Drifts and Shifts of the Peroneus Longus Roller Coaster

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01.26.2017

https://www.kenhub.com/en/library/anatomy/peroneal-muscles-of-the-lower-leg

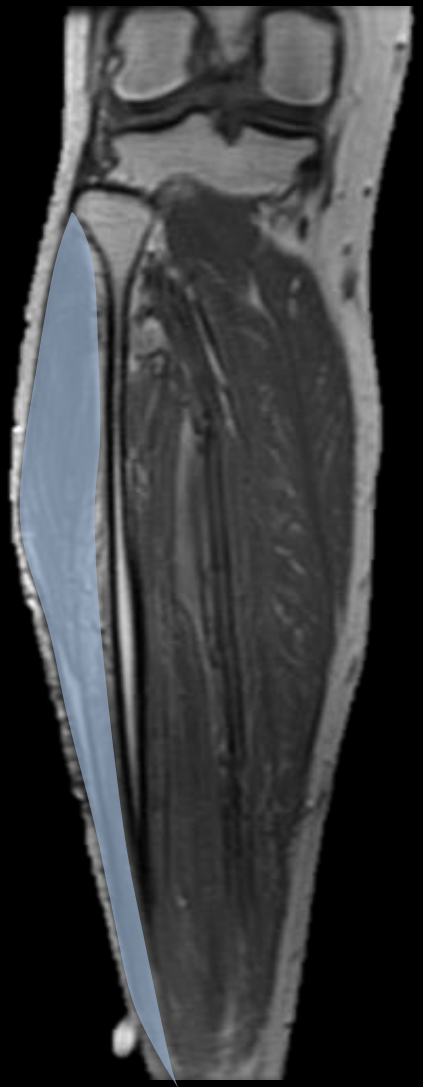
Overview

- Superficial muscle at upper-lateral aspect of leg

- Long tendon
- 1st turns anteriorly behind the lateral malleolus, in a fibro-osseous canal underneath the superior peroneal retinaculum.
- 2nd turn extends forward across the lateral side of the calcaneus, below the peroneal tubercle, beneath the inferior peroneal retinaculum.
- 3rd turn anteriorly below the cuboid, may have os peroneum.
- Crosses sole of foot obliquely and inserts predominantly at base of MT1 and C1.

- Evert (strong) and Plantarflex (weak) ankle. Plantarflex first ray.

Muscular and Tendinous Origins

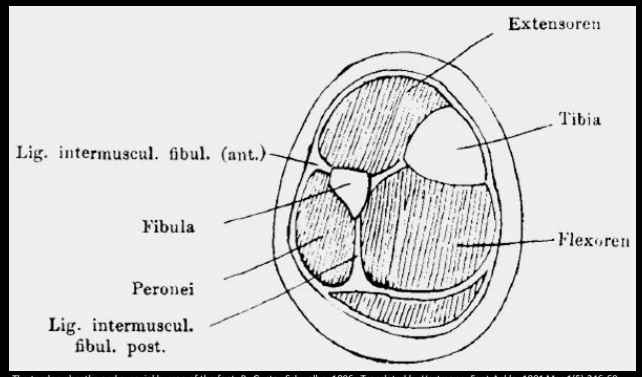


Tendinous

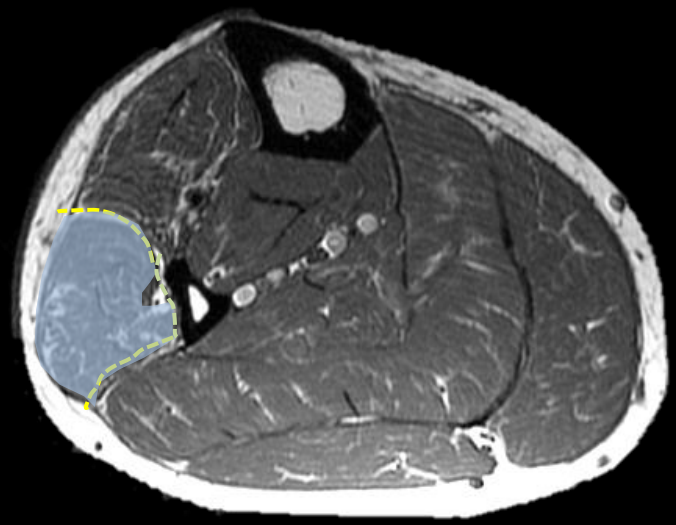
- Anterior tibiofibular ligament
- Lateral Tibial Condyle
- Fibular head

Muscular

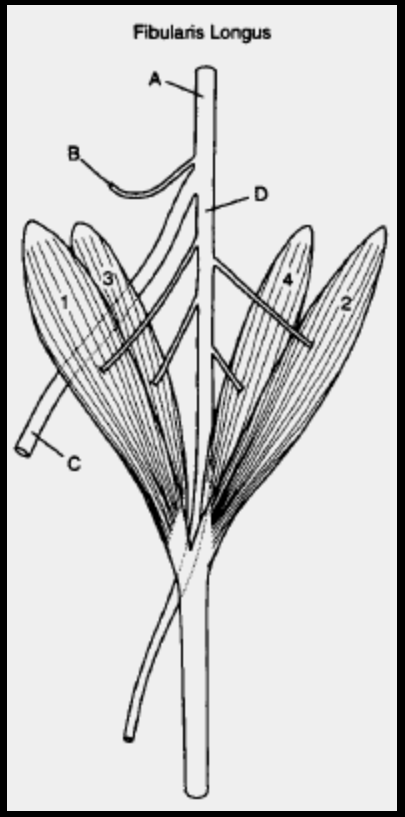
- Anterior and Posterior Intermuscular Septa (extensions of the crural fascia)
- Lateral Surface of Proximal 2/3 of Fibula



The tendon sheaths and synovial bursae of the foot. By Gustav Schwalbe, 1896. Translated by Hartmann. Foot Ankle. 1981 Mar;1(5):246-69.

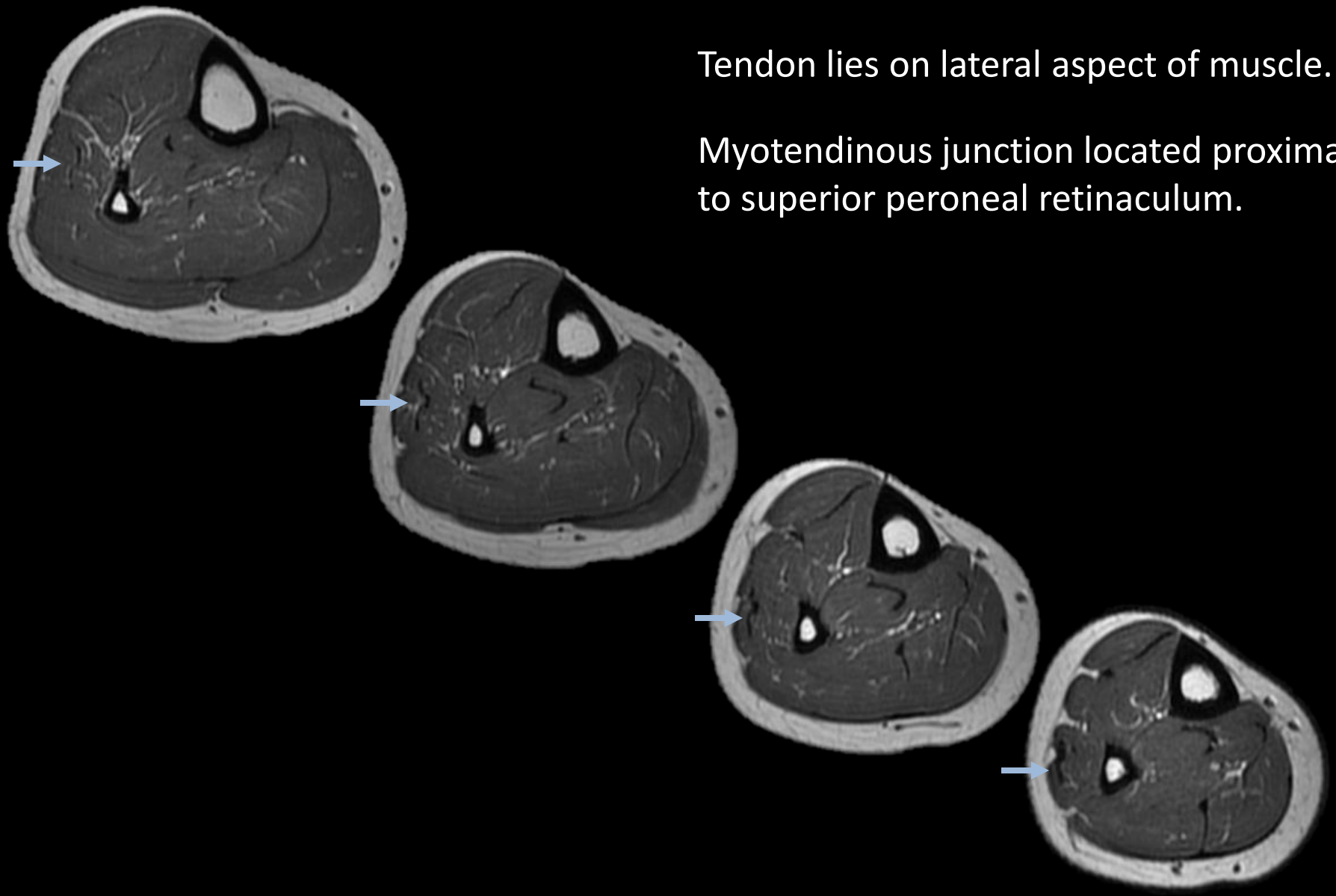


Peroneus Longus Muscle



Bakkum BW, Russell K, Adamcryck T, Keyes M. Gross anatomic evidence of partitioning in the human fibularis longus and brevis muscles. Clin Anat. 1996;9(6):381-5.

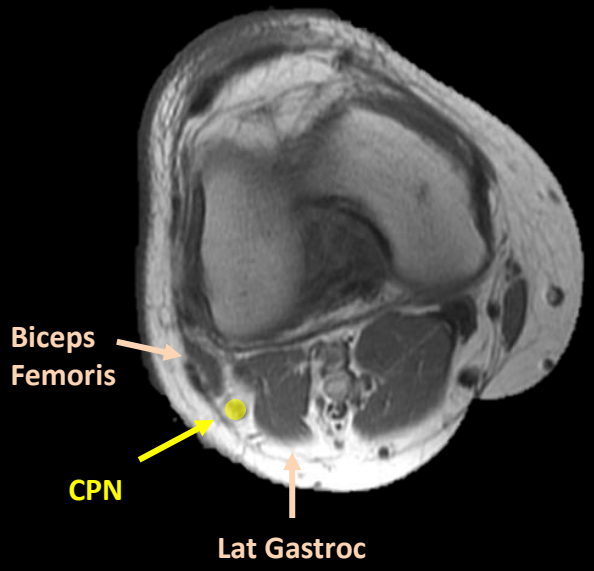
- Bipennate muscle
- Connective tissue partitioning separates PL muscle into 4 segments, each with its own motor branch from superficial peroneal nerve.
  - Anterior Superficial
  - Anterior Deep
  - Posterior Deep
  - Posterior Superficial
- Pattern of partitioning is constant. But relative sizes of compartments vary.



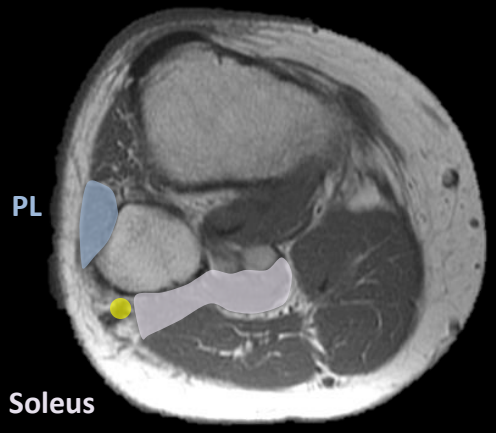
Tendon lies on lateral aspect of muscle.

Myotendinous junction located proximal to superior peroneal retinaculum.

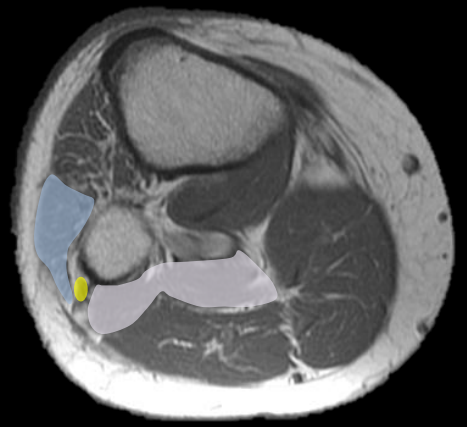
Arising from sciatic nerve, CPN courses btw lateral gastrocnemius and biceps femoris.

