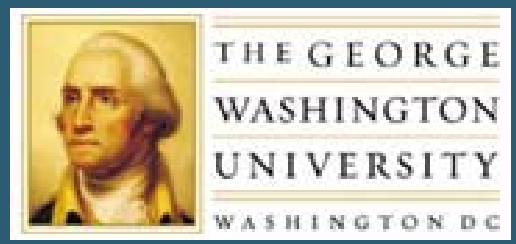
MR Imaging of the Ankle

Raymond W. Sze, M.D.
Children's National Medical Center
George Washington University Medical Center



Outline of Presentation

- Normal Anatomy
- Imaging Technique
- Selected Pathology

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Normal Anatomy

- Bones and Joints
- Tendons
- Ligaments

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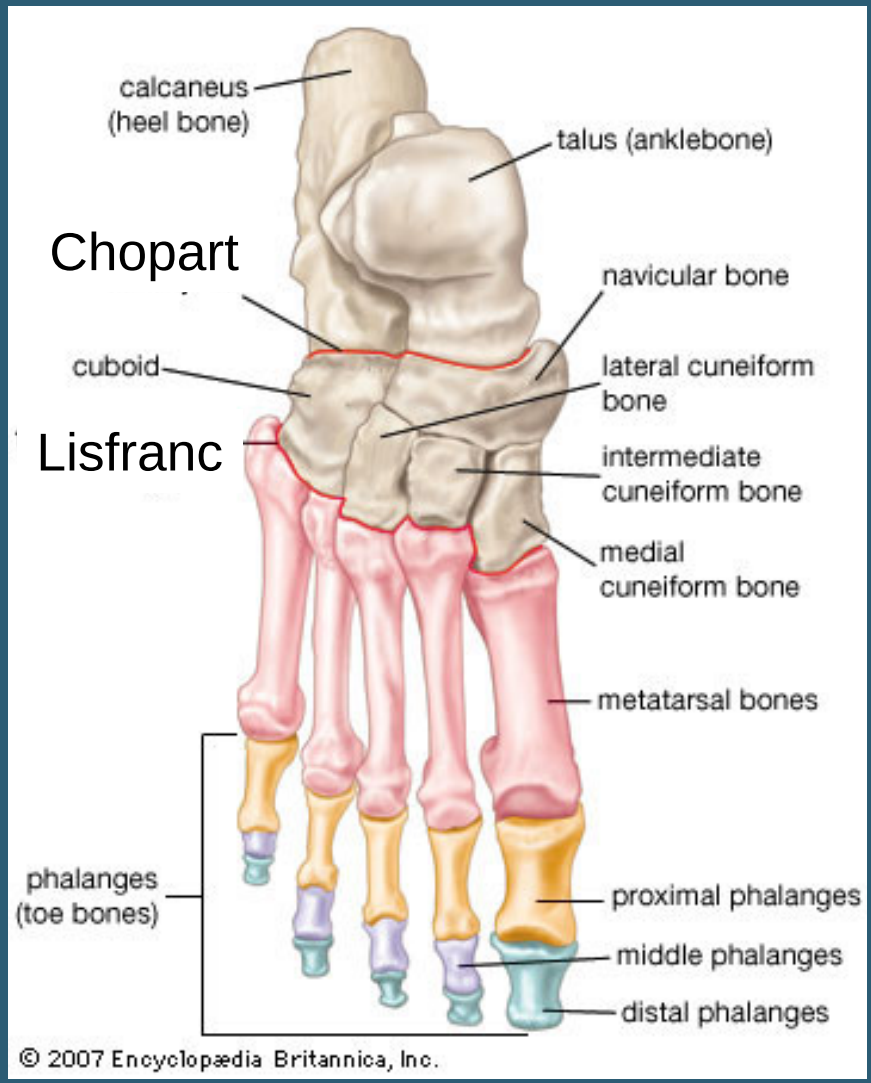
Bones and Joints: Foot



- Hindfoot
  - Talus and calcaneus
- Midfoot
  - Navicular, cuboid, 3 cuneiforms
- Forefoot
  - Metatarsals & phalanges

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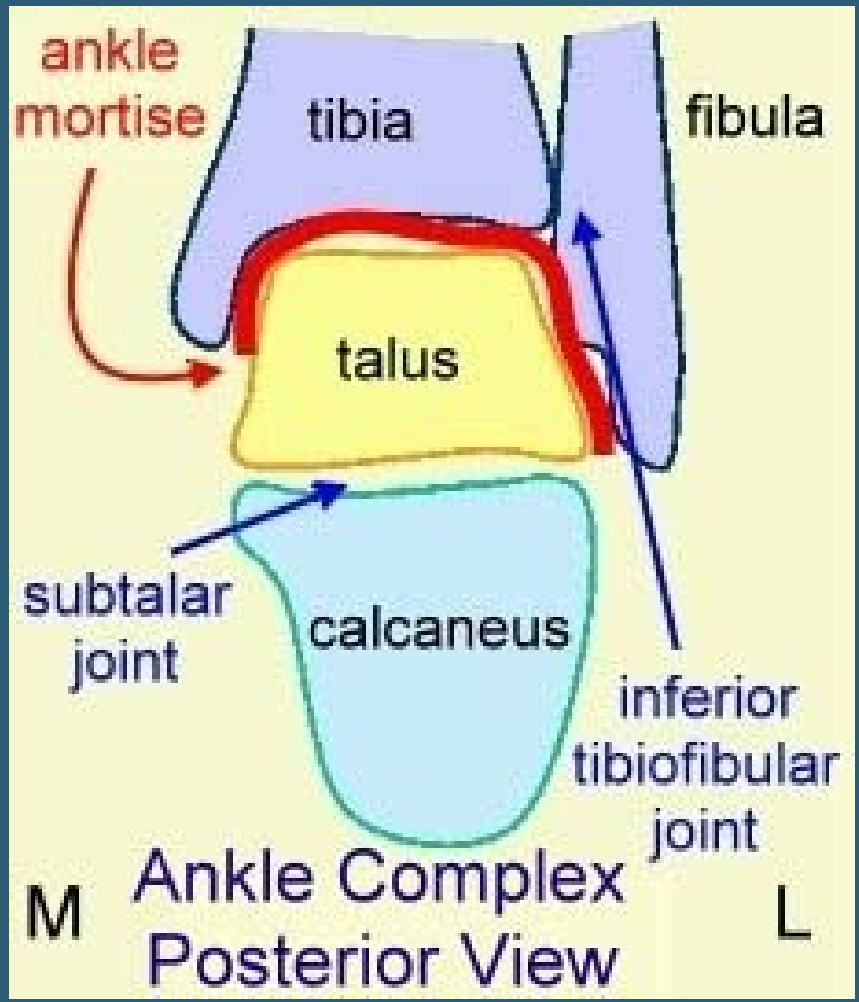
Bone and Joints: Ankle Joint



- Joint=Articulation between bottom of tibia (plafond) and top of talus (talar dome)
- Mortise=rectangular opening formed by medial malleolus, plafond, and lateral malleolus

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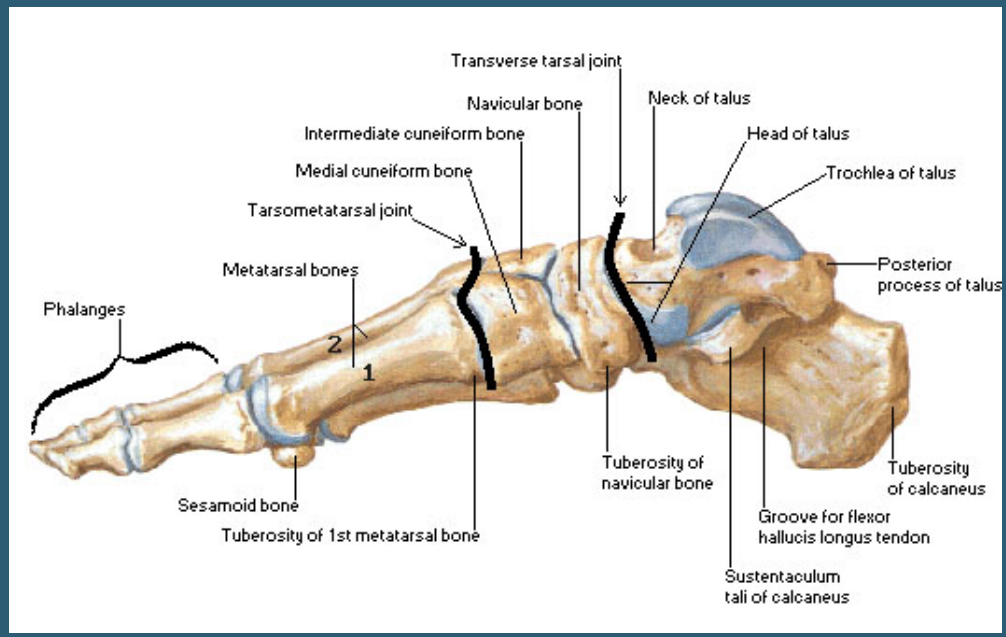
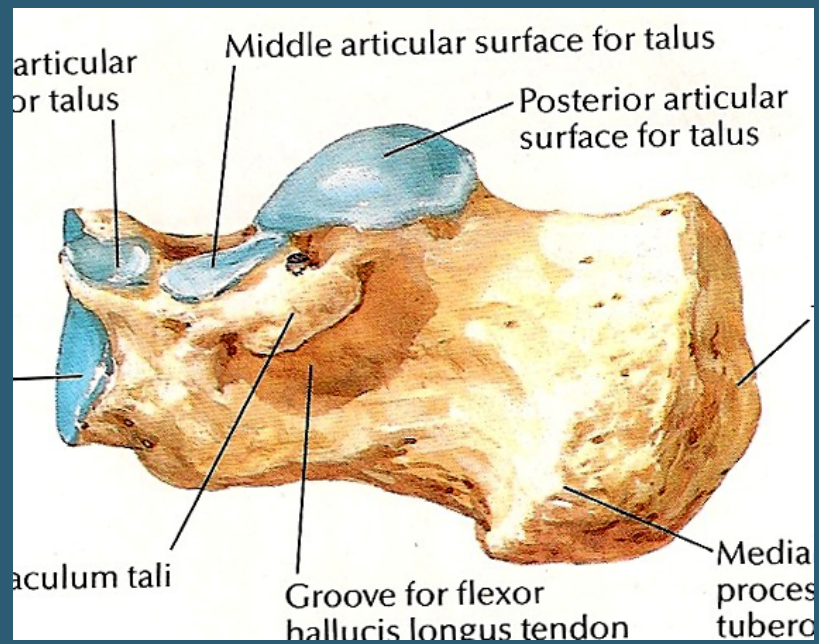
Bones and Joints: Subtalar joint





- Articulation between talus and calcaneus
- Posterior, middle, and anterior facets

