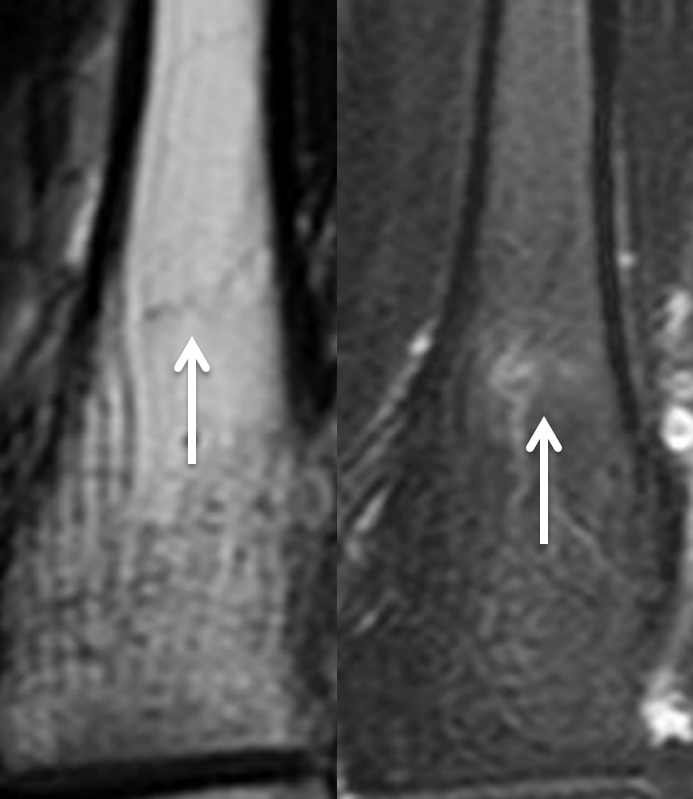


Bursitis + Morton's neuroma ?