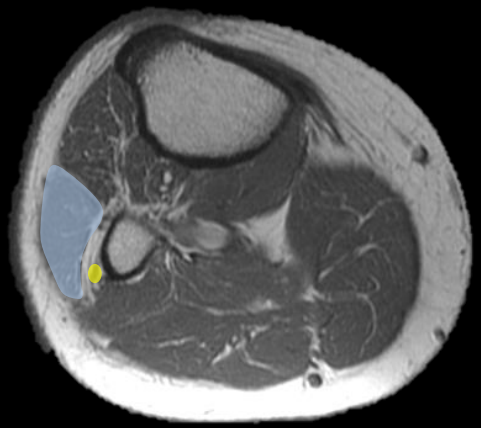


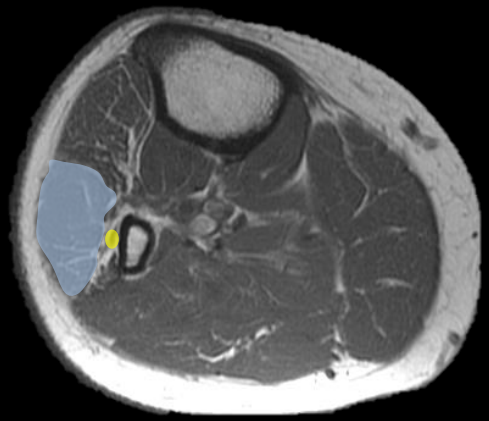
CPN winds around the fibular neck, in a subcutaneous position.



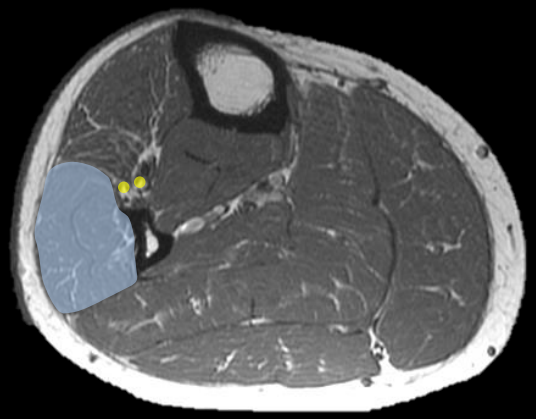
Peroneal Tunnel





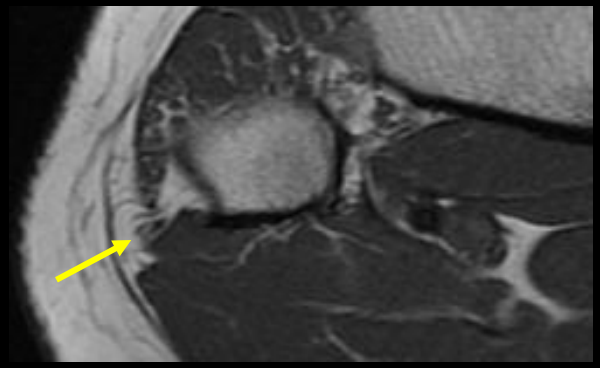


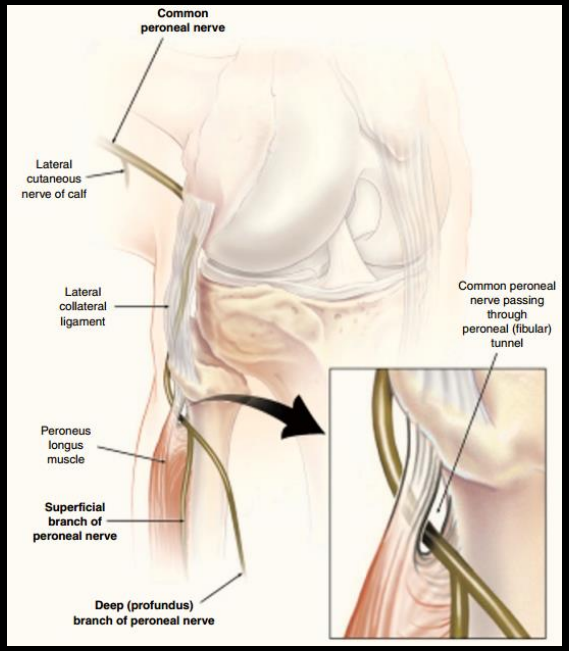
CPN divides into superfical and deep peroneal nerves

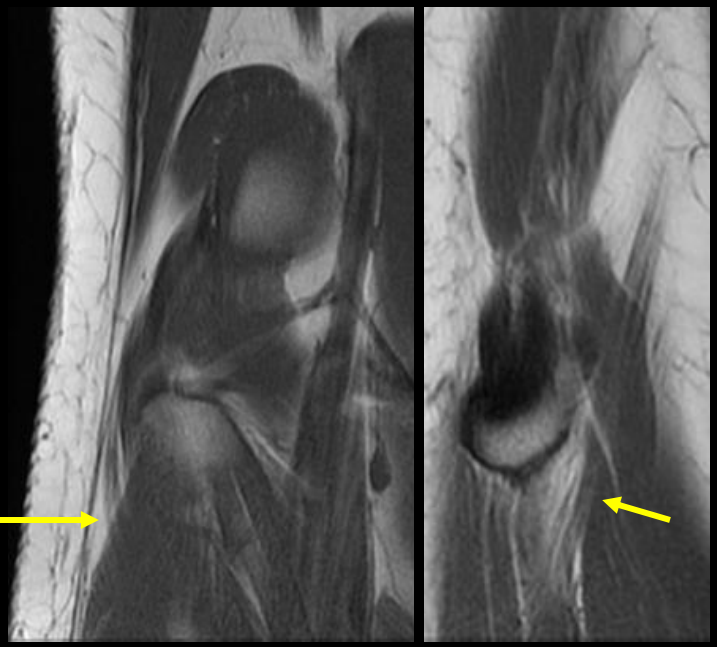


Peroneal Tunnel

- A musculo-aponeurotic arch formed by peroneus longus and soleus
- CPN courses btw tendinous heads of peroneus longus.
- Fibular neck = floor
- CPN is relatively fixed at this location.







McCrory P, Bell S, Bradshaw C. Nerve entrapments of the lower leg, ankle and foot in sport. Sports Med. 2002;32(6):371-91.

Common Peroneal Nerve Palsy

Background

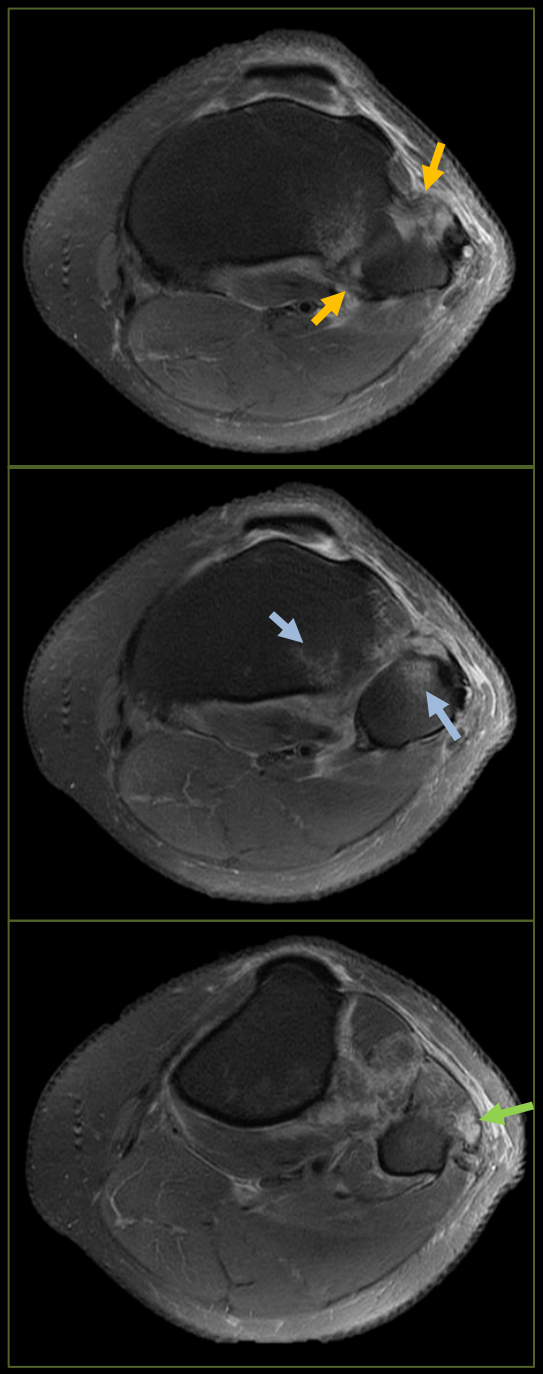
- Most common mono-neuropathy in lower extremity
- Occurs most commonly in knee
- Etiology: Traction, contusion, penetrating trauma, iatrogenic, etc.

Clinical Features

- Pain over fibular neck
- Pain radiating to anterolateral leg
- Weakness of dorsiflexion and eversion
- Footdrop
- Worse with ankle inversion, stretching peroneal nerve

Van den Bergh FR, Vanhoenacker FM, De Smet E, Huysse W, Verstraete KL. Peroneal nerve: Normal anatomy and pathologic findings on routine MRI of the knee. Insights Imaging. 2013 Jun;4(3):287-99.

- Ossification at PL origin
- Occurs at lateral side of fibula
  - vs. soleus tug lesion occurs on medial side of fibula
- Narrows peroneal tunnel



Sprains of anterosuperior & posterosuperior tibiofibular lig

Bone marrow contusions pattern concerning for recent transient dislocation of proximal tib-fib joint

Muscle strains of anterior and lateral compartments

44yo F, deceleration/twisting injury of knee during softball game, now with pain and weakness.

Lateral supporting structures were intact except for very-low-grade sprain of fibular collat lig.

Tears of the Peroneus Longus Muscle

- Uncommon
- Much less frequent than distal tendon tears
- Handful of reported cases tell a similar story of acute inversion injuries in young adult males, often athletes
- Able to ambulate following injury, but present hours later with lateral compartment syndrome

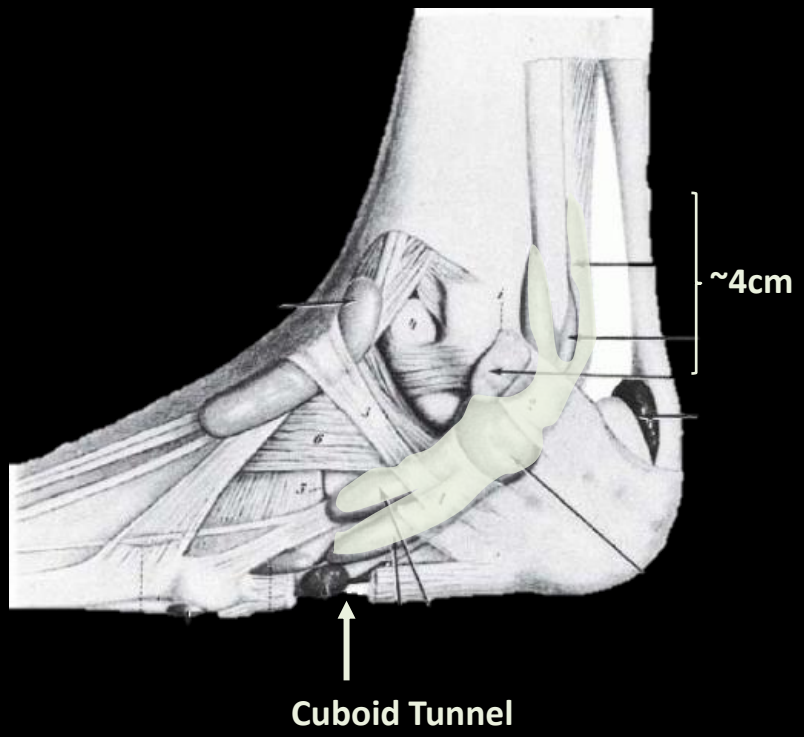
	Age/Gender	Injury	Location	Complete/ Incomplete Tear	Compartment Syndrome
Davies (1979)	26yo M	Soccer	**Myotendinous Junction**	C	Yes
Arciero et al (1984)	24yo M	Soldier, Football	**Myotendinous Junction**	C	Yes
Gwynne and Theis (1997)	21yo M	Rugby	**Mid-portion of muscle**	?C	Yes
Slabaugh et al (2008)	33yo M	Walking	**Myotendinous Junction**	?	Yes
Lee et al (2009)	37yo M	Soccer	**Origin**	C	Yes
Merriman et al (2015)	23yo M	Football	**Proximal muscle**	I (Large)	Yes

Pulau Wotap, Indonesia

https://twitter.com/i_we_gaia/status/498905866771632128
http://www.justdogbreeds.com/scottish-terrier.html

Synovial Sheath

- Peroneus longus and brevis share a H-shaped common synovial sheath at the level of the lateral malleolus, dividing at both its proximal and distal portions.
  - Location of upper bifurcation varies
  - Distal bifurcation occurs at peroneal tubercle
- There may be a separate PL sheath at level of cuboid tunnel, overlapping with the main sheath.
- Separate PL sheath in plantar foot after tendon passes cuboid, terminating just before insertion.