Normal Anatomy

- Bones and Joints
- Tendons
- Ligaments

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Tendons: Grouping

- Anterior
- Medial
- Lateral
- Posterior

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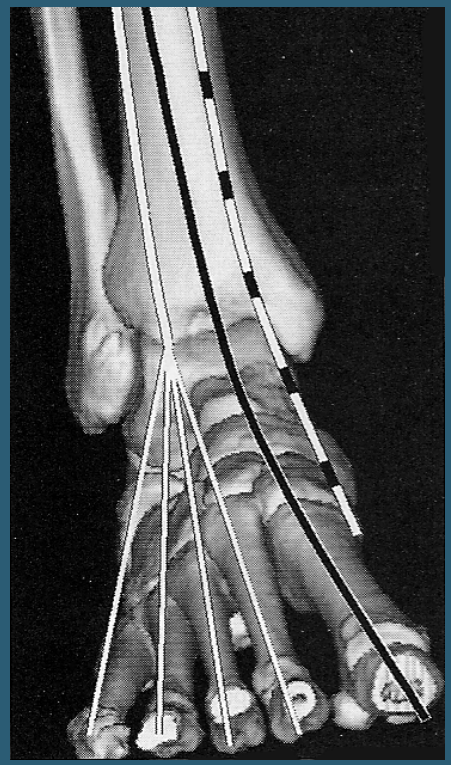
Tendons: Anterior Tendons



- Tibialis anterior
  - Insertion: plantar base 1st metatarsal & cuneiform
  - Internal standard: largest tendon (except Achilles)

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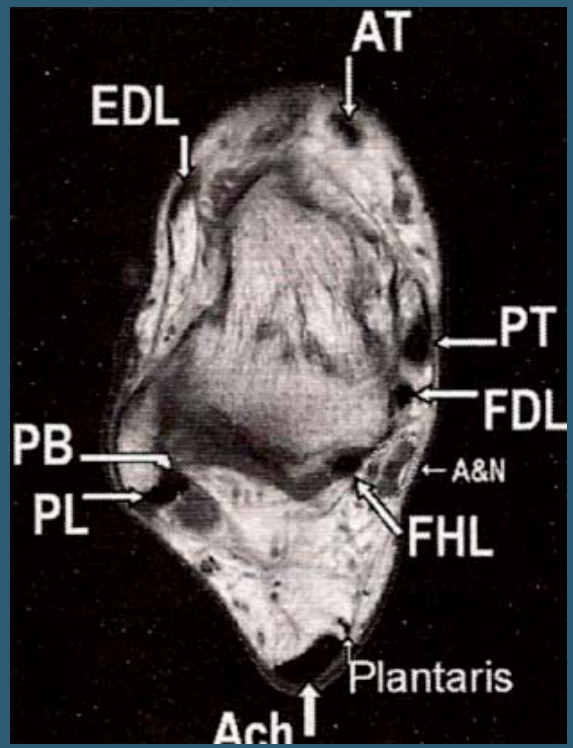
Tendons: Anterior Tendons



- Extensor Hallucis Longus
  - Insertion: dorsal base of great toe distal phalanx
  - Common to not see over midfoot 2º to magic angle

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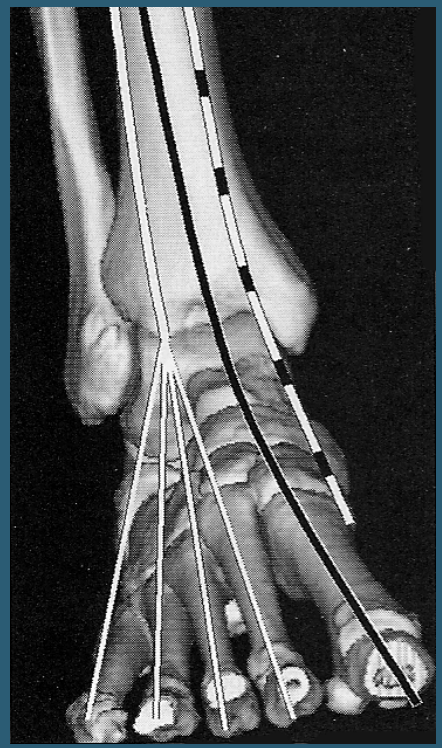
Tendons: Anterior Tendons



- Extensor Digitorum Longus
  - Fans into 4 slips at midfoot
  - Insertion: base of 2nd-5th middle & distal phalanges

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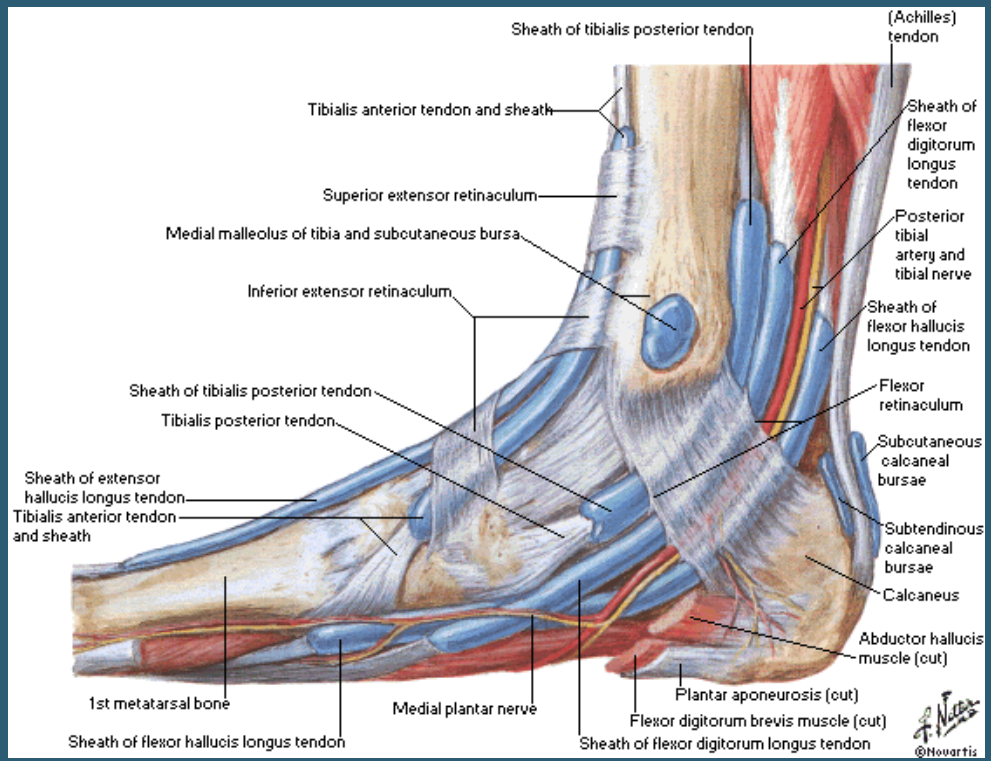
Tendons: Posterior Tendons



- Achilles
  - straight and black all sequences
  - Distal tendon should “smile”

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Tendons: Posterior Tendons

- Plantaris
  - Clinically insignificant

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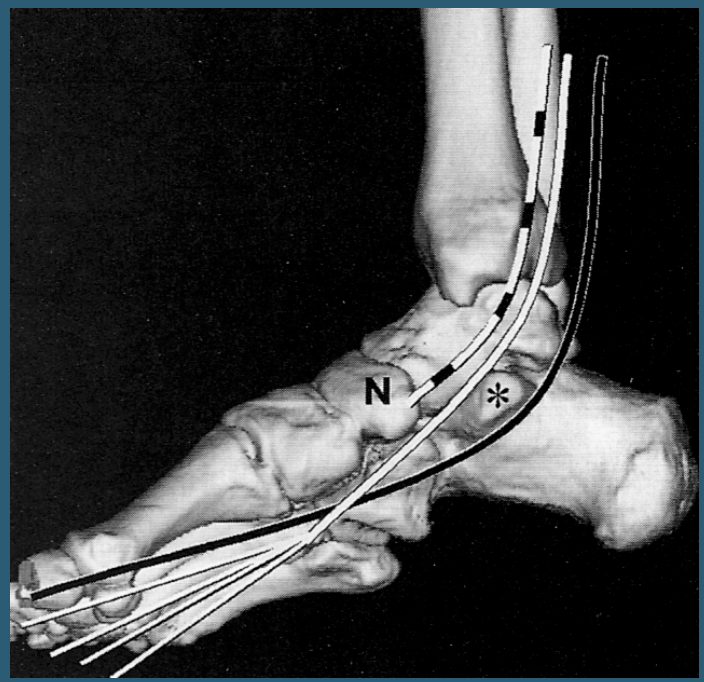
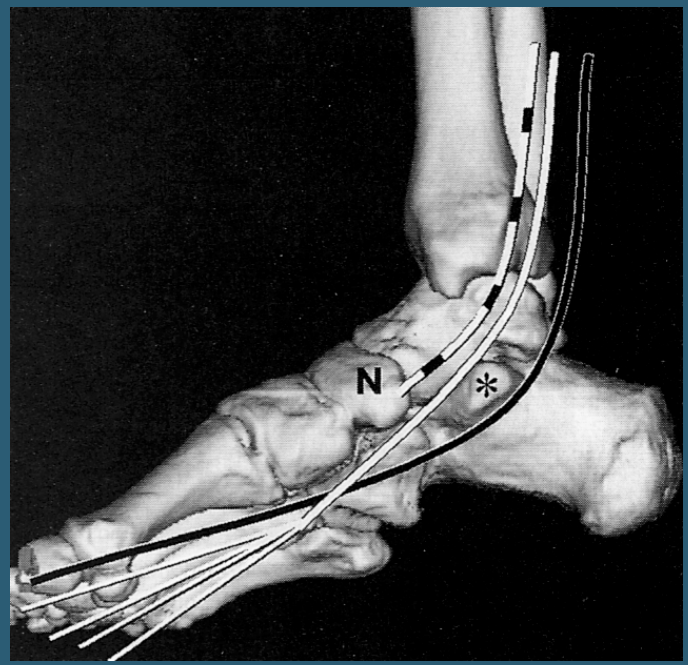
Tendons: Medial Tendons



- Tibialis posterior
  - Pulley: medial malleolus
  - Insertion 1º: medial navicular (navicular tubercle)
  - Insertion 2º: cuneiform & bases of 2nd-4th metatarsals

Tendons: Medial Tendons



- Flexor Digitorum Longus
  - Pulley: medial malleolus
  - Insertion: bases of 2nd-5th distal phalanges
  - Cross superficial to FHL at “Master knot of Henry”