D. Stress fracture







E.Freiberg's disease



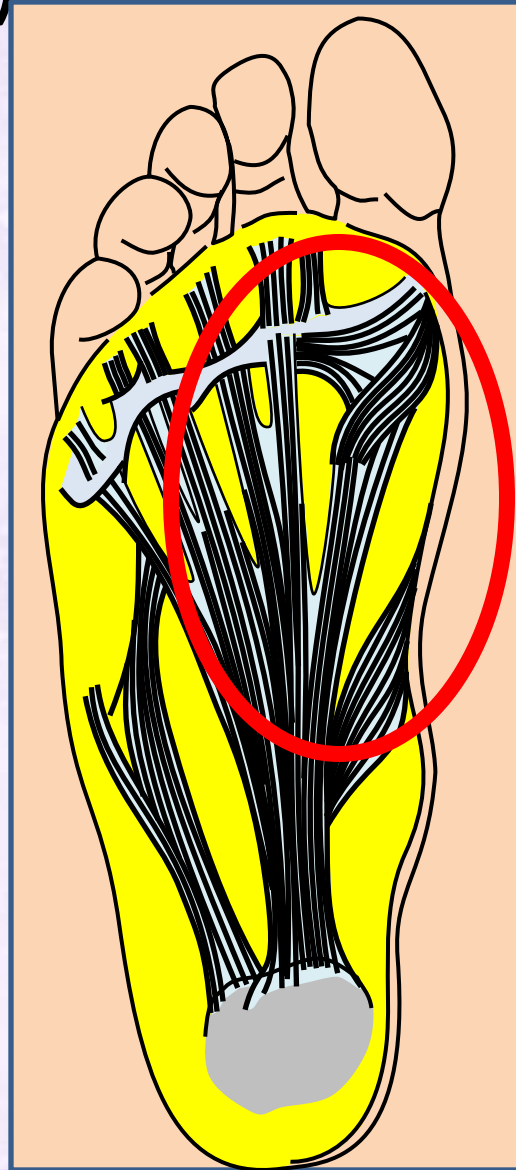
Plantar fascia pathology

1. Plantar fibroma
2. Plantar fasciitis
3. Plantar fascia tear