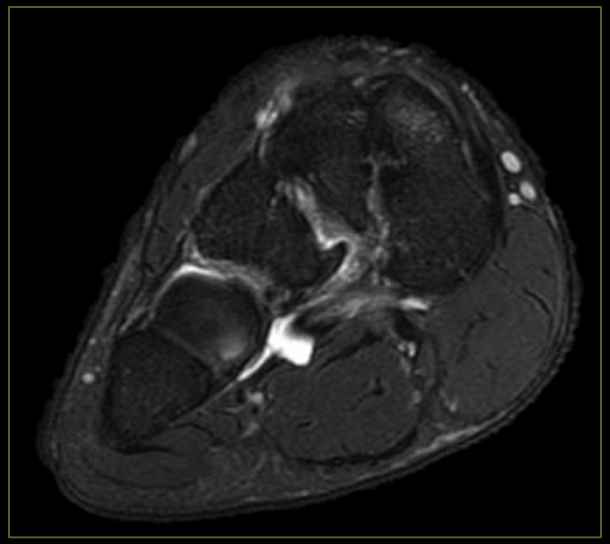


The tendon sheaths and synovial bursae of the foot. By Gustav Schwalbe, 1896. Translated by Hartmann. Foot Ankle. 1981 Mar;1(5):246-69.

http://musculoskeletalkey.com/tendon-sheaths-and-bursae/#R3-6

Tenosynovial Fluid

- Small amounts of tenosynovial fluid frequently occur in asymptomatic ankles
- Amount of fluid is proportional to size of ankle and posterior subtalar joint effusion.



Tenosynovitis

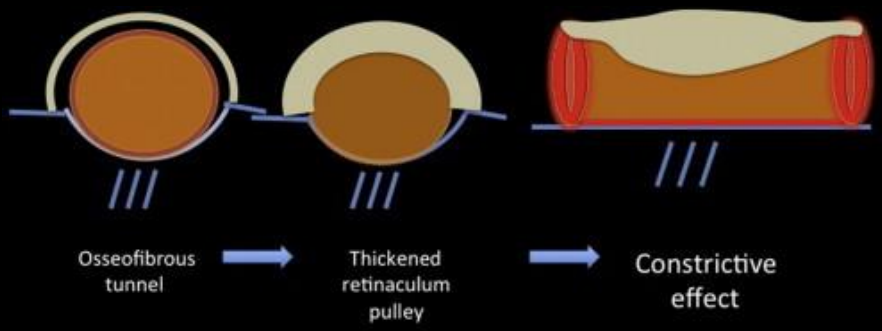
- Inflammation of synovial sheath (thickening and enhancement)
- Etiologies: Inflammatory (RA), infectious, mechanical, hormonal

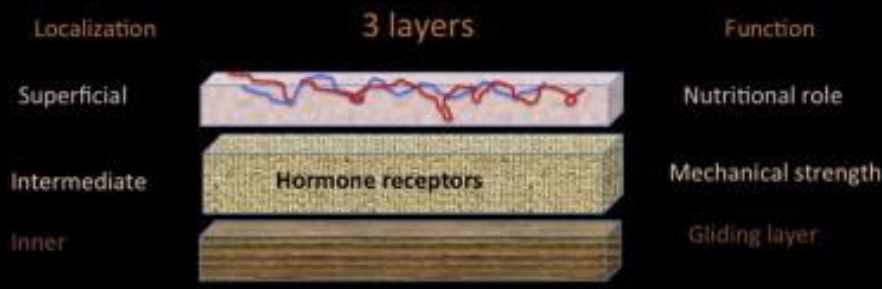
Stenosing Tenosynovitis

- Mechanical constriction of tendon by thickened retinacula or pulley of fibro-osseous channels , limiting free tendon excursion and causing tendon/sheath damage

- Etiologies
  - Overuse
    - Repetitive movements
    - Sports-related
    - Occupational
  - Trauma
  - Estrogen stimulation/deficit
  - Congenital

- Named ST's
  - De Quervain Tenosynovitis
  - Trigger finger

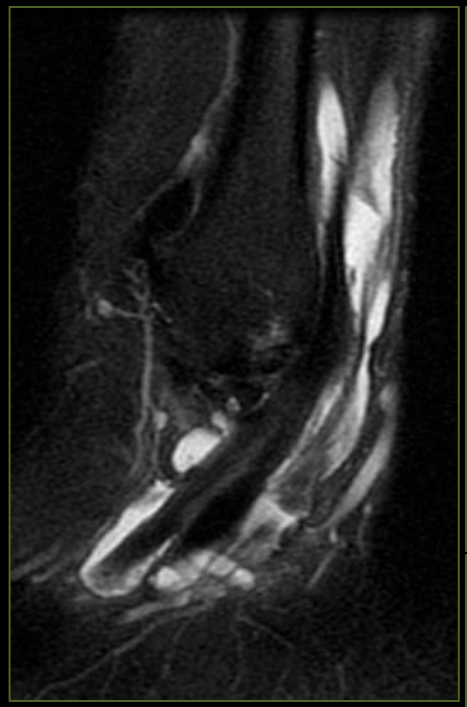


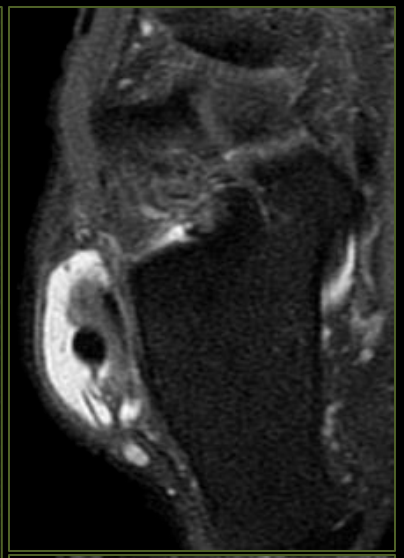


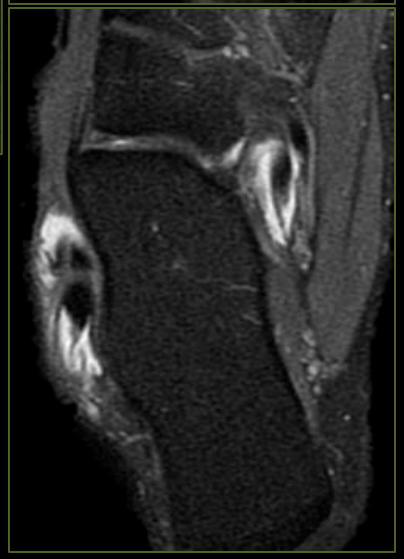
Vuillemin V, Guerini H, Bard H, Morvan G. Stenosing tenosynovitis. J Ultrasound. 2012 Feb;15(1):20-8.

Stenosing Tenosynovitis of PL

- 3 Fibro-Osseous Channels
  - Retromalleolar sulcus
  - Peroneal tubercle
  - Cuboid tunnel
- Predisposing factors
  - Enlarged peroneal tubercle
  - Peroneus quartus
  - Os peroneum
- Symptoms
  - Lateral ankle pain and swelling
  - Worse with motion
  - No instability