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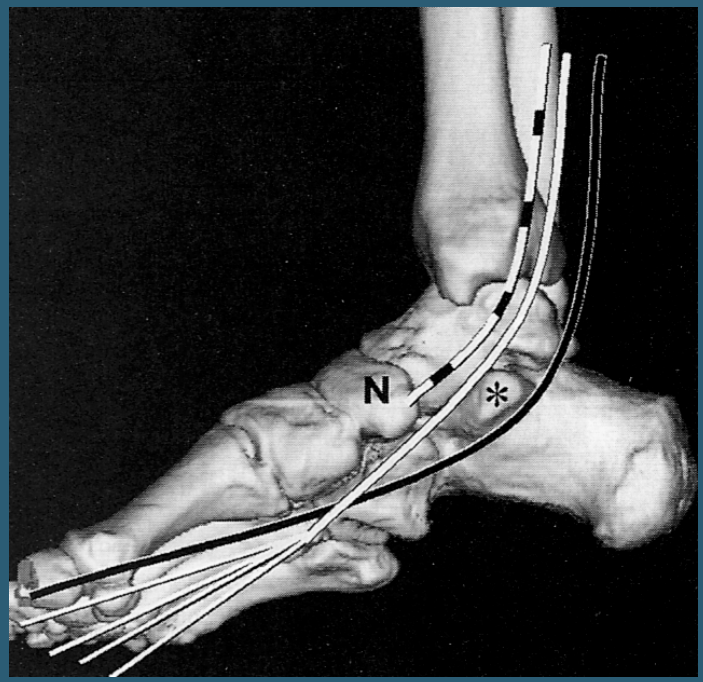
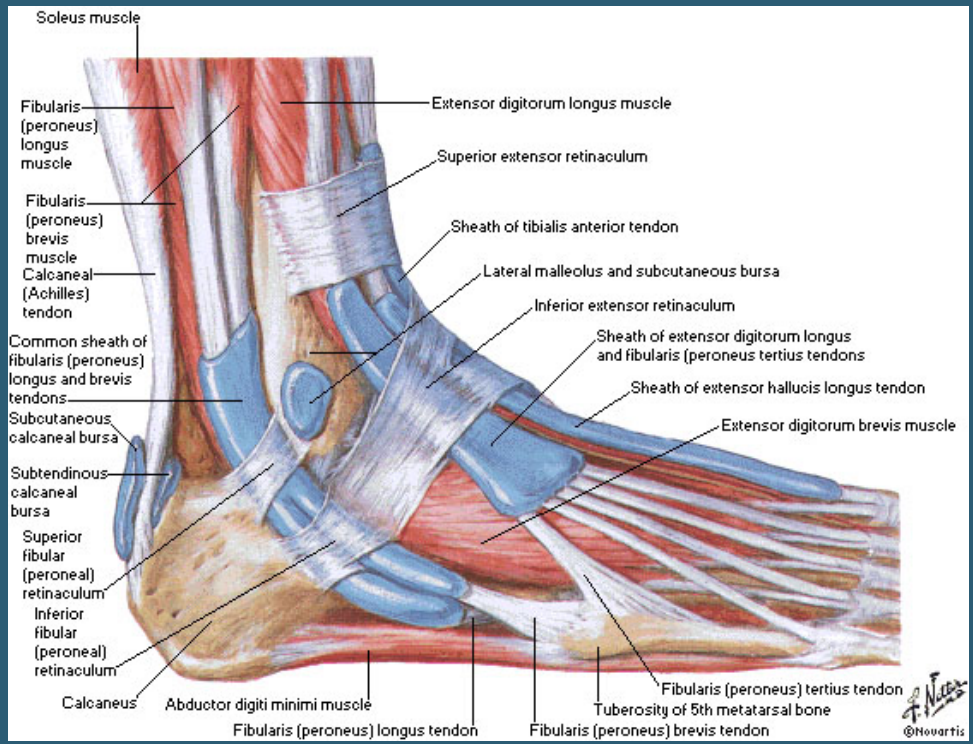
Tendons: Medial Tendons



- Flexor Hallucis Longus
  - Pulley: sustentaculum tali
  - Insertion: base of great toe distal phalanx
  - Cross deep to FDL at “Master knot of Henry”

Tendons: Lateral Tendons



- Peroneus Brevis
  - Proximal: common sheath; distal: separate sheath
  - Pulley: lateral malleolus
  - Insertion: tuberosity lateral base 5th metatarsal

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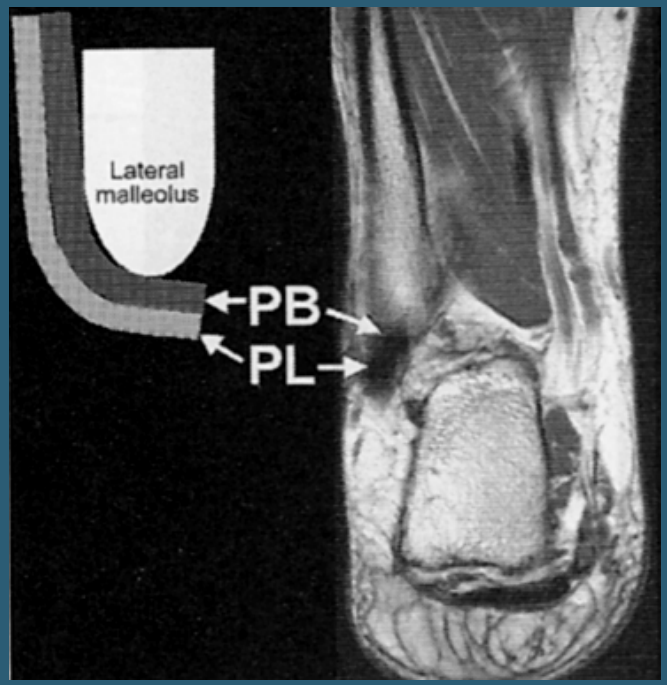
Tendons: Lateral Tendons



- Peroneus longus
  - Pulley: lateral malleolus
  - Insertion: medial cuneiform; base of 1st metatarsal
  - Race track: shorter tendon of PB hugs inside

Normal Anatomy

- Bones and Joints
- Tendons
- Ligaments

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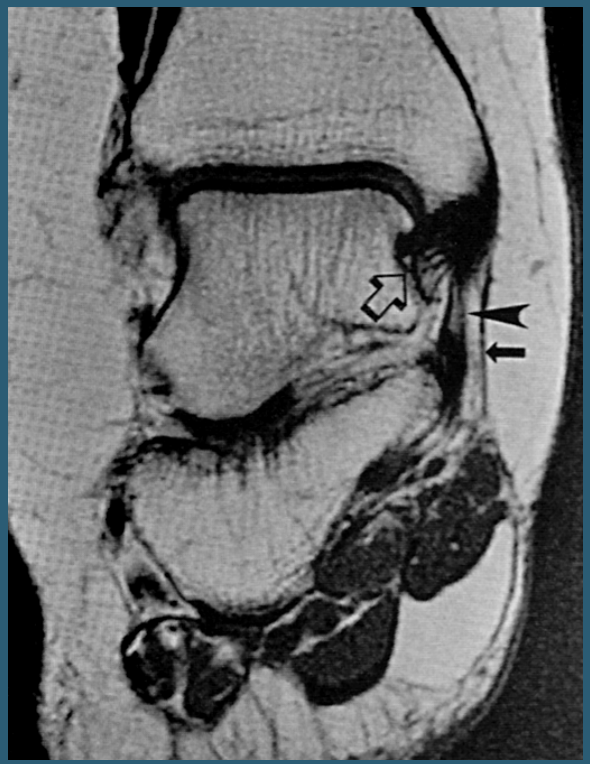
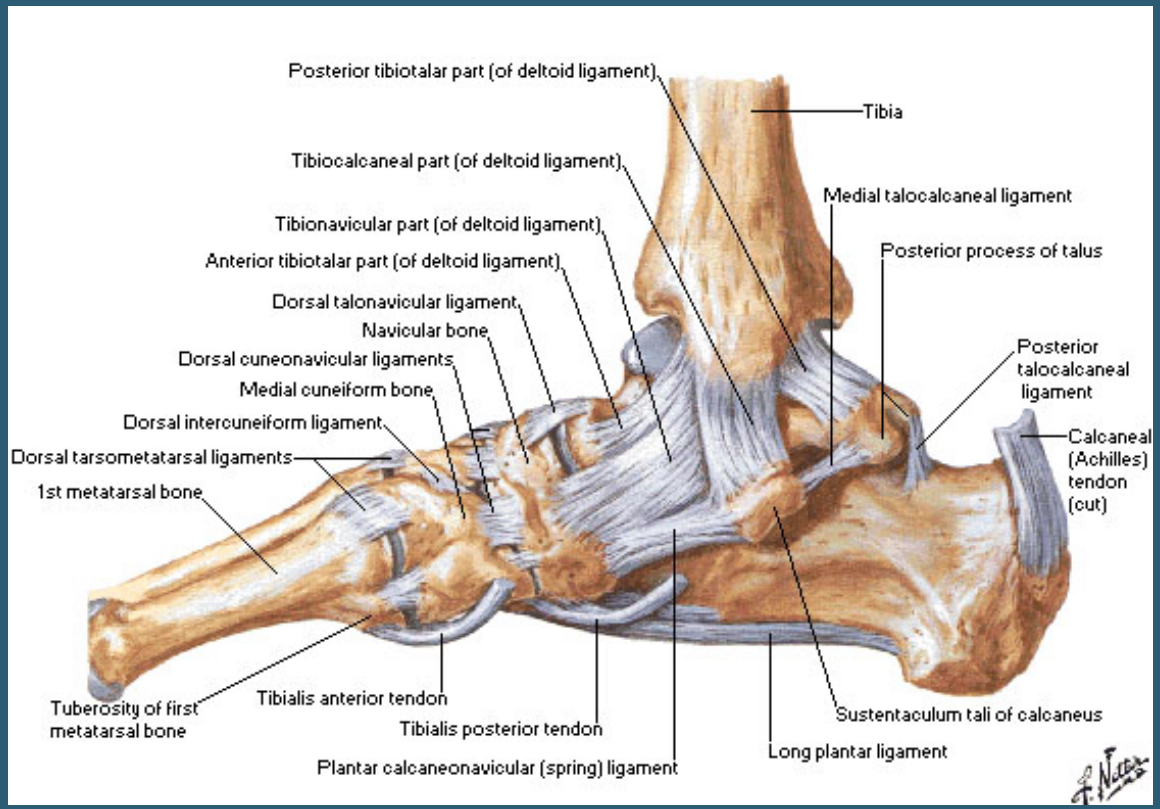
Ligaments: Medial





- Deltoid ligament
  - Tibiotalar (deep)
  - Tibiocalcaneal (superficial)