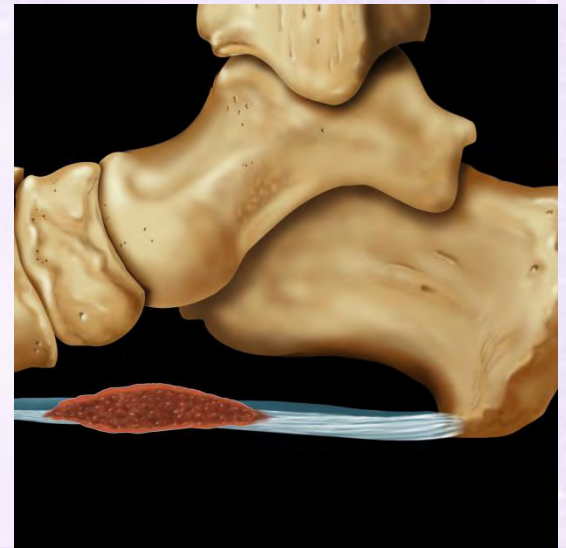
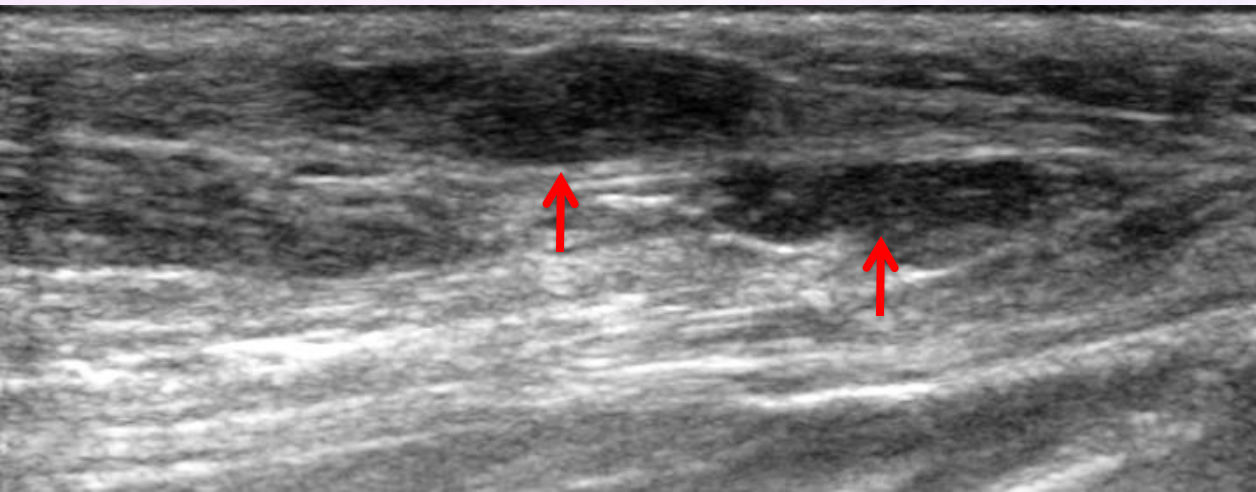
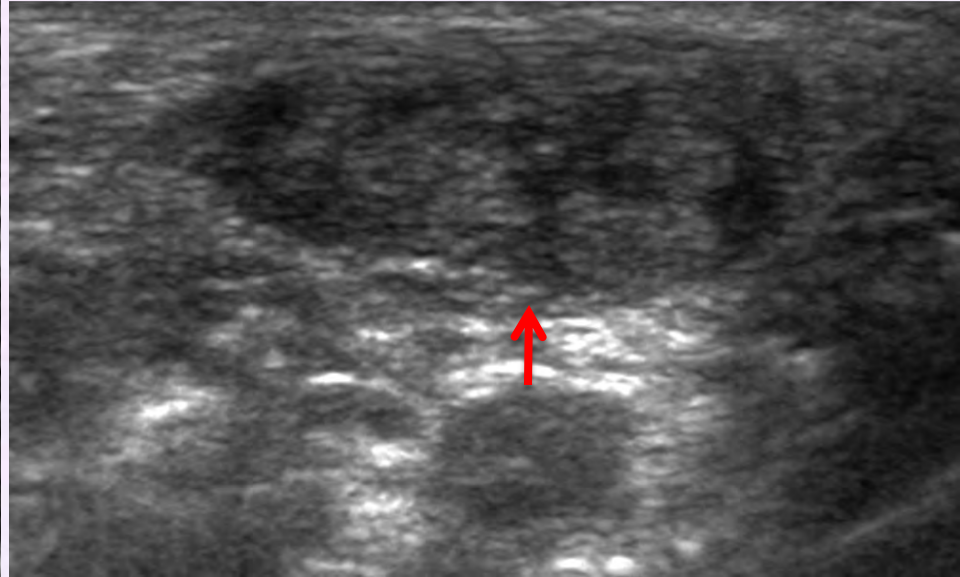
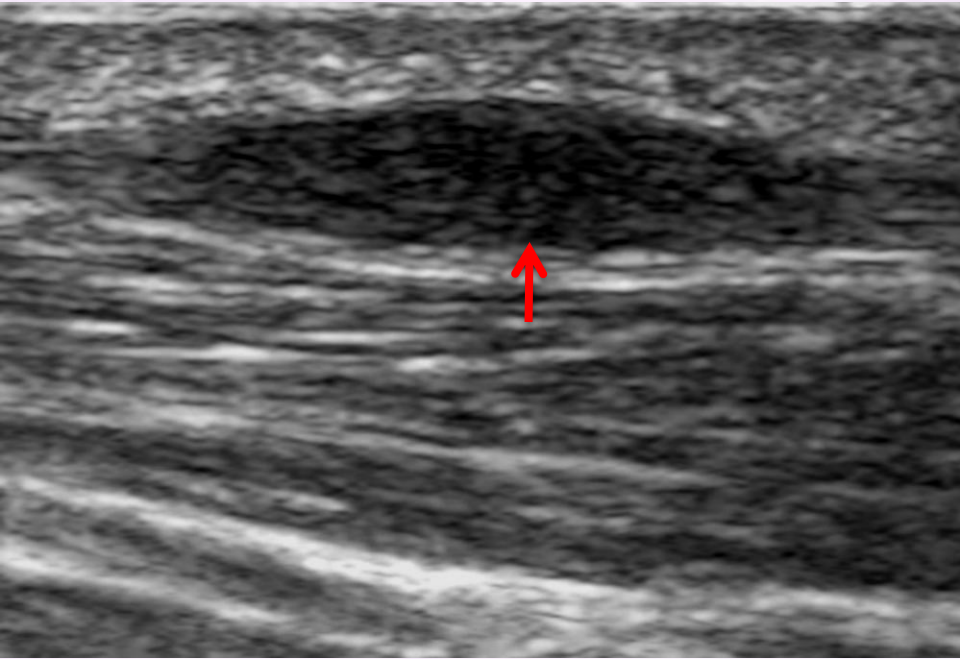