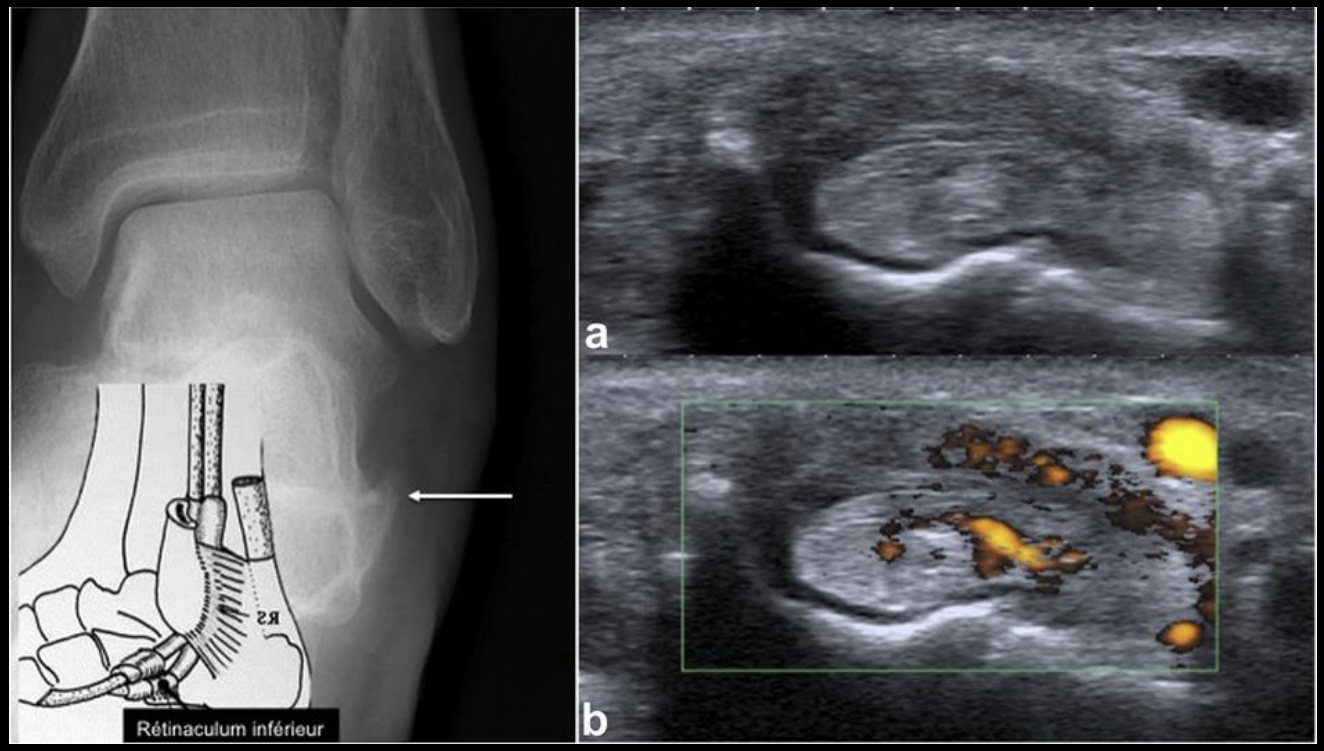




Tenosynovitis with linear areas of hypointensity and synovial constriction

Partially healed tear of the peroneus brevis

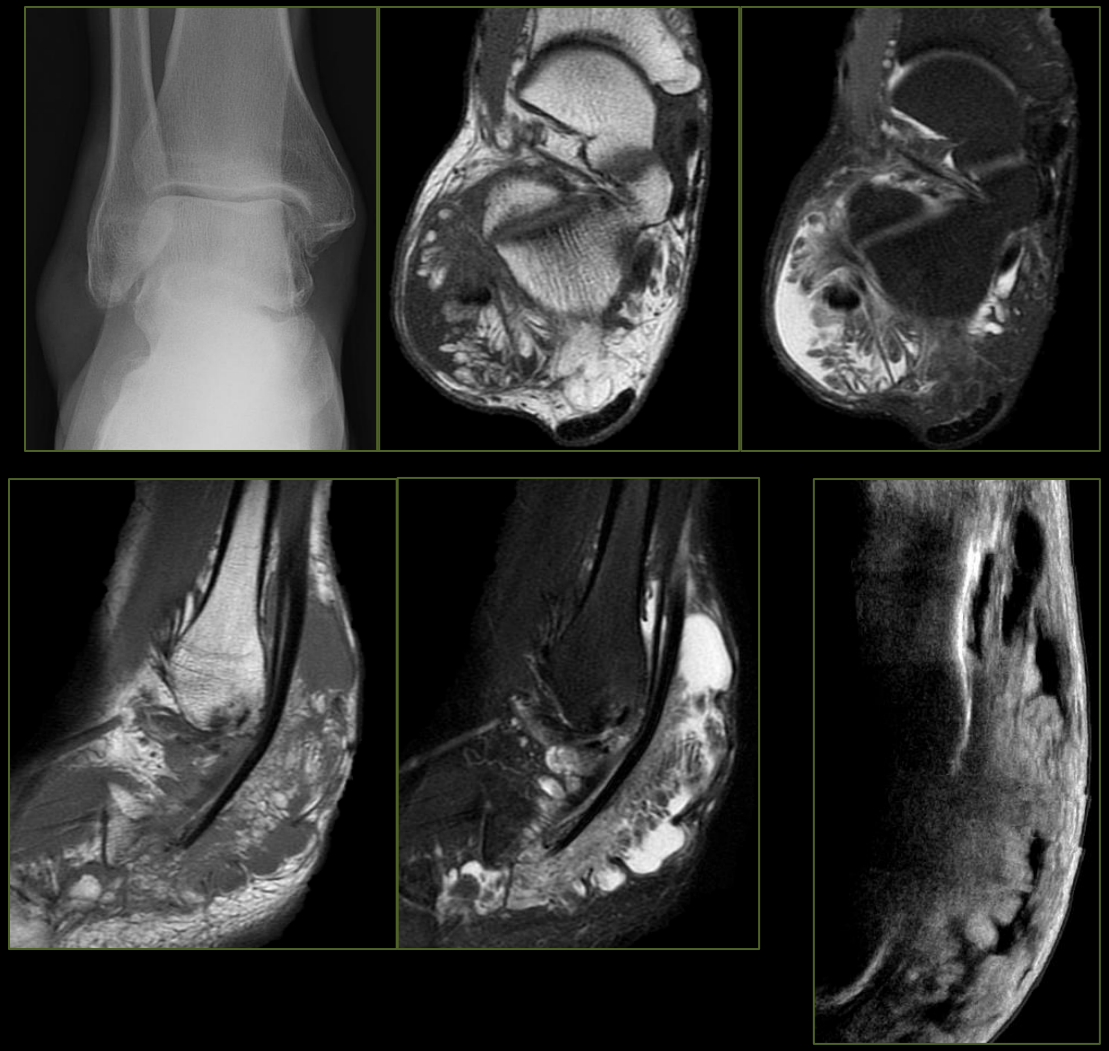
Stenosing Tenosynovitis of PL 2/2 Compression btw Enlarged Peroneal Tubercle and Inferior Peroneal Retinaculum



Vuillemin V, Guerini H, Bard H, Morvan G. Stenosing tenosynovitis. J Ultrasound. 2012 Feb;15(1):20-8.

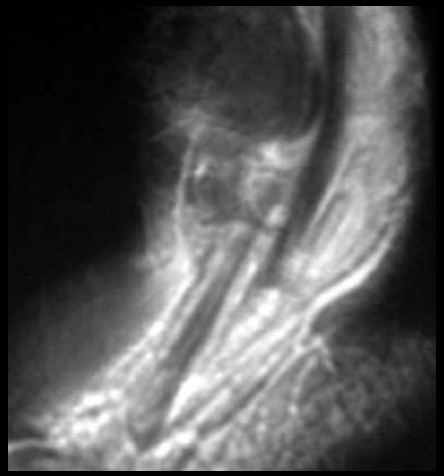
(a) Retinacular thickening
(b) Retinacular hypervascularization

Synovial Lipomatosis Arborescens



- Fatty infiltration and hyperplasia of sub-synovial tissue
- Etiology
  - Idiopathic
  - Occasionally associated with OA, chronic RA, trauma
- Insidious onset of joint swelling and mechanical symptoms

Tophaceous Synovitis



Chronic tophaceous synovitis and urate crystal deposing in tendon reduce tensile strength, and may lead to eventual tendon rupture.

Lagoutaris ED, Adams HB, DiDomenico LA, Rothenberg RJ. Longitudinal tears of both peroneal tendons associated with tophaceous gouty infiltration. A case report. J Foot Ankle Surg. 2005 May-Jun;44(3):222-4.

http://www.express.co.uk/news/nature/441975/Barking-the-tree-that-looks-like-a-dog

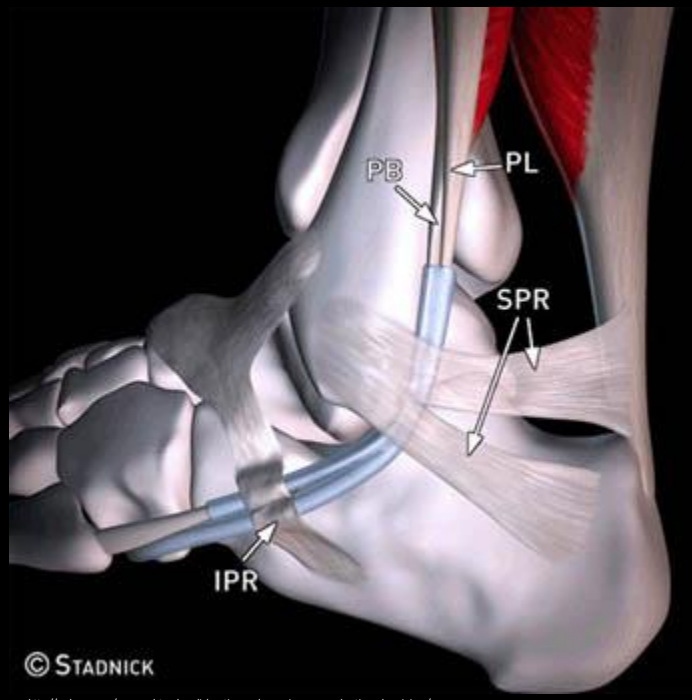
Superior Peroneal Retinaculum

- Anchors peroneal tendons behind retromalleolar groove
- Primary restraint against lateral peroneal tendon subluxation

- Width 10 – 20 mm
- Thickness 1 mm

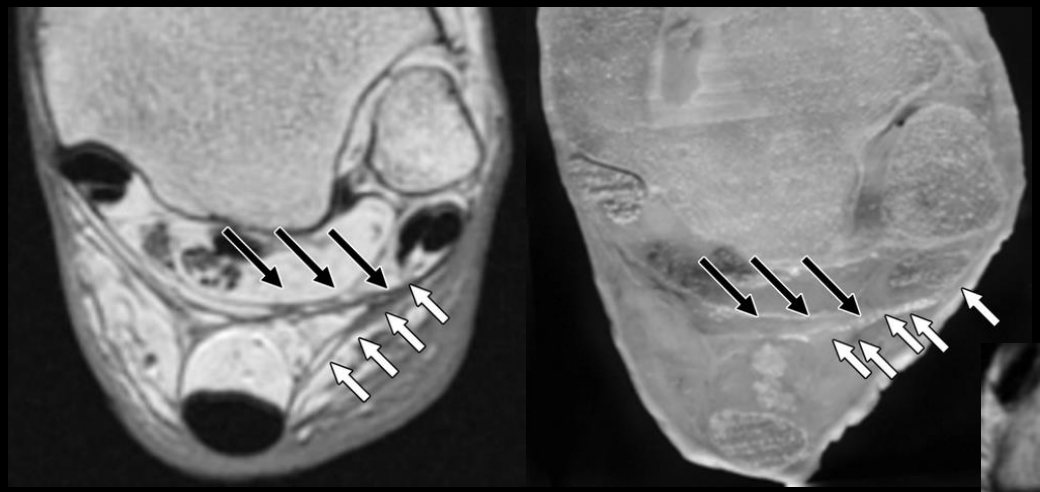
- Origin:
  - Periosteum along lateral border of retromalleolar groove and distal fibula

- Insertion:
  - Achilles tendon aponeurosis
  - Inferior oblique band (40%): lateral calcaneus behind CF ligament or deep aponeurosis

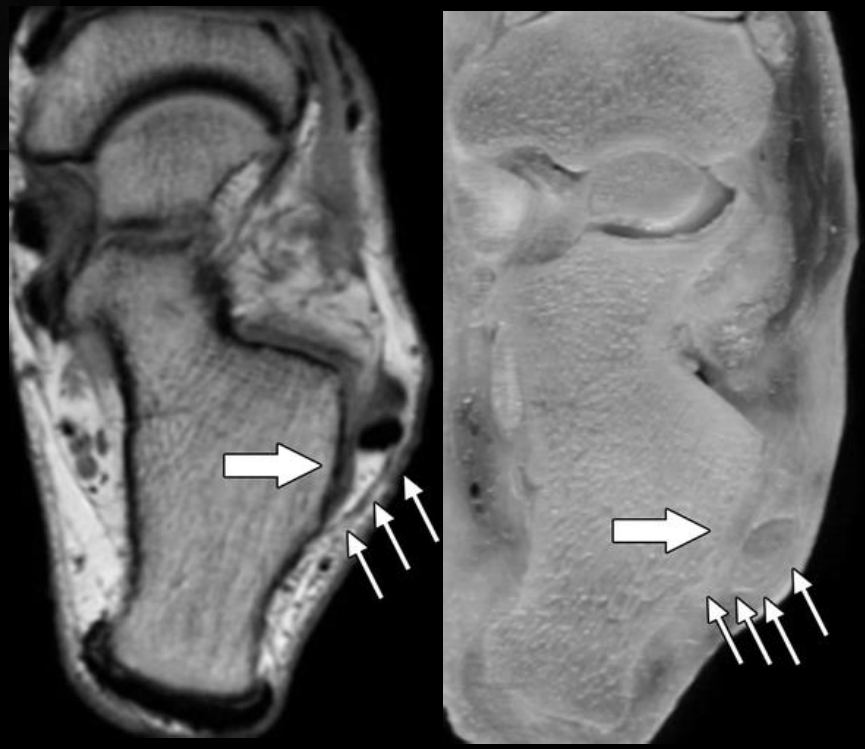


http://radsource.us/peroneal-tendon-dislocation-and-superior-peroneal-retinaculum-injury/

Superior Peroneal Retinaculum



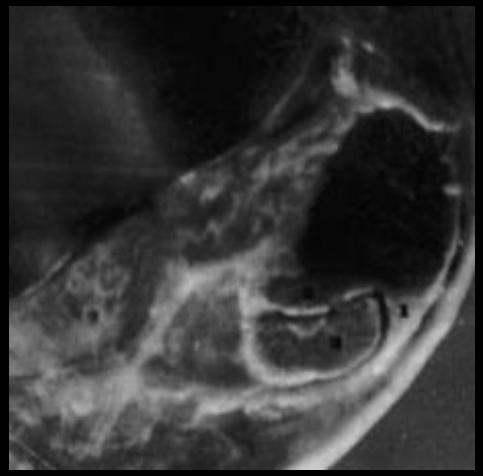
SPR continuous with superficial and deep aponeuroses



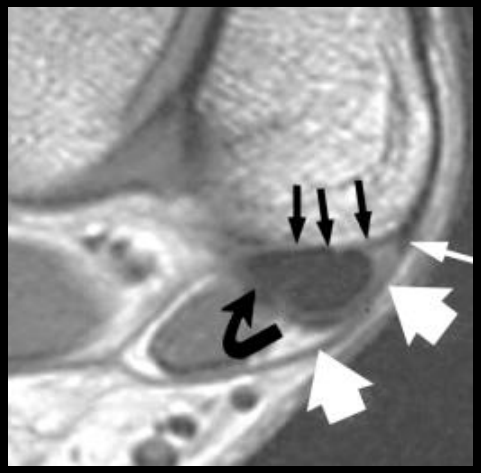
Inferior oblique band inserts at lateral wall of calcaneus behind CF lig

Numkarunarunrote N, Malik A, Aguiar RO, Trudell DJ, Resnick D. Retinacula of the foot and ankle: MRI with anatomic correlation in cadavers. AJR Am J Roentgenol. 2007 Apr;188(4):W348-54.

Fibrocartilaginous Labrum



Mabit, C. et al. The retromalleolar groove of the fibula: a radio-anatomical study. Foot and Ankle Surgery. 1999, Volume 5 , Issue 3 , 179 – 186.



Rosenberg ZS, Bencardino J, Astion D, Schweitzer ME, Rokito A, Sheskier S. MRI features of chronic injuries of the superior peroneal retinaculum. AJR Am J Roentgenol. 2003 Dec;181(6):1551-7.