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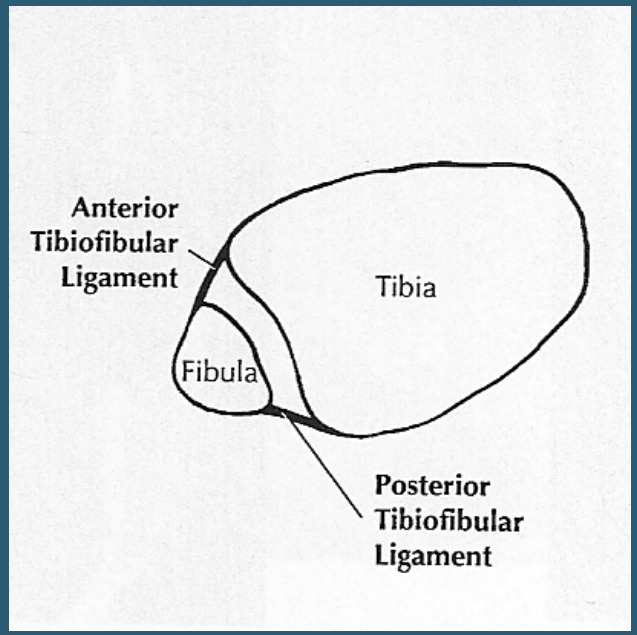
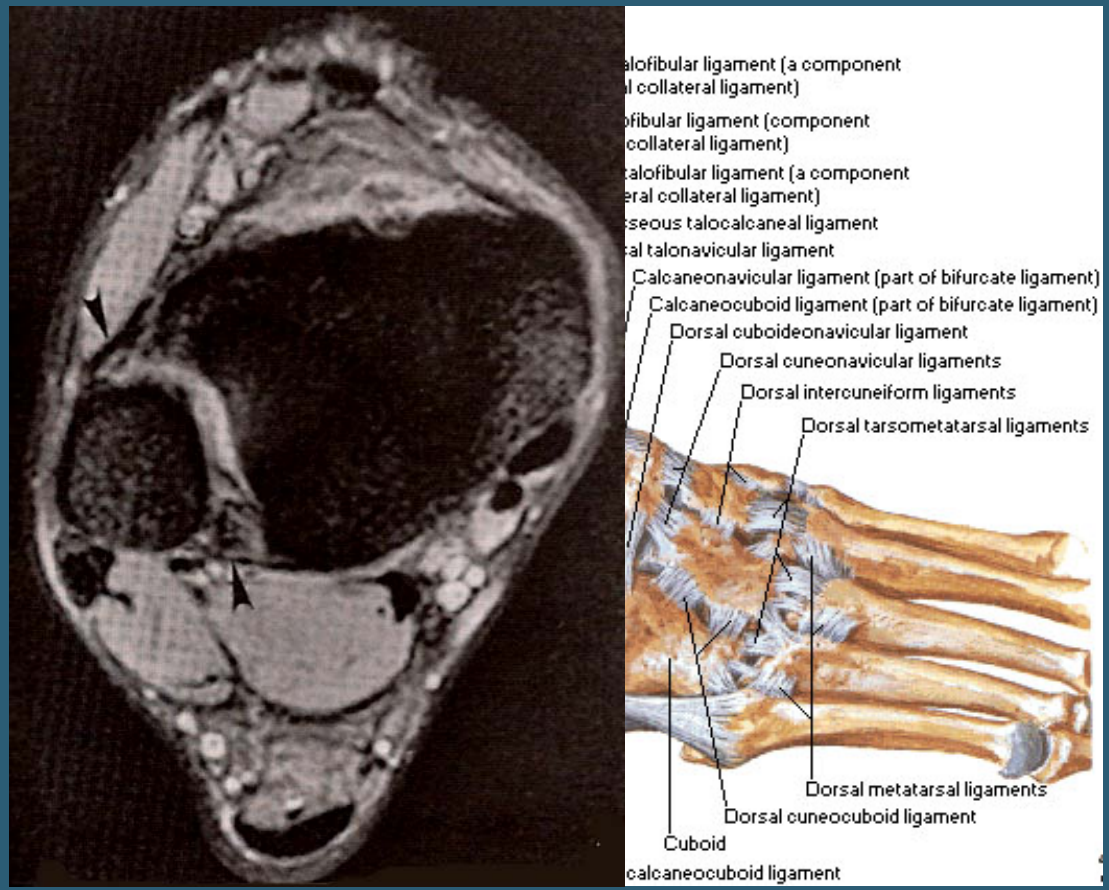
Ligaments: Lateral





- Superior group
  - Anterior & Posterior Tibiofibular ligaments

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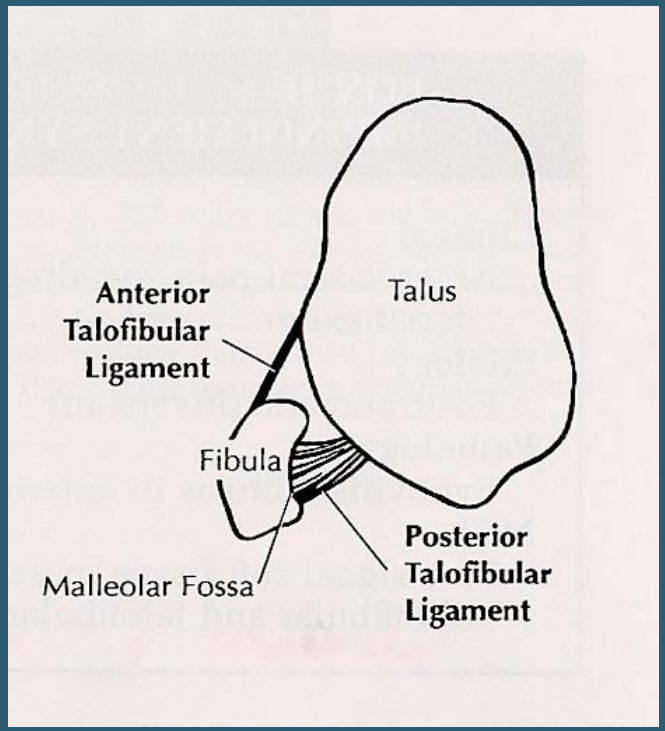
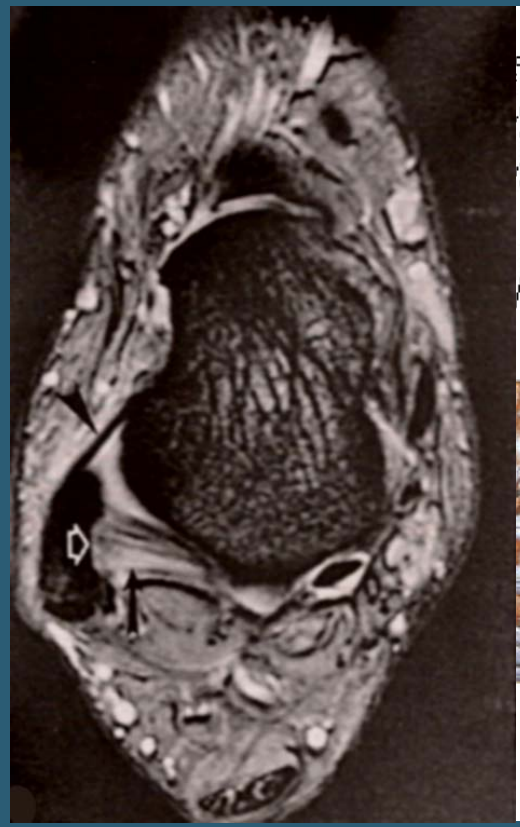
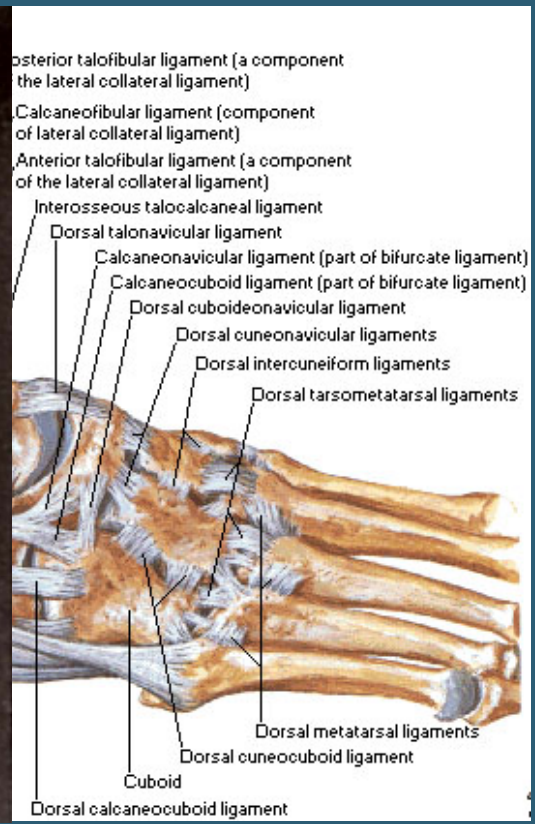
Ligaments: Lateral







- Inferior group
  - Anterior & Posterior Talofibular
  - Calcaneofibular

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Mental Health Break I

Outline of Presentation

- Normal Anatomy
- Imaging Technique
- Selected Pathology

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Imaging Technique

- Planes of the Ankle-Direct
- Planes of the Ankle-Oblique
- Dueling Sequences

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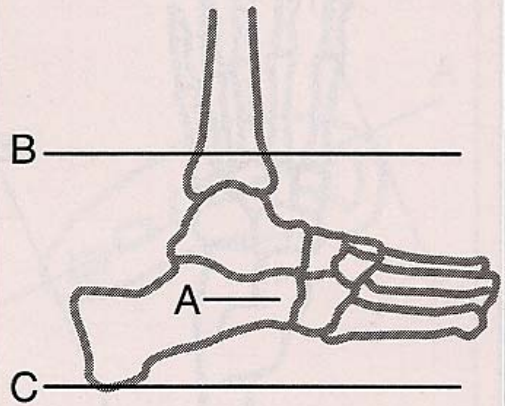
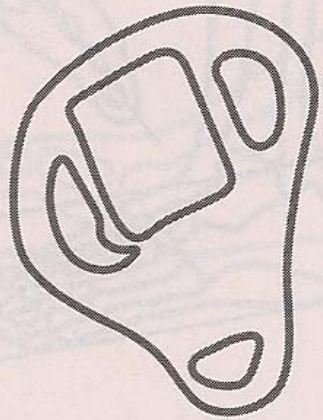
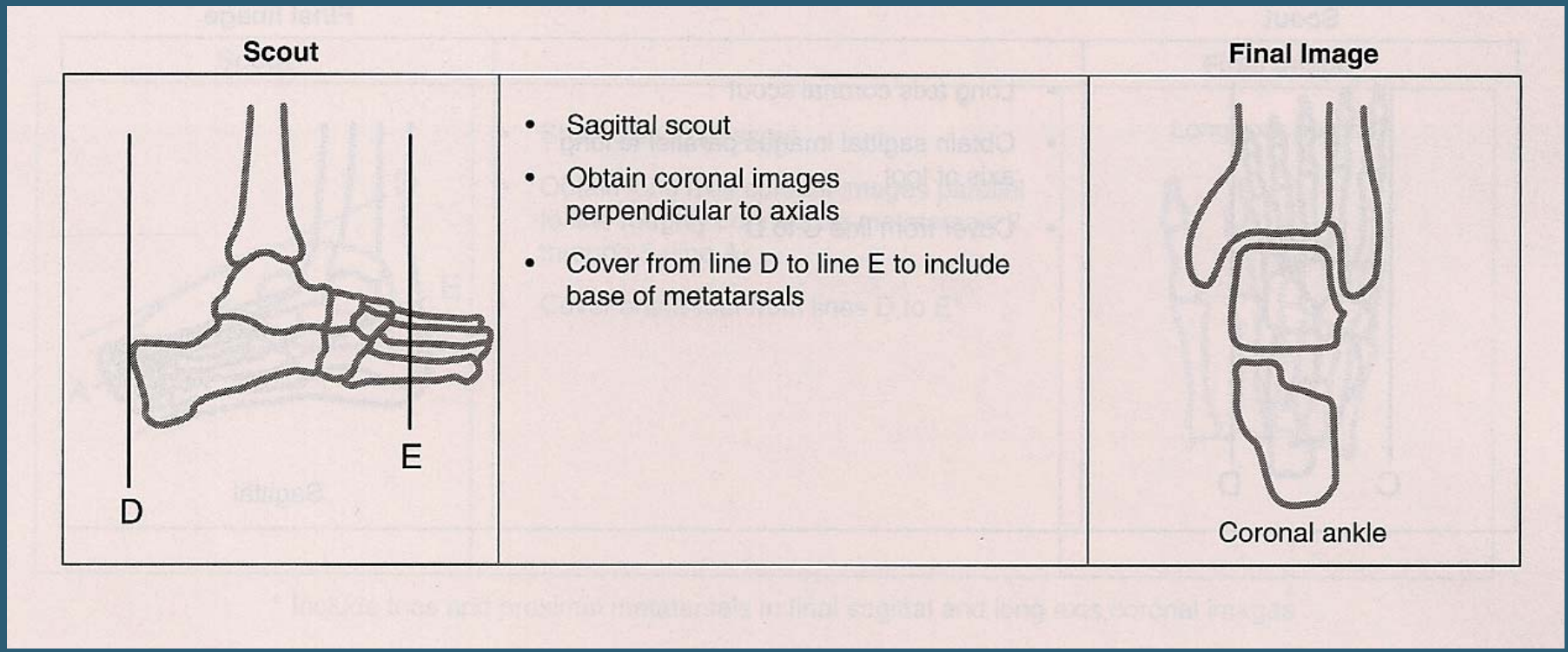
Planes of the Ankle- Direct