Plantar fibroma (Ledderhose disease)

- Benign focal proliferation of fibrous tissue
- Between 30-50 years
- Discrete fusiform or nodular thickening along long axis

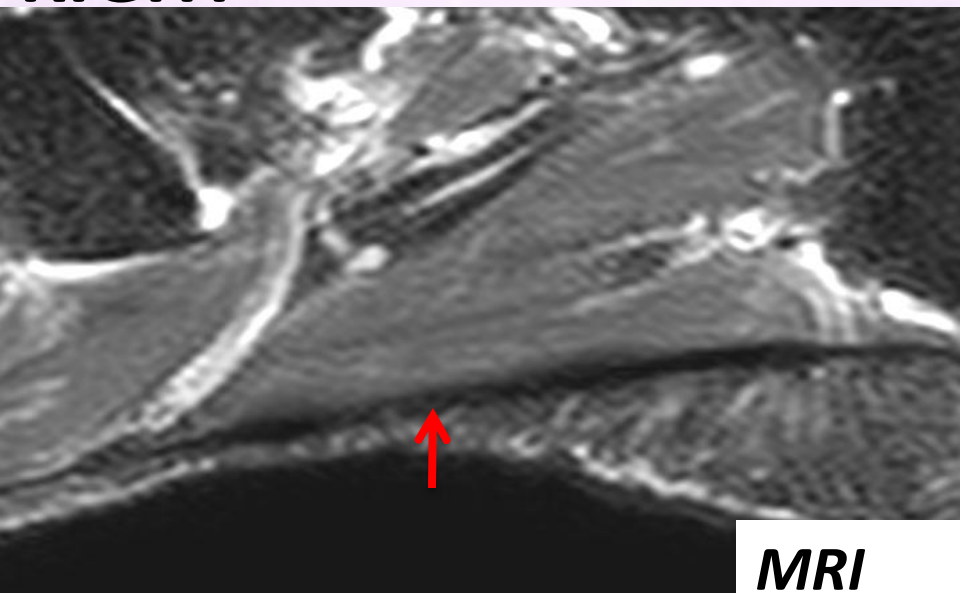


Plantar fibroma

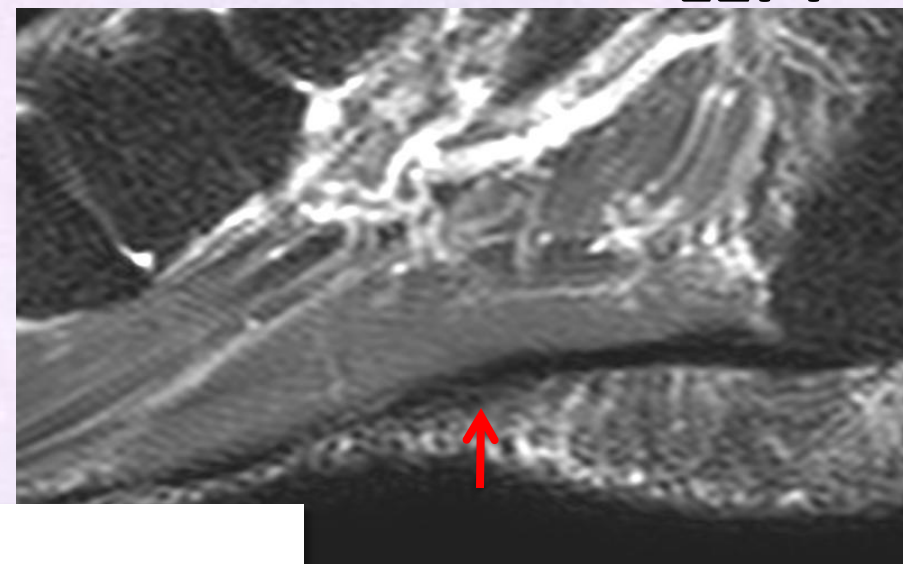


USG vs MRI

RIGHT



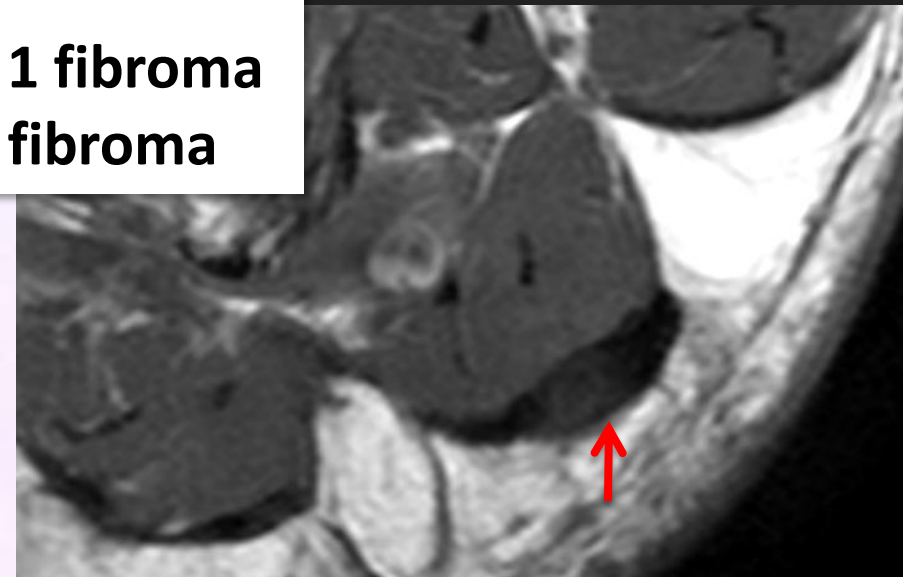
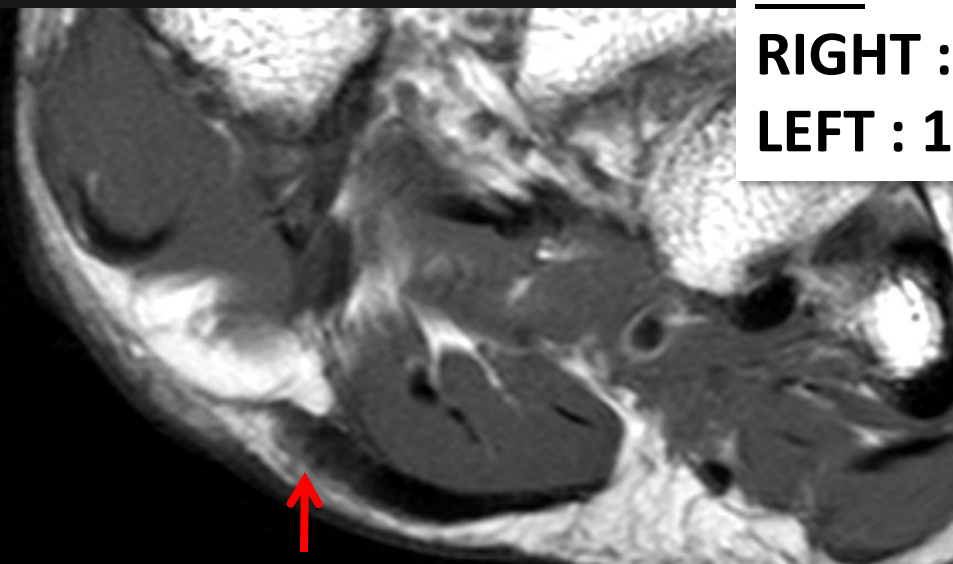
LEFT