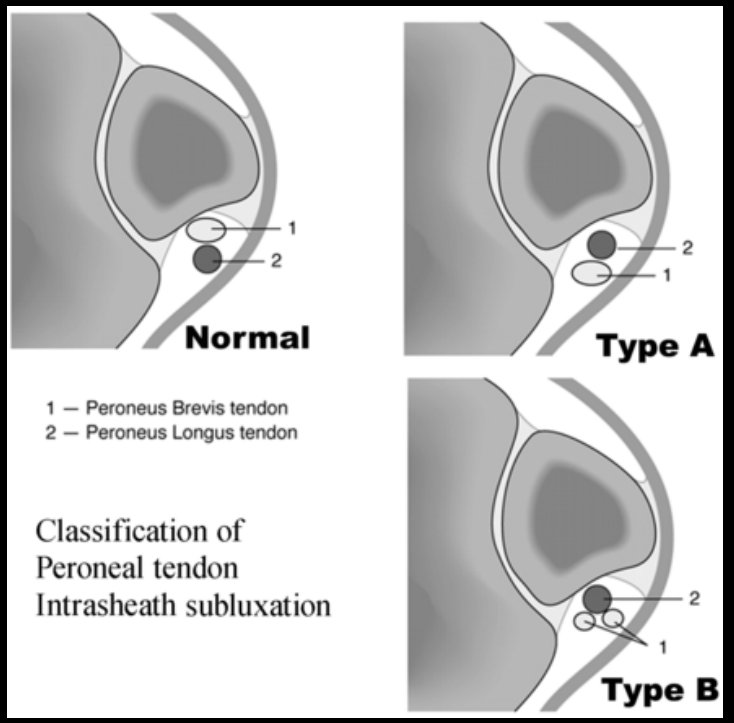
- 3 cm – 4 cm long ridge of tissue on posterolateral bank of retromalleolar groove
- Resembles fibrocartilage
  - Composed of dense collagen fibers and elastin
- Deepens effective depth of retromalleolar groove
  - Functional importance debated
- Loosely connected to the periosteum
  - Usually stays with fibula when SPR avulsed

Intra-Sheath Peroneal Tendon Subluxation

- Intact SPR
- Reversal of normal peroneal tendon relationship, with PL anterior to PB
- May be elicited with dorsiflexion and eversion

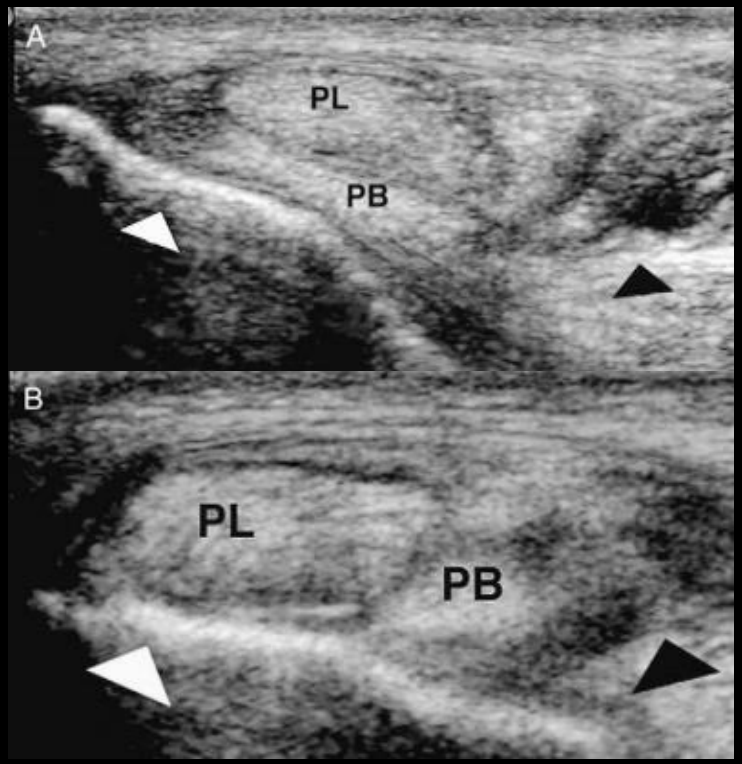
- Subjective sense of popping, snapping, and/or clicking without clinical or imaging evidence of subluxation

- Association with
  - Low-lying peroneus brevis muscle or peroneus quartus
  - Peroneal tendinosis, tears, prior surgery



Raikin, Steven M., Ilan Elias, and Levon N. Nazarian. "Intrasheath Subluxation of the Peroneal Tendons." The Journal of Bone and Joint Surgery-American Volume 90.5 (2008): 992-99.

Type A Intra-Sheath Subluxation



Thomas JL, Lopez-Ben R, Maddox J. A preliminary report on intra-sheath peroneal tendon subluxation: a prospective review of 7 patients with ultrasound verification. J Foot Ankle Surg. 2009 May-Jun;48(3):323-9.

Type B Intra-Sheath Subluxation

Superior Peroneal Retinacular Injuries

Mechanism

- Sudden dorsiflexion of the foot and forceful contraction of peroneal muscles

Predisposition

- Congenital foot deformities
- Peroneus quartus or low-lying peroneus brevis muscle

Associations

- Chronic peroneal tendon dislocation
- Peroneal tendon tears
- Low lateral ligamentous injuries

Oden's Classification of SPR Injuries

Type I (most common injury)

SPR periosteum stripped from distal fibula

Type II

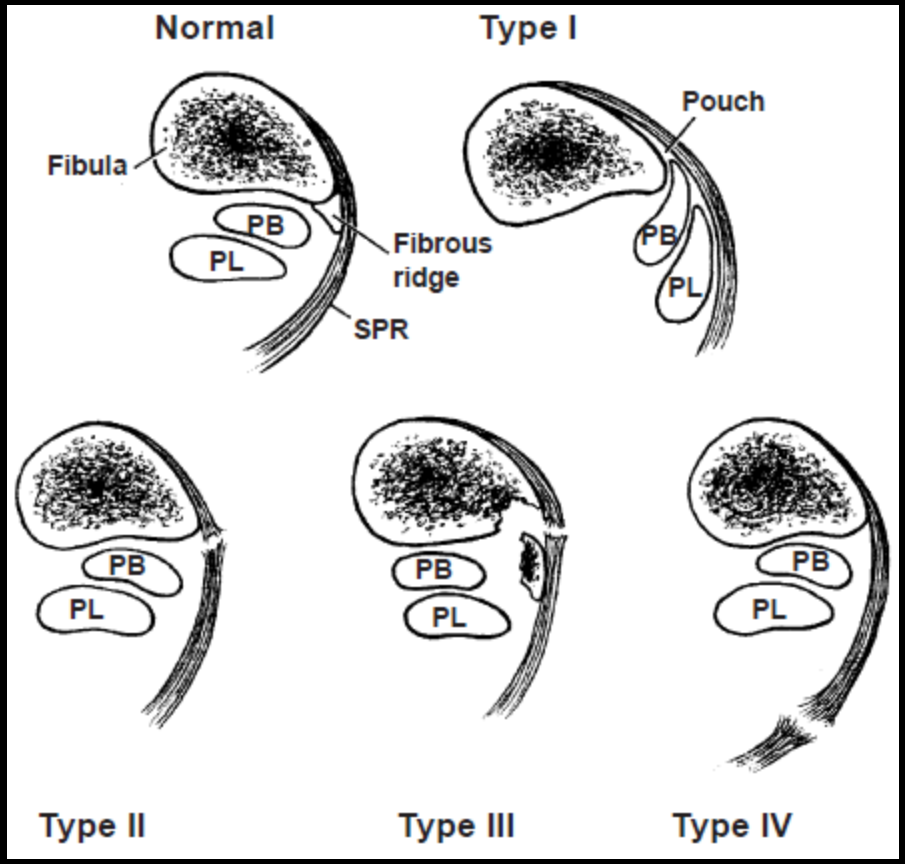
SPR avulsed from fibula

Type III

Avulsion fracture from fibula

Type IV

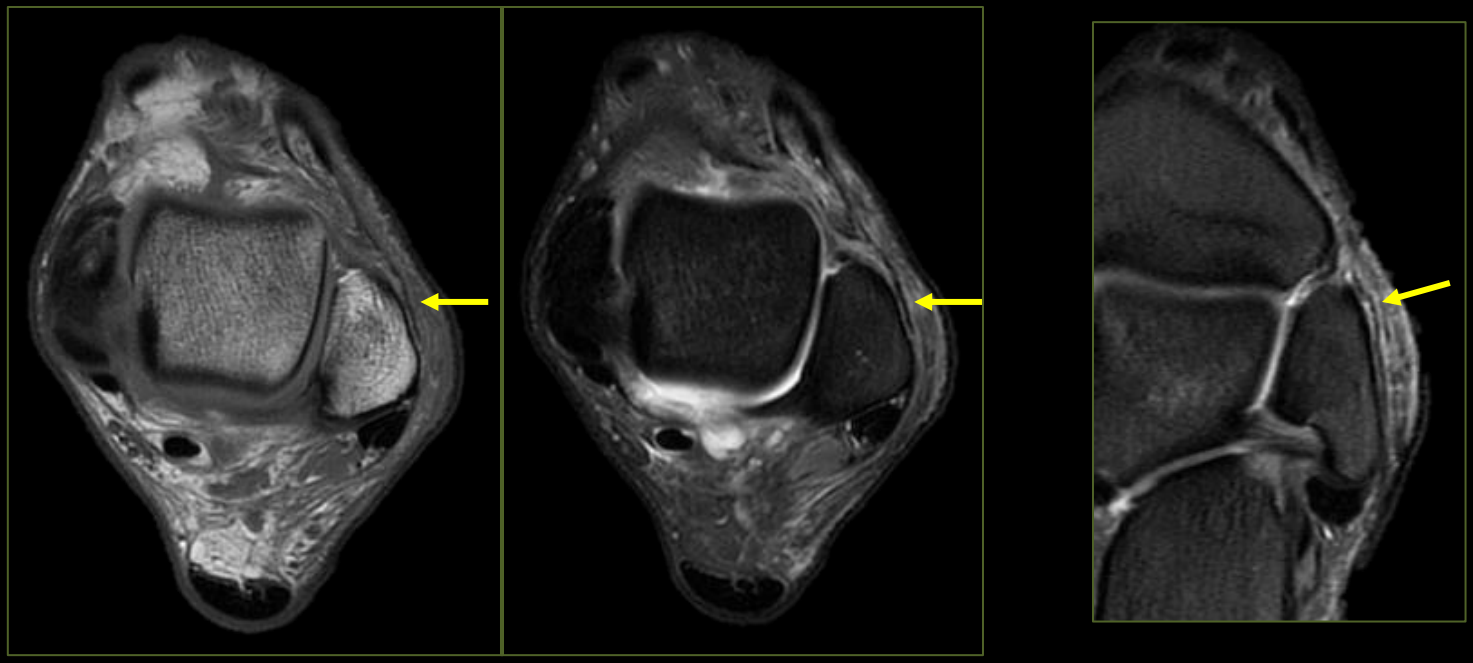
SPR torn at posterior attachment



Rosenberg ZS, Bencardino J, Astion D, Schweitzer ME, Rokito A, Sheskier S. MRI features of chronic injuries of the superior peroneal retinaculum. AJR Am J Roentgenol. 2003 Dec;181(6):1551-7.