- Axial

Scout		Final Image
	• Sagittal scout • Obtain axial images parallel to axis of calcaneus (line A) • Cover from line B to line C (bottom of calcaneus) • Obtain axial plane as first plane (most valuable) • Base of metatarsals should be included on final images	 Axial ankle

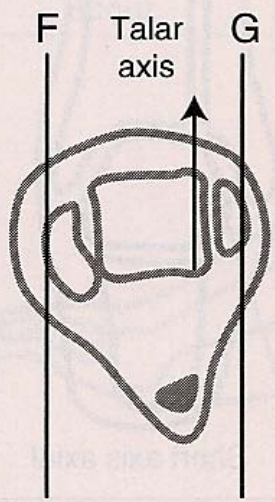
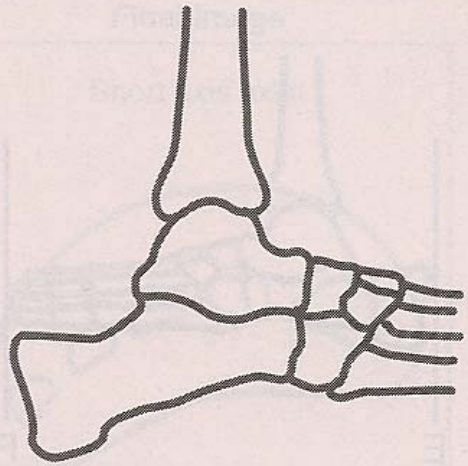
Planes of the Ankle- Direct

- Coronal



Planes of the Ankle- Direct

- Sagittal

Scout		Final Image
	• Axial scout • Obtain sagittal images parallel to talar axis • Cover from line F to line G including malleoli • Obtain sagittals as last plane (least valuable)	 Sagittal

Imaging Technique

- Planes of the Ankle-Direct
- Planes of the Foot-Oblique
- Dueling Sequences

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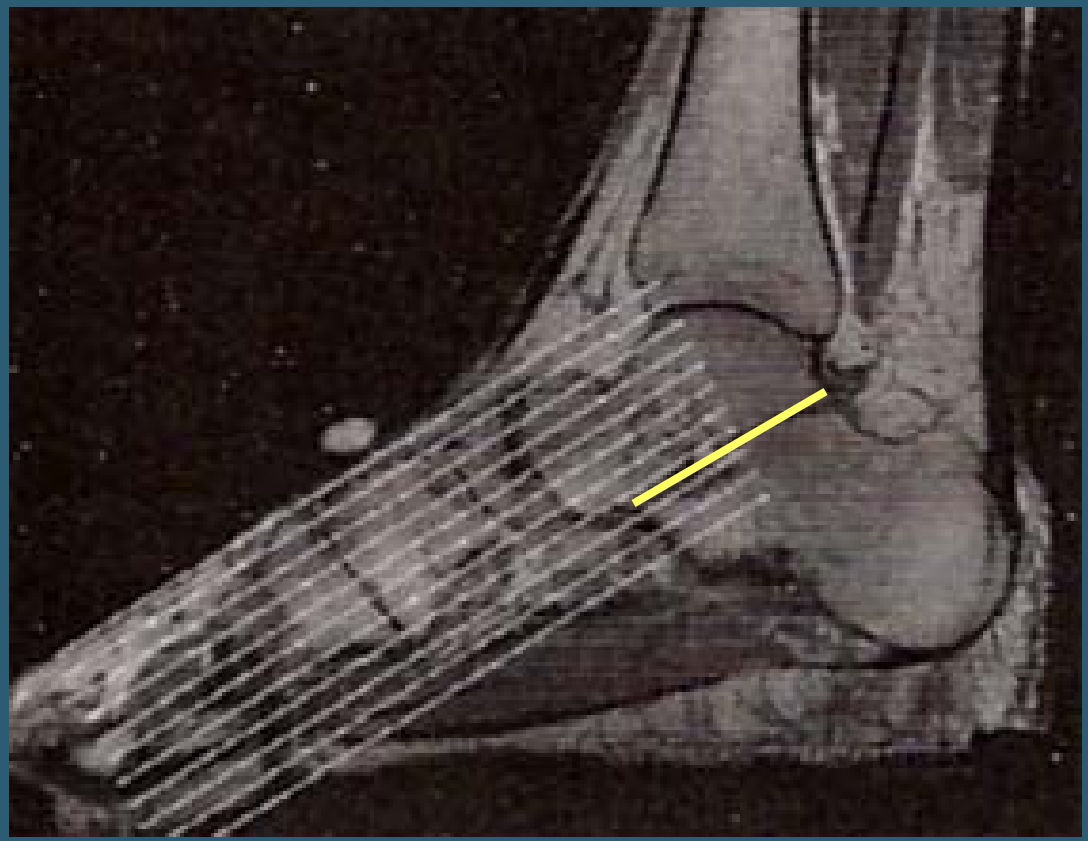
Planes of the Ankle- Oblique



- Oblique axial
  - Parallel to subtalar joint
  - Bones of mid & forefoot

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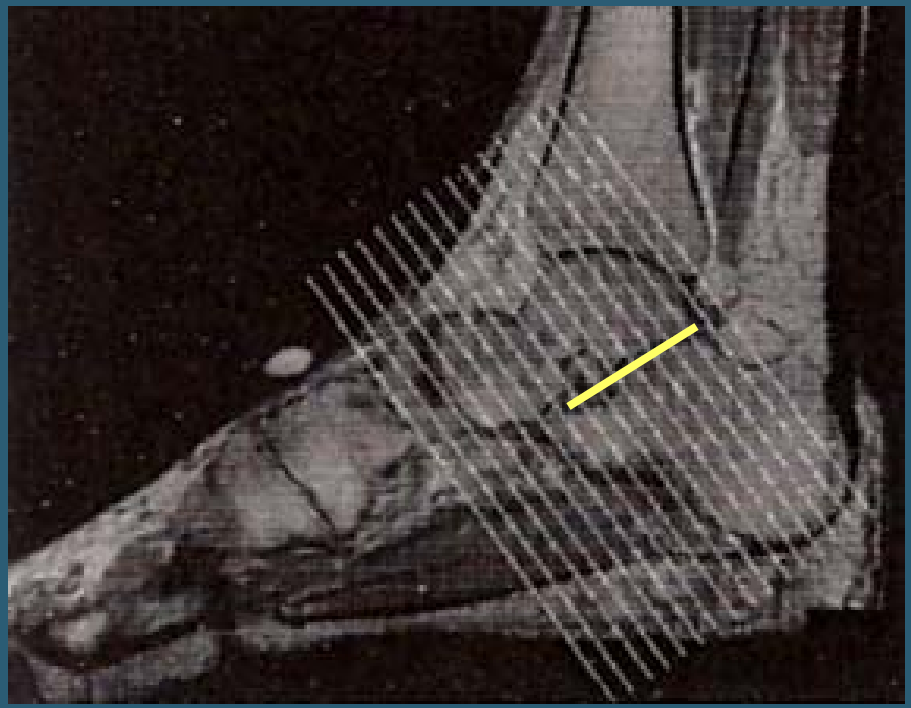
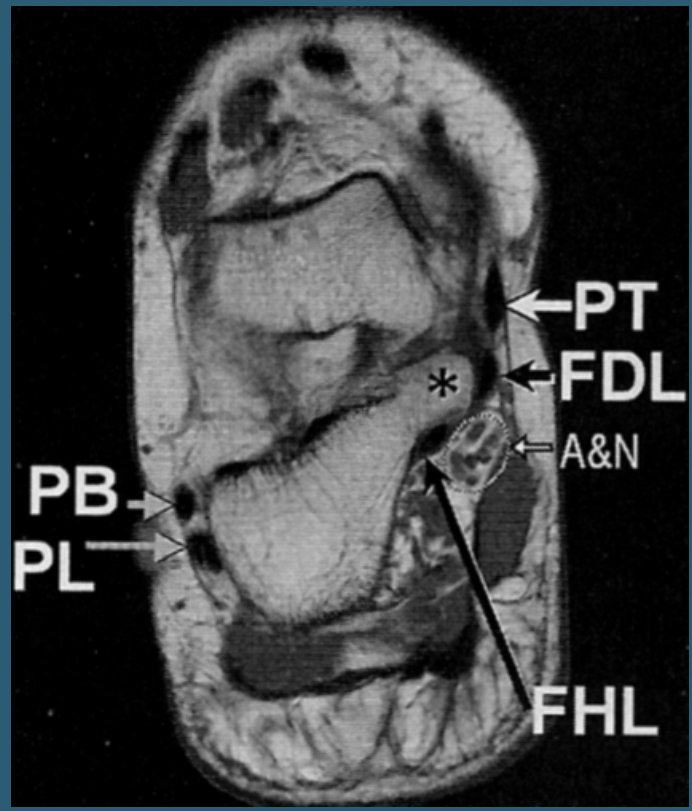
Planes of the Ankle- Oblique





- Oblique coronal
  - Perpendicular to subtalar joint
  - 2nd look at medial and lateral tendons

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Imaging Technique

- Planes of the Ankle-Direct
- Planes of the Foot-Oblique
- Dueling Sequences

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Dueling Sequences: Leanne Seeger, MD

- Sagittal T1
  - Achilles
- Axial PD & T2
  - Tendons: Medial, lateral, anterior, posterior
  - Lateral ligaments
- Coronal T2 fat saturation
  - Lateral ligaments

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Dueling Sequences: Ken Schreibman, MD, PhD

- Sagittal FSE T2 with fat sat or STIR
  - "bone scan": tarsal stress fx; good coverage of mid- and hindfoot
- Axial CSE PD & T2 without fat sat
  - Ankle tendons
  - PD=spatial resolution between tendons and adjacent structures
  - T2=contrast resolution for fluid in tendons and sheaths

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Dueling Sequences: Kaplan et al.