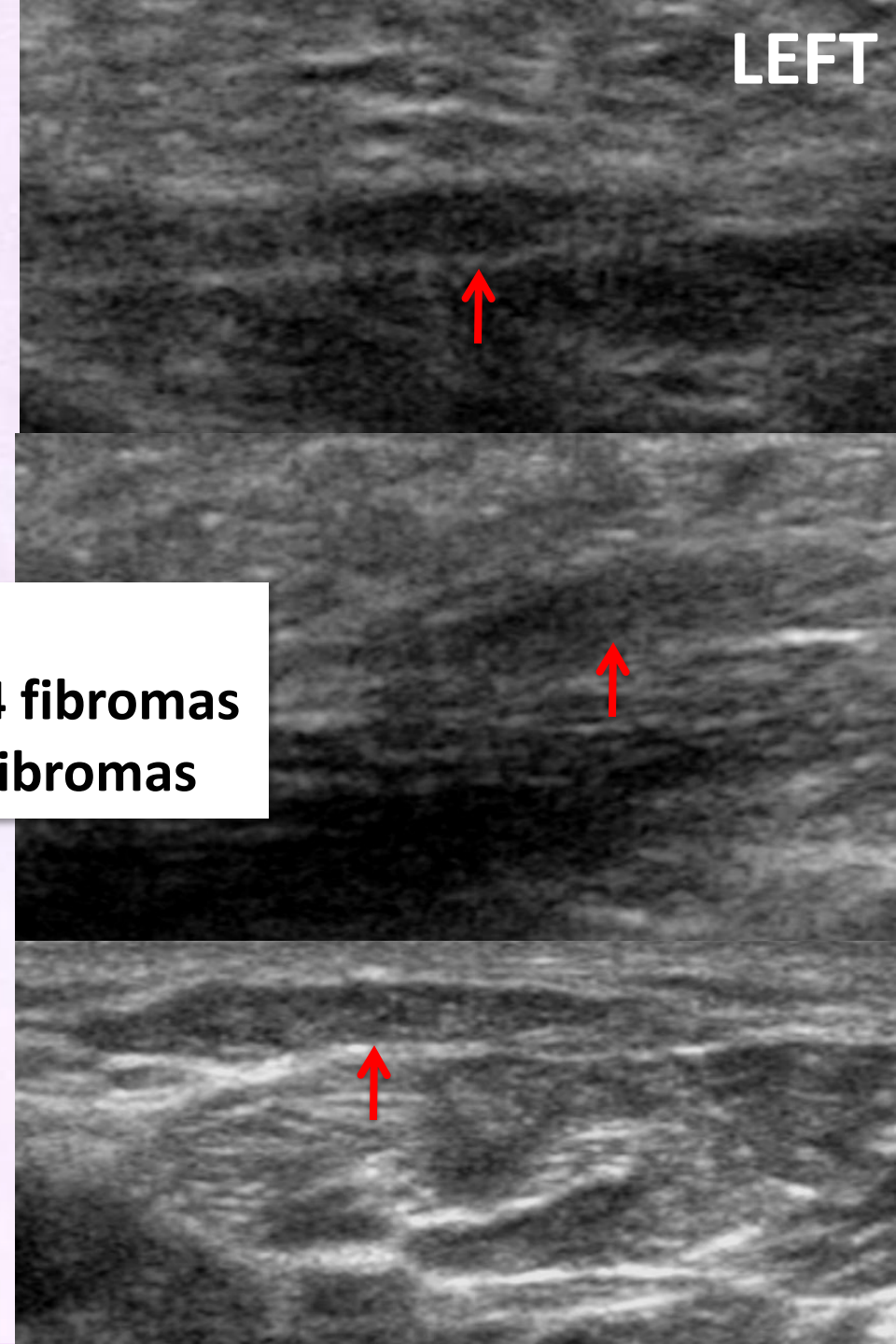
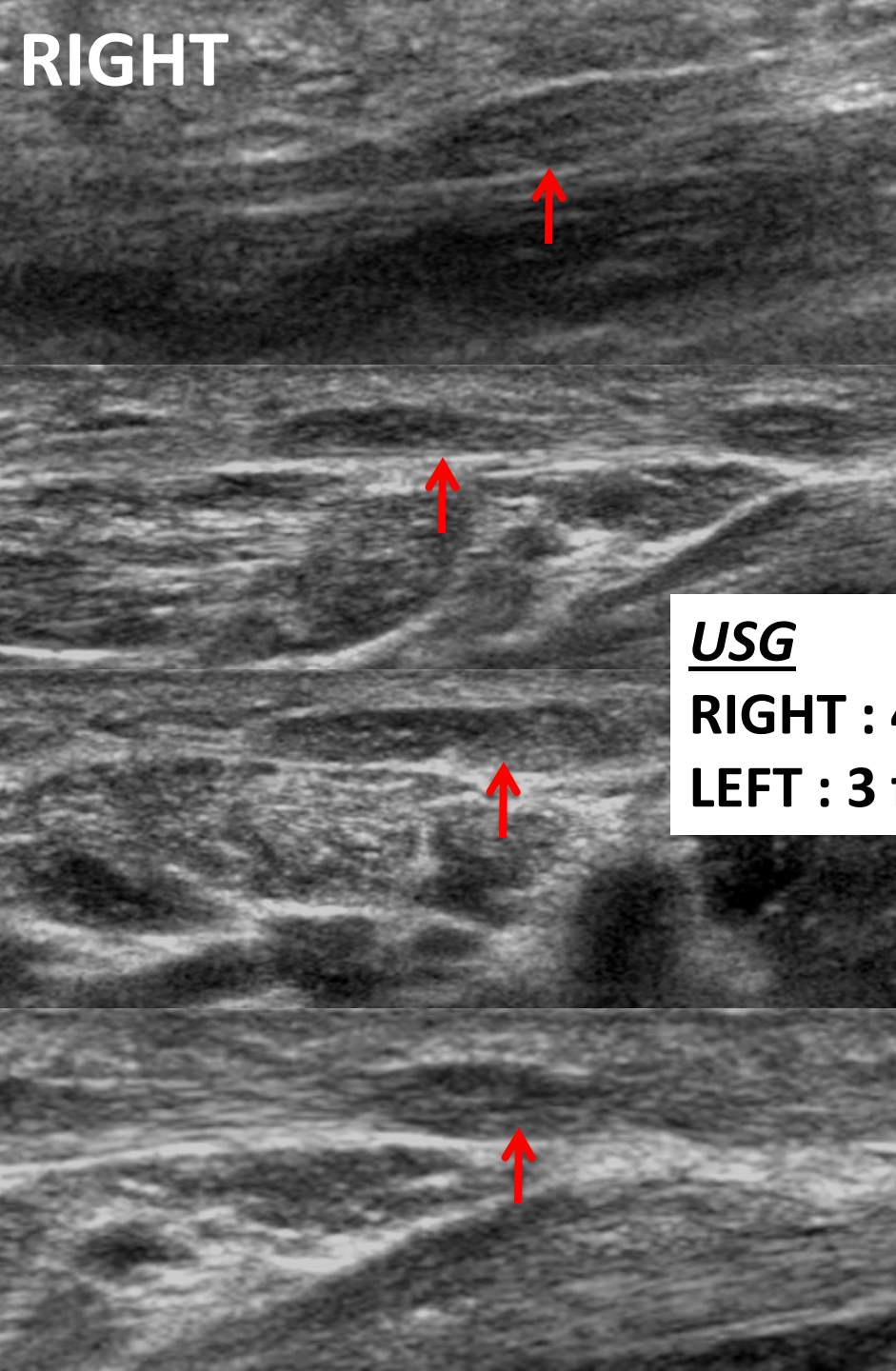


MRI

RIGHT : 1 fibroma

LEFT : 1 fibroma





USG
RIGHT : 4 fibromas
LEFT : 3 fibromas