Type I SPR Injury

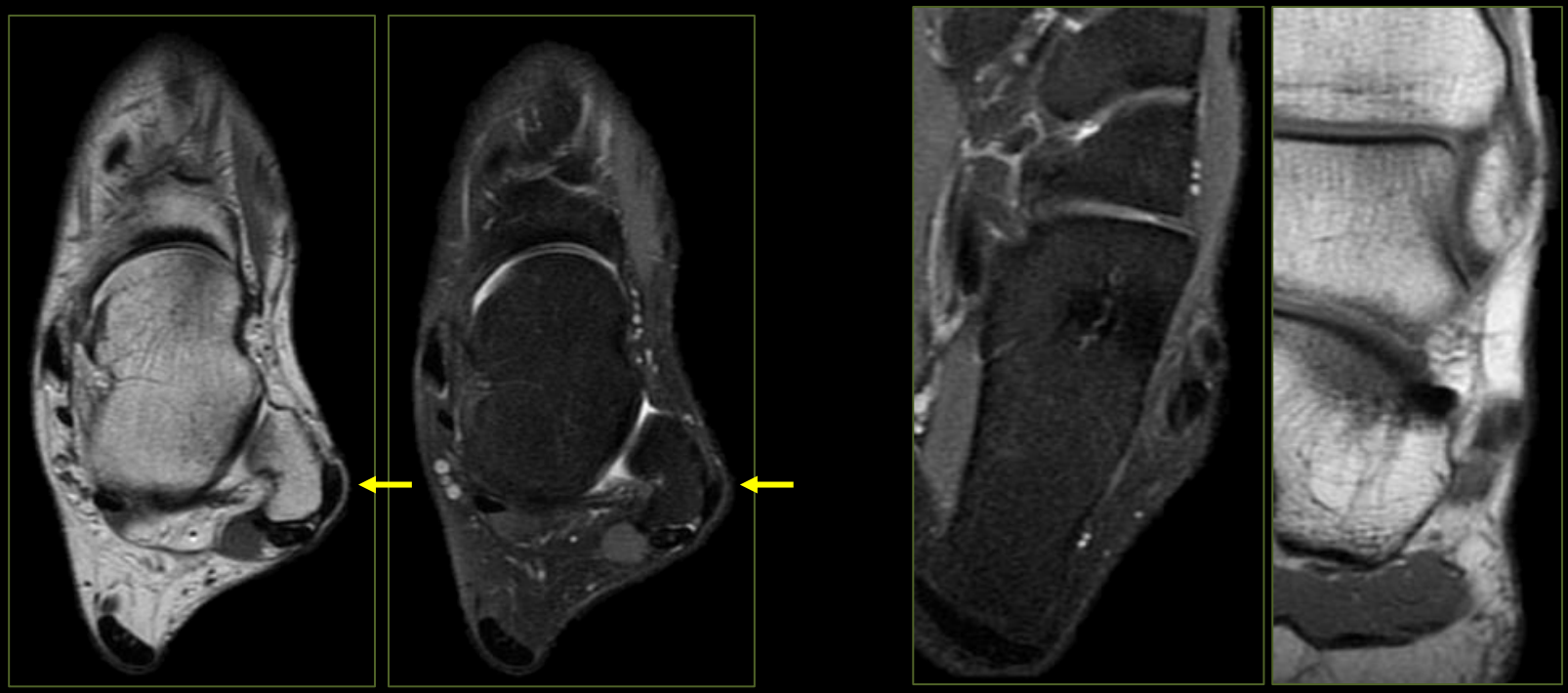
- Periosteal stripping of fibular attachment of SPR
- No peroneal tendon subluxation



Type I SPR Injury

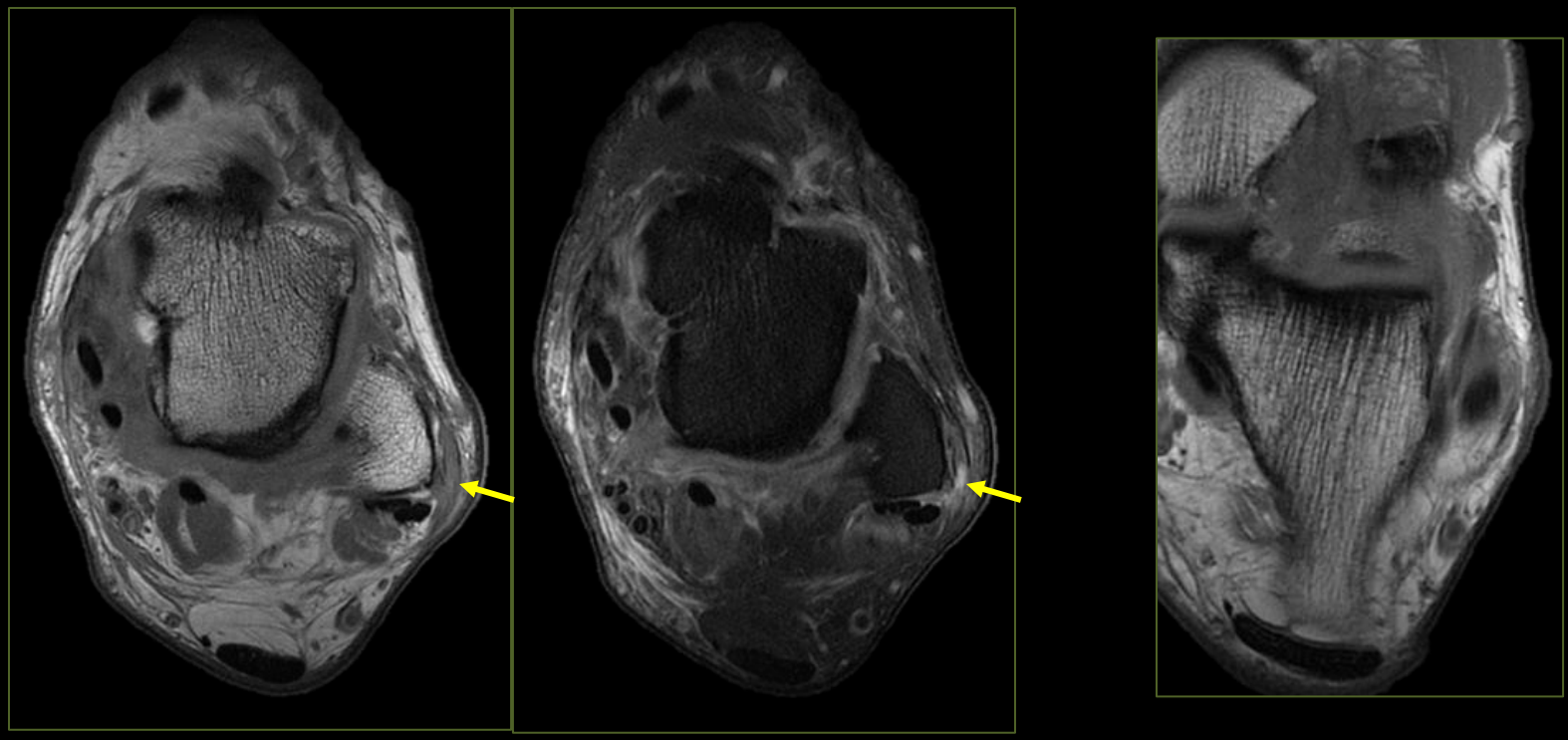
with lateral subluxation of peroneus brevis

- PL dislocated into pouch formed by stripped-off SPR and periosteum
- Convex retromalleolar groove



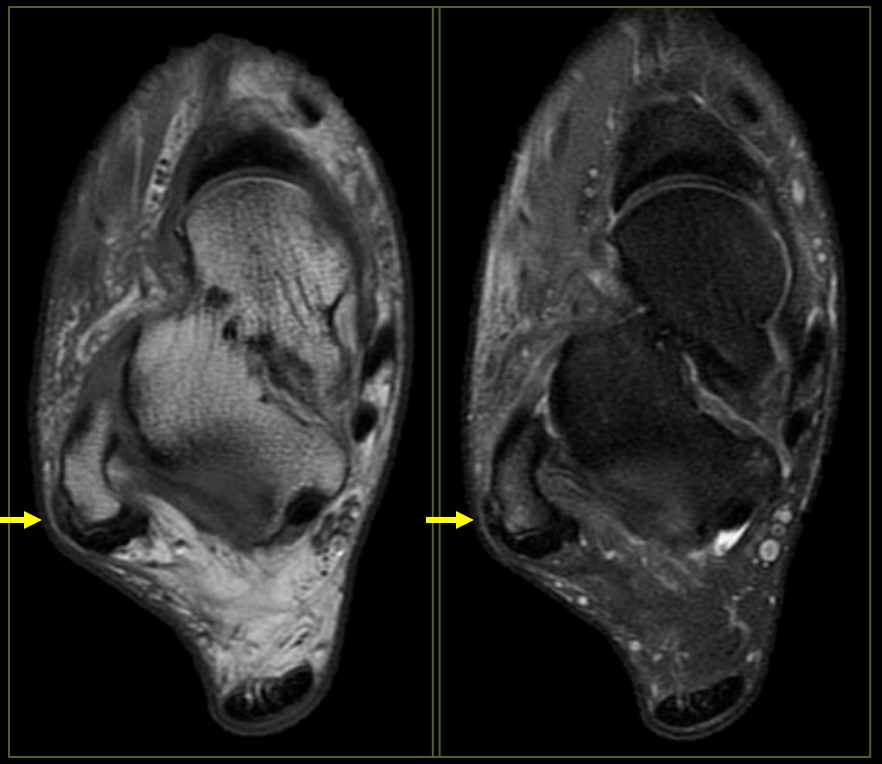
Type II SPR Injury

- Tear of SPR at its fibular attachment



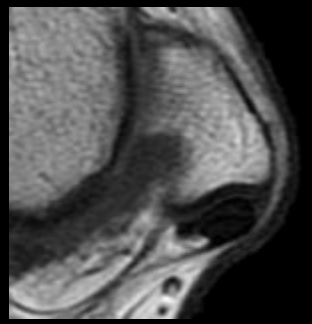
Type III SPR Injury

- Small, linear ossification adjacent to distal fibula, classic for SPR avulsion fracture
- PL tendinosis and lateral subluxation



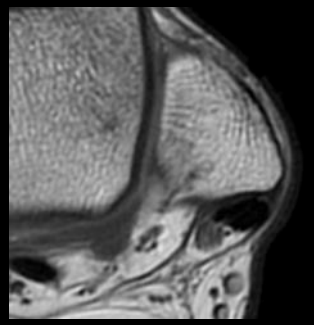
Retromalleolar Groove

6 -7 mm in 62%
(Range 5 – 10 mm)
Wider superiorly than inferiorly

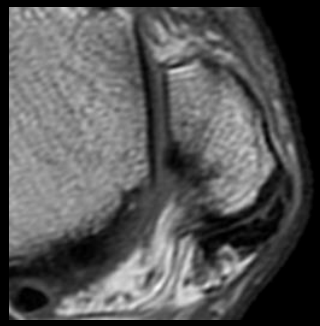


82% smooth and slightly concave

Up to 2 mm - 3 mm depth



11% flat

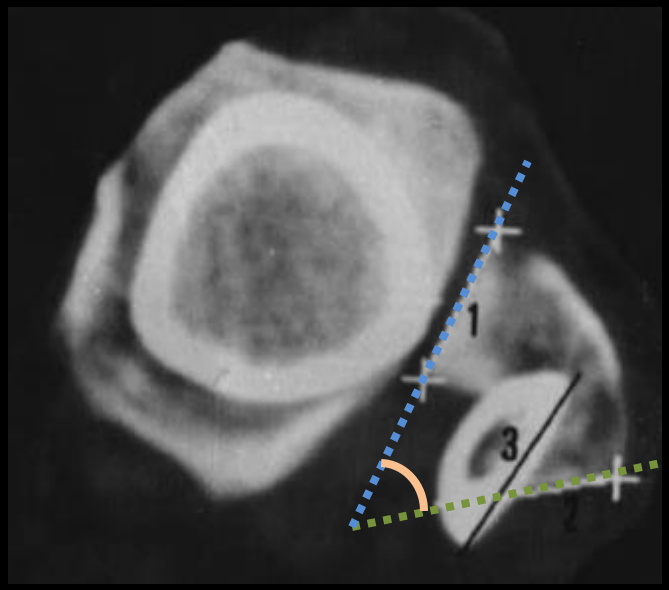


7% convex

Retromalleolar Groove

Mabit et al measured angle btw axis of tibiofibular articular surface and tangent of retromalleolar groove, based on 20 dry bone specimen.