Pain	Infection/Mass
Sagittal T1 & STIR	Sagittal T1 & STIR & T1 Gad ft st
Axial T1 & T2*	Axial T1 & T1 Gad ft st
Coronal T1 & T2*	Coronal STIR

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Mental Health Break II

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Outline of Presentation

- Normal Anatomy
- Imaging Technique
- Selected Pathology

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Selected Pathology

- Tendon and Ligament trauma
- Impingement Syndromes
- Osseous Pathology

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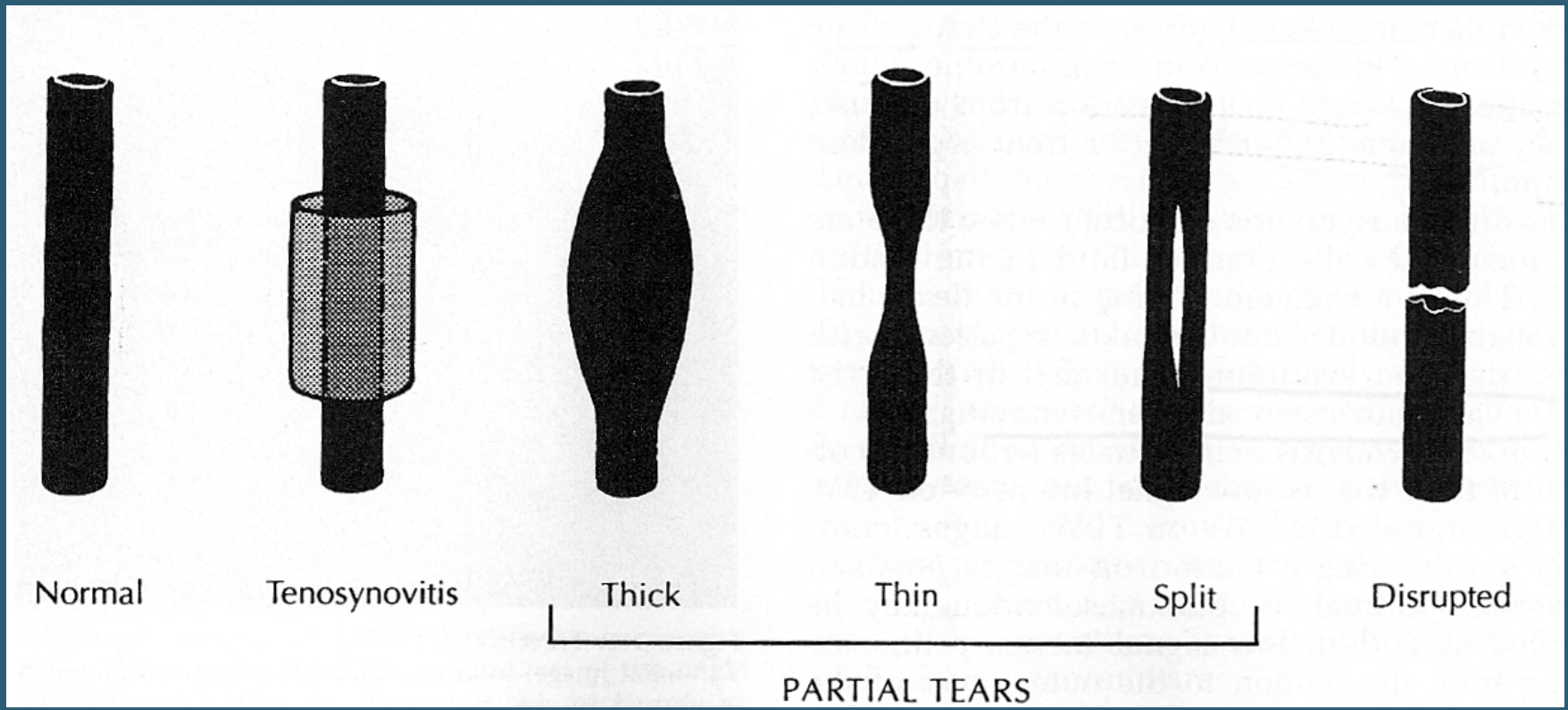
Spectrum of Tendon Pathology



Tendon Trauma: Anterior Tendons

- Tibialis anterior most likely (hill runners)

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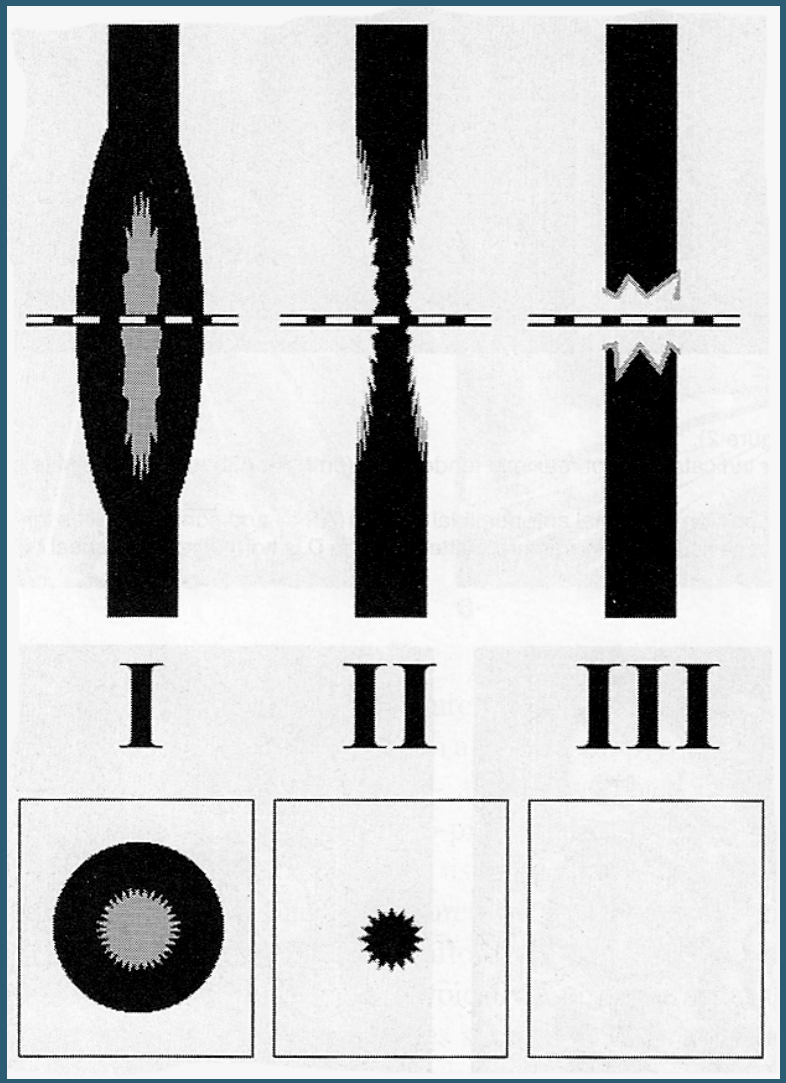
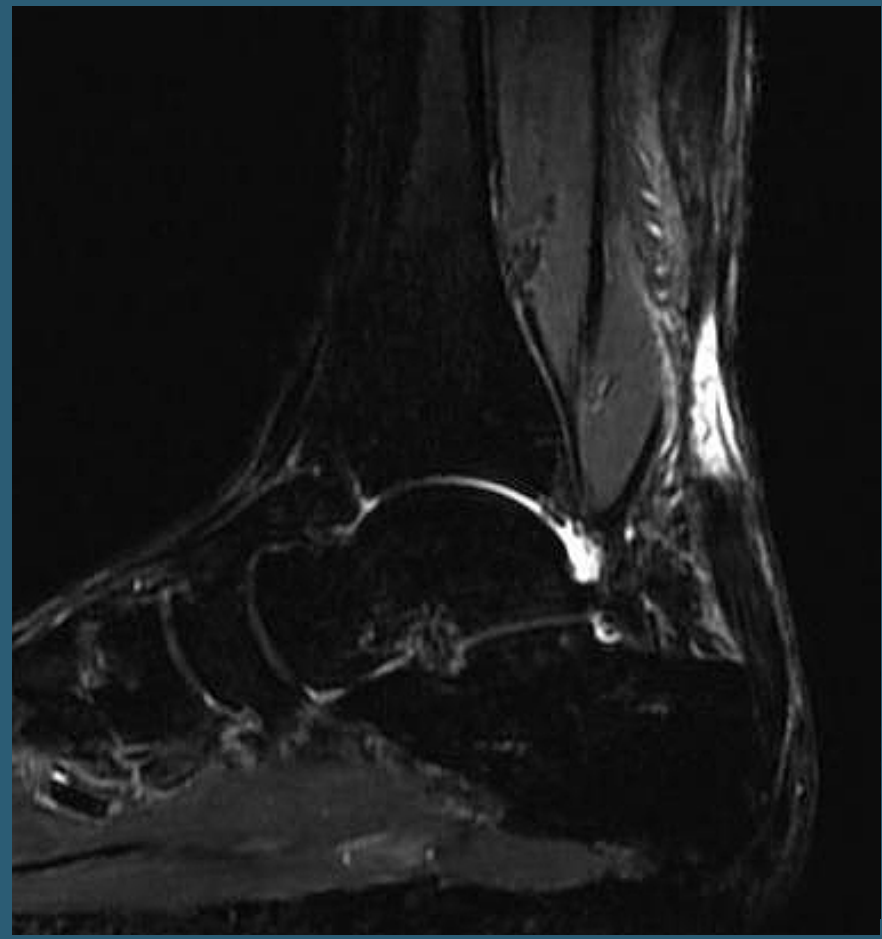
Tendon Trauma: Posterior Tendons





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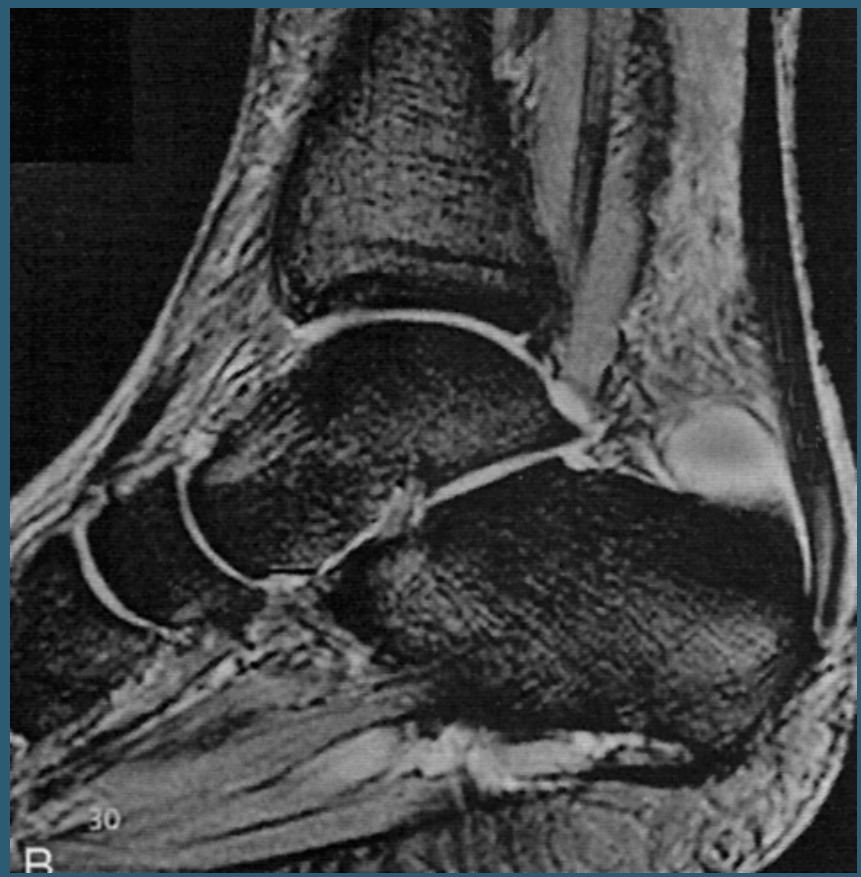
Tendon Trauma: Posterior Tendons

- Haglund's deformity
  - Retrocalcaneal bursitis
  - Retroachilles bursitis
  - Thickening of Achilles



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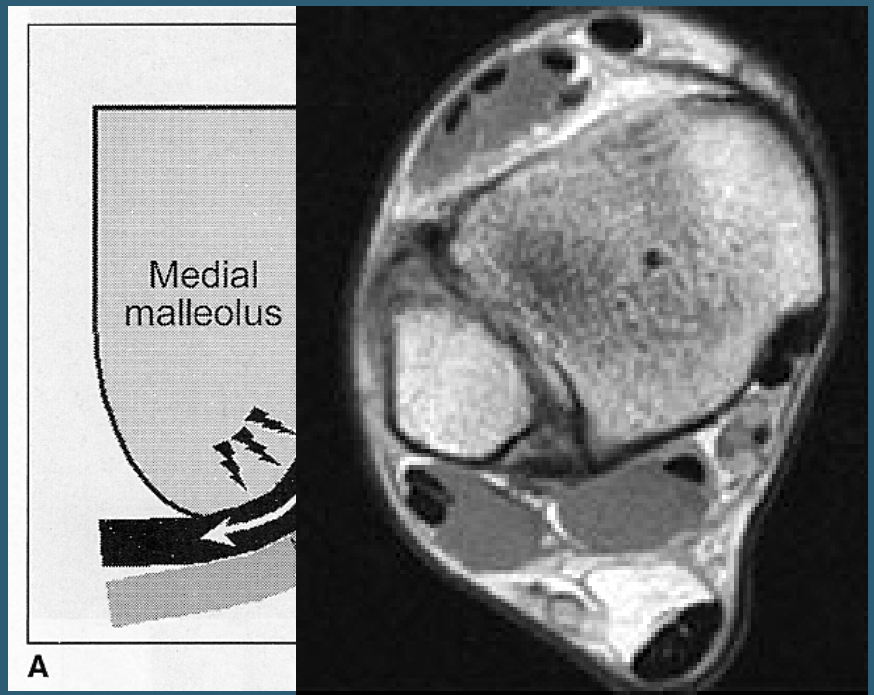
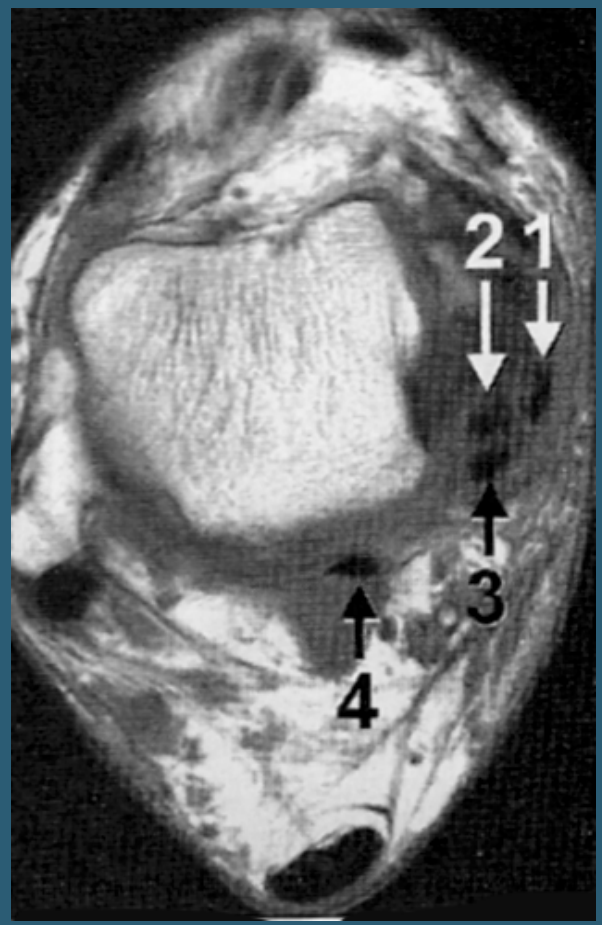
Tendon Trauma: Medial Tendons





- Tibialis posterior
  - Tear at medial malleolar curve
  - Longitudinal friction lead to longitudinal split (“4 tendon”)

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Tendon Trauma: Medial Tendons

- Flexor Hallucis Longus
  - Tenosynovitis>tear
  - 20% FHL synovial tendon sheath communicates with ankle joint

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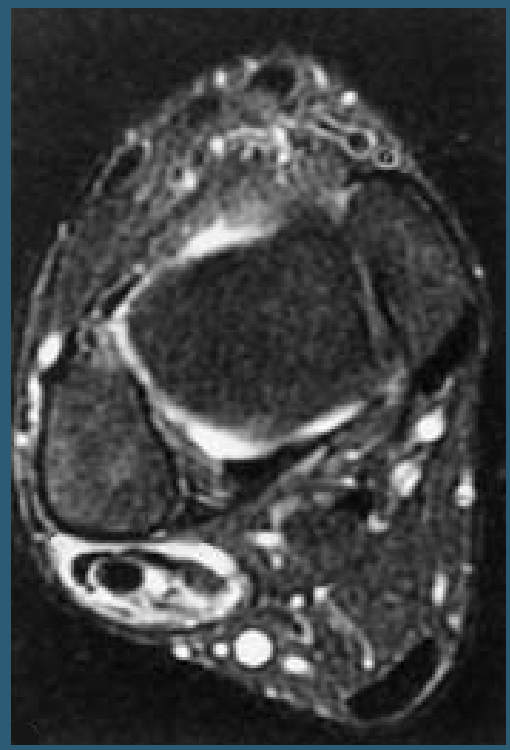
Tendon Trauma: Lateral Tendons


- Peroneus brevis splits
  - Longitudinal tear of PB (recurrent sprain and inversion)
  - “C” is abnormal

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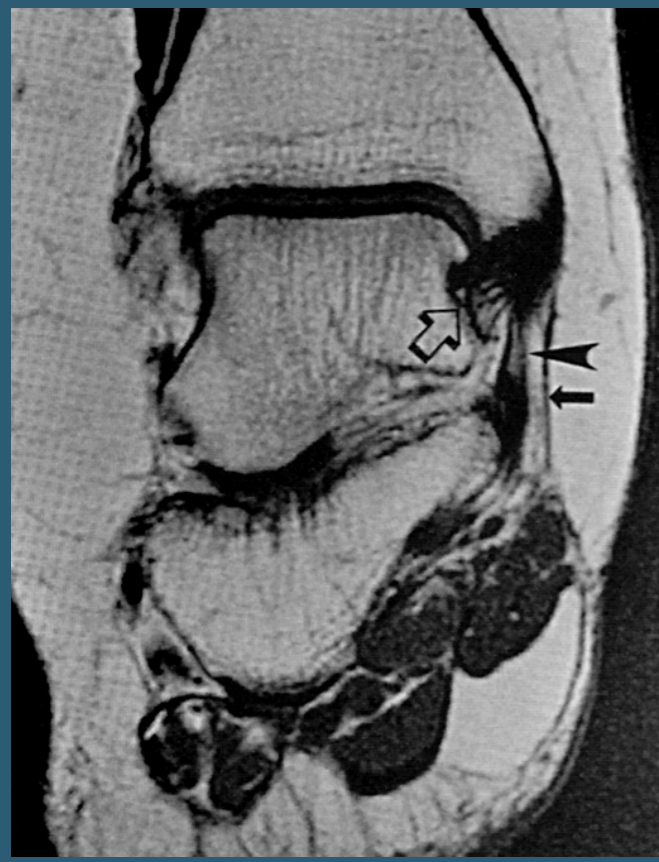
Ligament Trauma: Medial

Tibiotalar ligt tear



Normal comparison

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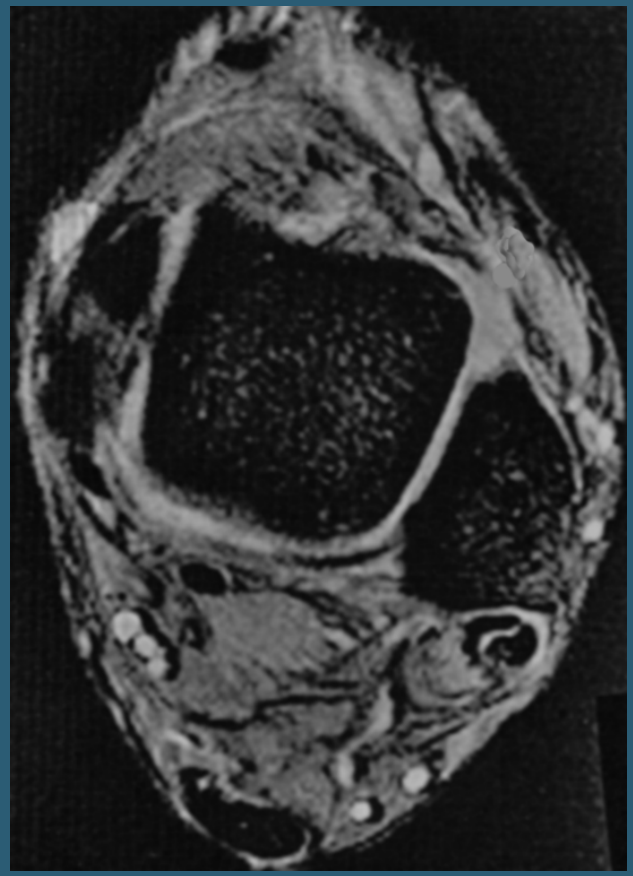
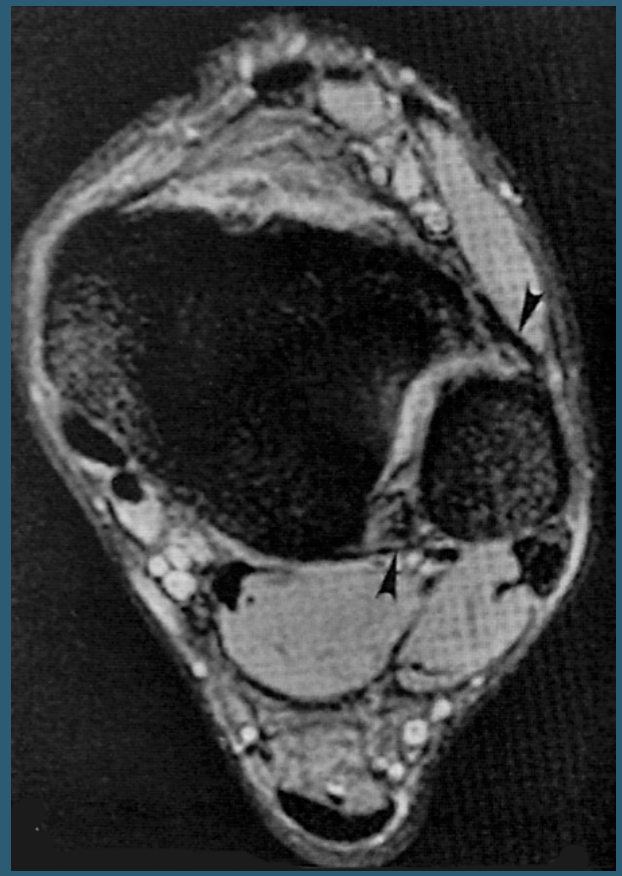
Ligament Trauma: Lateral