Average 78° posterior orientation
Range 55° - 90°



Examination of 3 clinical cases of ankle instability yielded orientations of:

45°
54°
70°

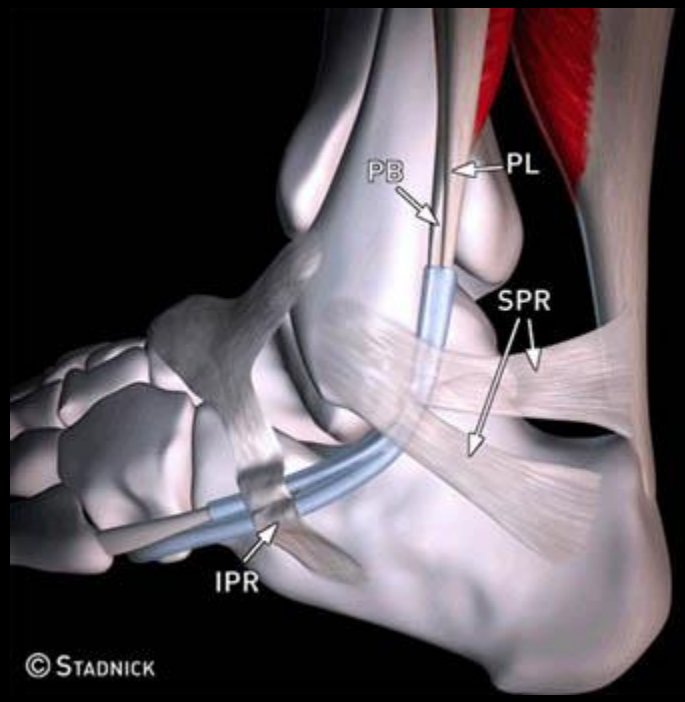
Inferior Peroneal Retinaculum

- Rectangular band
- Thickness 0.8 mm

- Origin: Posterior aspect of lateral rim of sinus tarsi
  - May blend with lateral root of inferior extensor retinaculum

- Insertion:
  - Retrotrochlear eminence (behind peroneal tubercle)
  - A slip to peroneal tubercle separates PB anteriorly and PL posteriorly
  - Also divides common peroneal tendon sheath

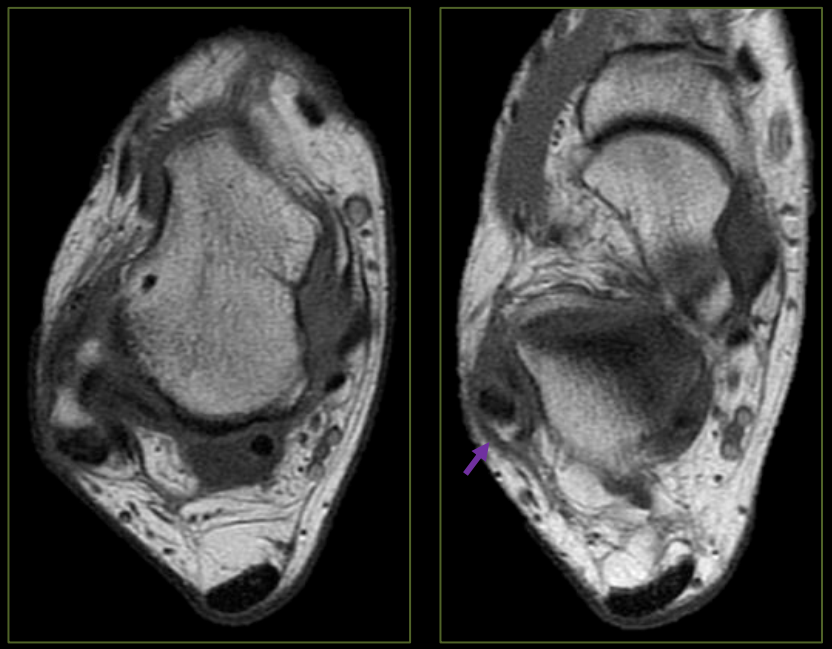
- Covers both peroneal tendons



http://radsource.us/peroneal-tendon-dislocation-and-superior-peroneal-retinaculum-injury/

Inferior Peroneal Retinaculum

Numkarunarunrote N, Malik A, Aguiar RO, Trudell DJ, Resnick D. Retinacula of the foot and ankle: MRI with anatomic correlation in cadavers. AJR Am J Roentgenol. 2007 Apr;188(4):W348-54.

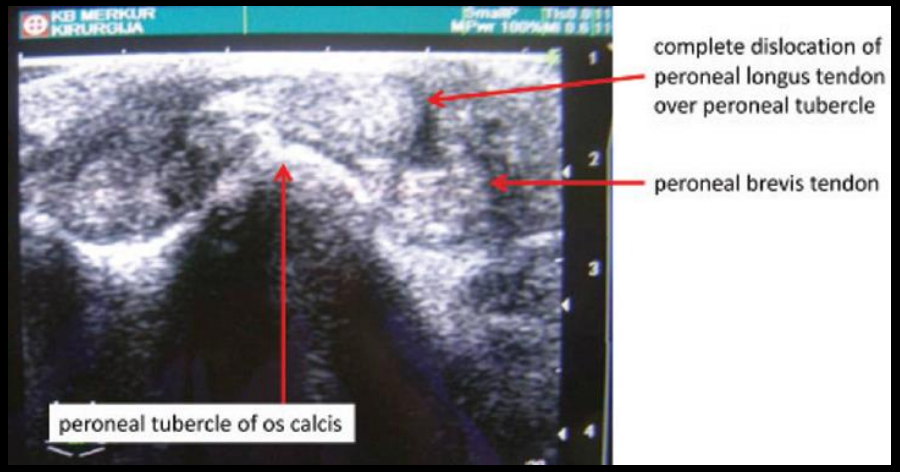


32yo M s/p inversion injury 3 months ago.

- High-grade ATFL tear
- Thickened IPR

If IPR torn, PL may dislocate over peroneal tubercle.

Clinical lateral ankle instability.

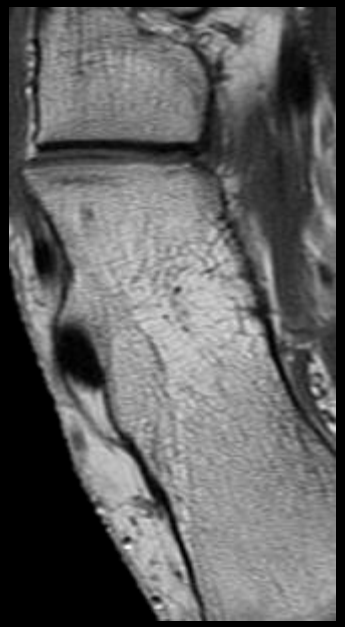


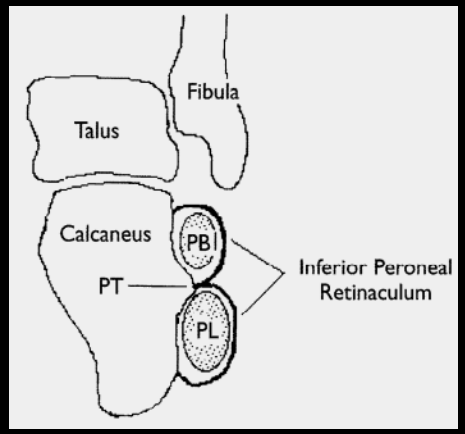
Staresinic et al. Isolated inferior peroneal retinculum tear in professional soccer players. Injury. 2013 Sep;44 Suppl 3:S67-70.

Peroneal Tubercle

- aka Trochlear process
- Incidence: 33 – 97.6%
- Bony protuberance along anterior 1/3 of lateral wall of calcaneus
- Runs posterosuperior to anteroinferior
- Located anterior to retrotrochlear eminence

- Insertion site of inferior peroneal retinaculum
- Serves as pulley for PL tendon



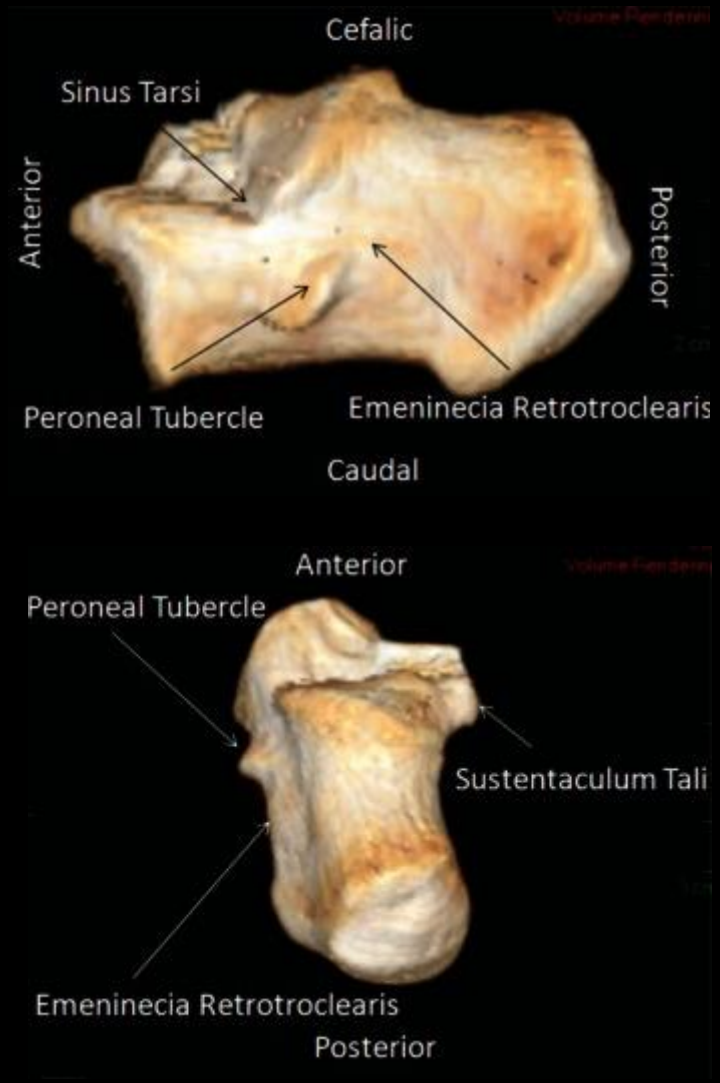


Hofmeister, E.p., P. Juliano, and F. Lippert. "The Anatomical Configuration and Clinical Implications of the Peroneal Tubercle." The Foot 6.3 (1996): 138-42.

Peroneal Tubercle

- Size varies: average ~ 3 mm
  - Length: 2 – 20 mm
  - Width: 0.2 – 10 mm
  - Height: 0 – 9 mm

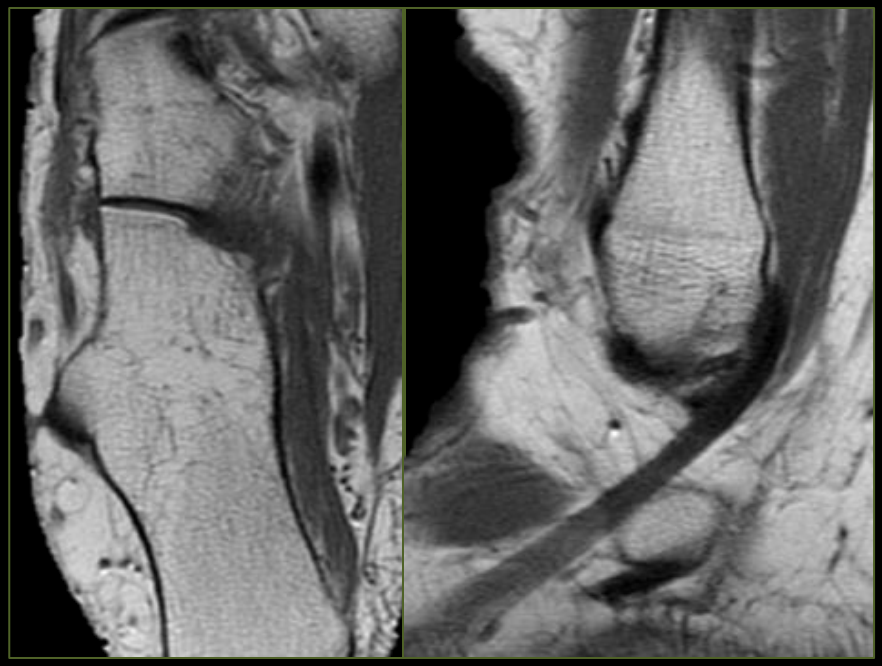
- Shape varies
  - Flat
  - Oval
  - Ridge
  - Anterior and posterior ridges
  - Tunnel-like



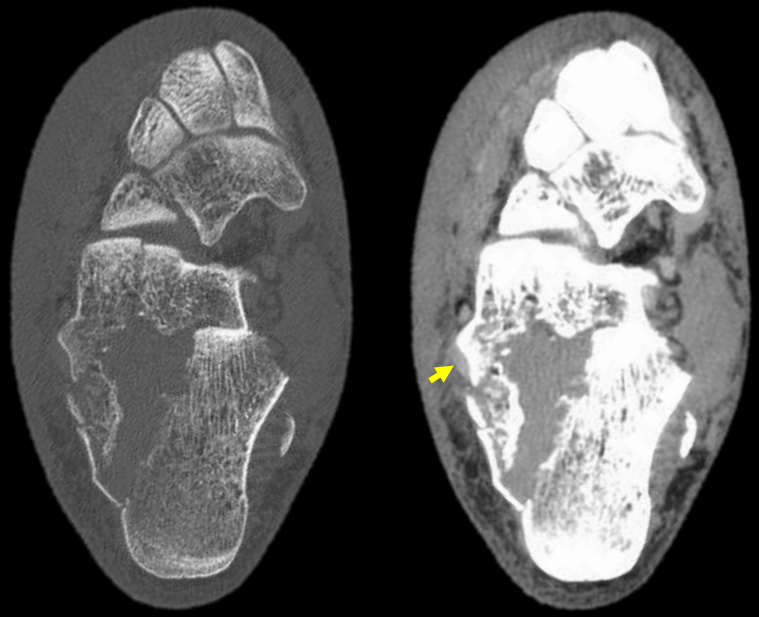
Palmanovich E, Laver L, Brin YS, Kotz E, Hetsroni I, Mann G, Nyska M. Peroneus longus tear and its relation to the peroneal tubercle: A review of the literature. Muscles Ligaments Tendons J. 2012 Apr 1;1(4):153-60.