Anterior Tibiofibular Ligament Tear



Normal comparison

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Selected Pathology

- Tendon and Ligament trauma
- Impingement Syndromes
- Osseous Pathology

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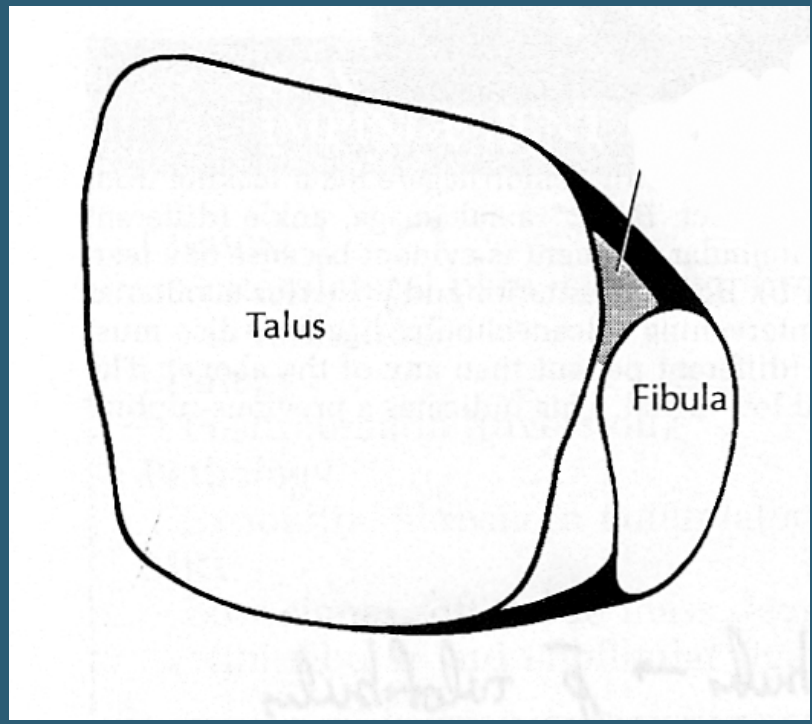
Impingement Syndromes: Anterolateral

- Anterolateral Gutter
  - Anterior: Anterior Tibiofibular & Talofibular ligts
  - Medial: Talus
  - Lateral: Fibula
  - Superior: Plafond, Syndesmosis
  - Inferior: Calcaneofibular ligts



Impingement Syndromes: Anterolateral

- Pathology
  - Hypertrophic synovium, fibrotic scar
- Symptoms
  - Anterolateral pain, swelling, limited dorsiflexion

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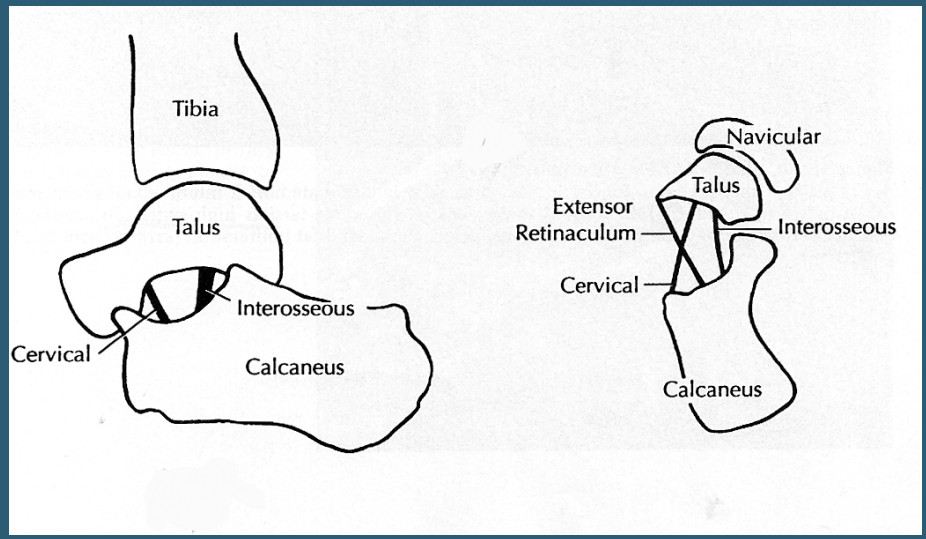
Impingement Syndromes: Sinus Tarsi



- Anatomy
  - Cone (lateral base) between calcaneus and talus
  - Fat, ligts, nerve endings for proprioception of hind foot

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Impingement Syndromes: Sinus Tarsi

- Pathology
  - Inflammatory tissue or fibrosis
  - Trauma with tears of anterior talofibular & calcaneofibular ligts
- Symptoms
  - Lateral foot pain
  - Subjective hindfoot instability

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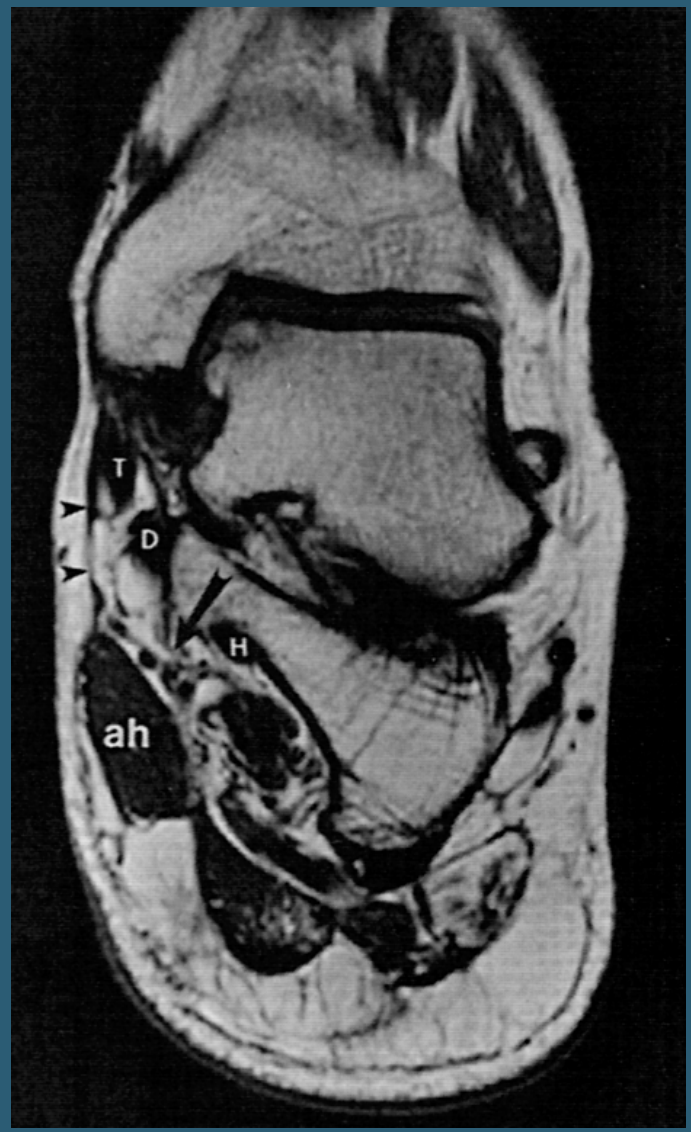
Impingement Syndromes: Tarsal Tunnel

- Anatomy
  - Superior to Inferior: medial malleolus to navicular
  - Lateral: talus & calcaneus
  - Medial: flexor retinaculum, abductor hallucis
  - Contains:
    - TP, FHL, FDL tendons
    - Posterior tibial nerve, artery, vein



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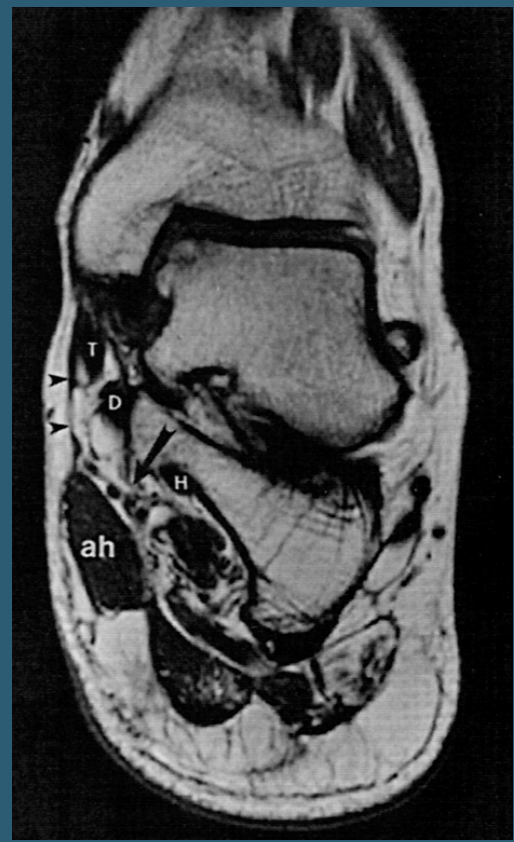
Impingement Syndromes: Tarsal Tunnel

- Pathology
  - Ganglion cysts, nerve sheath tumors
- Symptoms
  - Compression of PT nerve
  - Burning and paresthesias along sole of foot and toes



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Selected Pathology

- Tendon and Ligament trauma
- Impingement Syndromes
- Osseous Pathology

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Osseous Pathology: Tarsal Coalition

- Symptoms
  - Limited motion of subtalar joint
  - Spasm of peroneals and extensors & flat foot

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Osseous Pathology: Os Trigonum

- Compression between posterior tibia and calcaneus during plantar flexion
  - Fracture of synchondrosis
  - Compression of FHL tendon

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Osseous Pathology: Accessory Navicular

- Tibialis posterior tendon tears 2º altered stresses

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Summary of Presentation

- Normal Anatomy
  - Bones and Joints
  - Tendons
  - Ligaments
- Imaging Technique
  - Planes of the Ankle- Direct
  - Planes of the Ankle- Oblique
  - Dueling Sequences
- Selected Pathology
  - Tendon and Ligament Trauma
  - Impingement Syndromes
  - Osseous Pathology

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Thank you!

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