Peroneal Tubercle Hypertrophy

- Etiology
  - Trauma
  - Altered weight-bearing
  - Inflammation
- Association
  - PL tendinopathy
  - Peroneus quartus muscle (may insert onto retrotrochelar eminence or peroneal tubercle)
  - Fracture
  - Pes planus or cavus
  - Os trochlear calcanei
  - Osteochondroma



Intra-articular fracture of calcaneus has strong association with PL tendon injury.



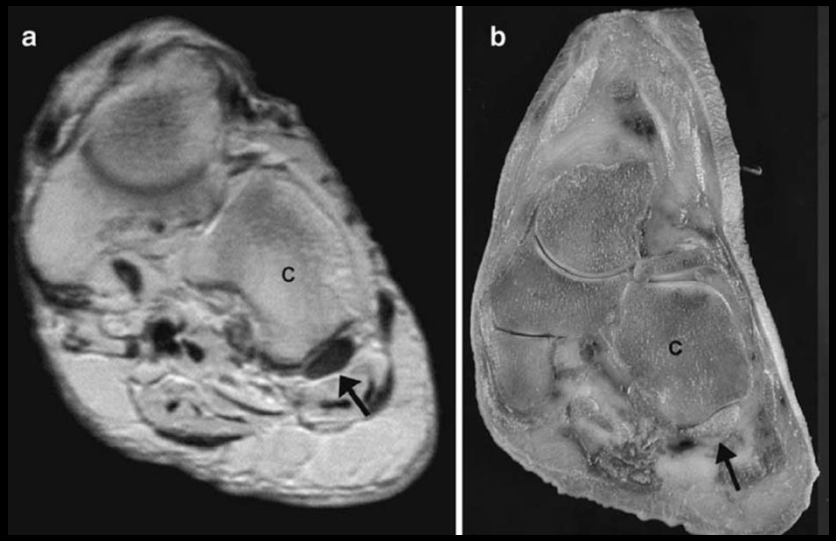
- Tenosynovitis
- Displacement or Extrinsic compression
- Entrapment
- Tear

Symptoms

- Chronic lateral ankle pain over the peroneal tendons
- Weakness

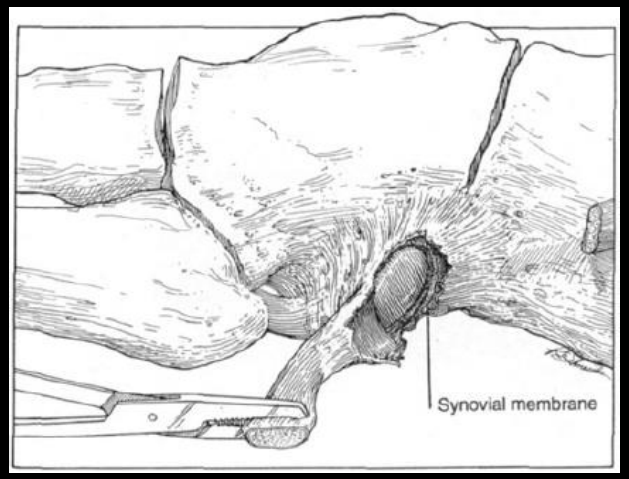
https://www.flickr.com/photos/smashgirl/2687798556/in/photostream/

Peroneocuboid Joint



Fernandes R, Aguiar R, Trudell D, Resnick D. Tendons in the plantar aspect of the foot: MR imaging and anatomic correlation in cadavers. Skeletal Radiol. 2007 Feb;36(2):115-22.

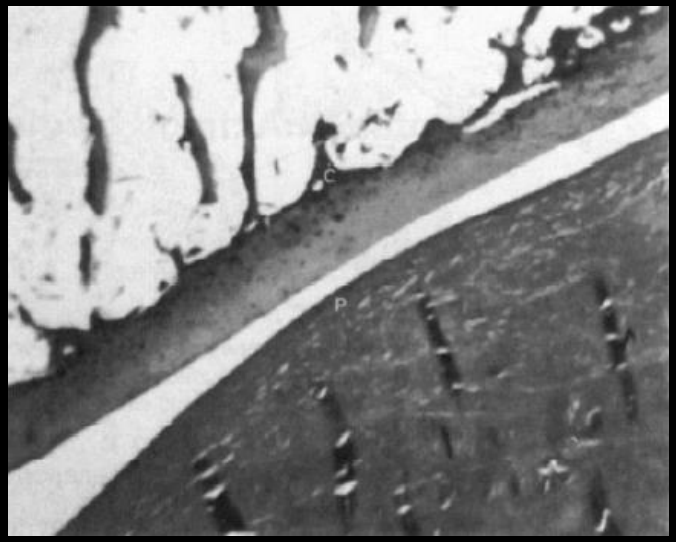
- PL tendon bends at nearly right angle around cuboid tubercle, which often bears an articular facet for os peroneum
- Thin synovial membrane
  - Does not communicate with PL tendon sheath or other tarsal joints



Ebraheim NA, Lu J, Haman SP, Yang H, Yeasting RA. Cartilage and synovium of the peroneocuboid joint: an anatomic and histological study. Foot Ankle Int. 1999 Feb;20(2):108-11.

Sarrafian's Anatomy of the Foot and Ankle

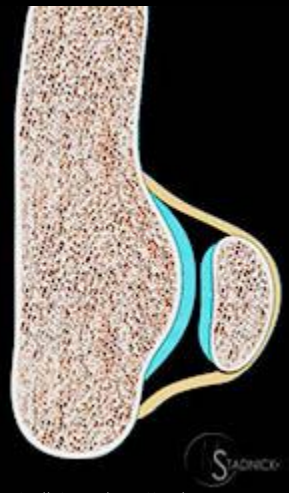
Peroneocuboid Joint



Ebraheim NA, Lu J, Haman SP, Yang H, Yeasting RA. Cartilage and synovium of the peroneocuboid joint: an anatomic and histological study. Foot Ankle Int. 1999 Feb;20(2):108-11.

	Cuboid, Lateral Tuberosity	**PL Articular Surface**
Shape	Oval	Round or Oval
Contour	Slightly convex	Flat or slightly concave
Cartilage	Hyaline cartilage	Fibrocartilage
Surface area (mm^2)	79.37 ± 20.24	67.35 ± 28.53
Cartilage thickness (mm)	0.52 ± 0.07	0.34 ± 0.08

Os Peroneum



Type B sesamoid

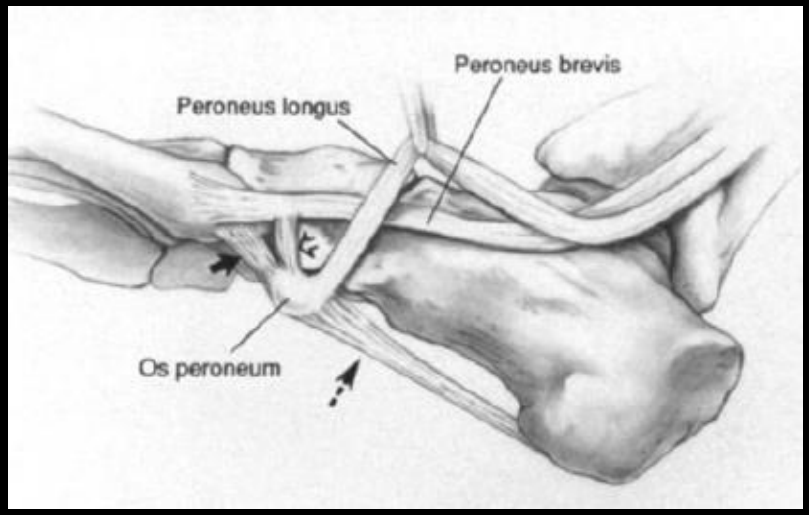
- Intratendinous accessory ossicle
- Usually at level of calcaneocuboid joint
- Cartilage-covered
- Separated from cuboid by a bursa

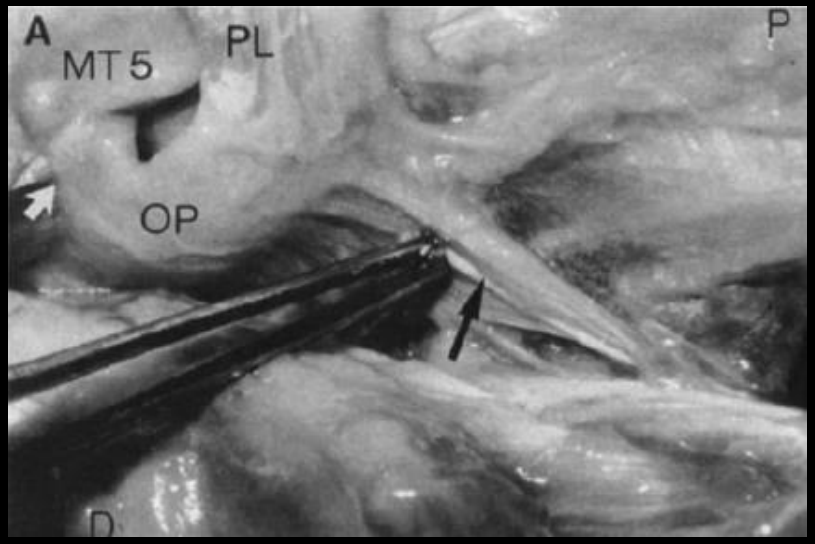
- Incidence: 5 – 26% of random radiographs
  - Often bipartite or multipartite
- Anatomical society study of 225 feet
  - 20% have os peroneum
  - additional 55% have fibrocartilaginous sesamoids

Os Peroneum

Four soft tissue anchors to

- Plantar fascia
- MT5 base
- Cuboid
- Peroneus brevis tendon





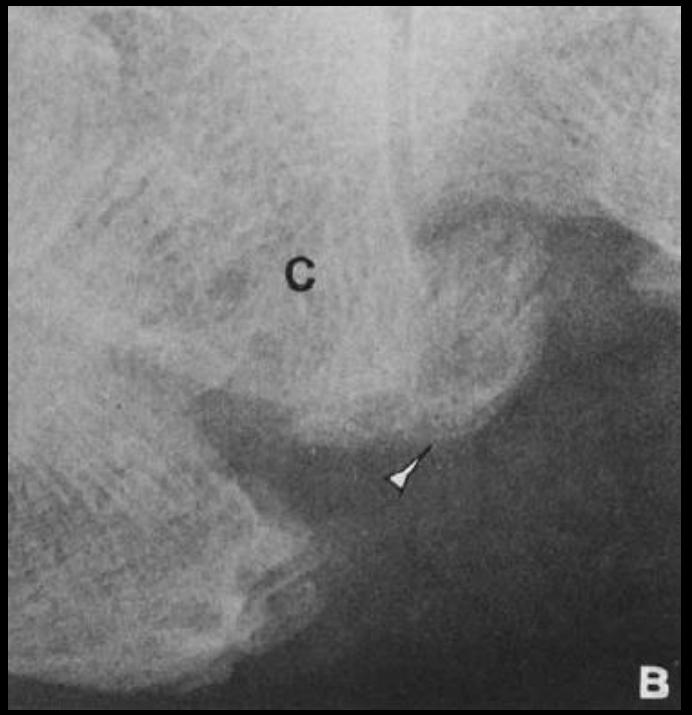
Sobel M, Pavlov H, Geppert MJ, Thompson FM, DiCarlo EF, Davis WH. Painful os peroneum syndrome: a spectrum of conditions responsible for plantar lateral foot pain. Foot Ankle Int. 1994 Mar;15(3):112-24.

Peroneocuboid Joint

- May undergo the same processes as adjacent joints (e.g. degenerative, inflammatory, septic arthritis)

DISH –

bony proliferation of os peroneum



Resnick D, Niwayama G, Feingold ML. The sesamoid bones of the hands and feet: participators in arthritis. Radiology. 1977 Apr;123(1):57-62.

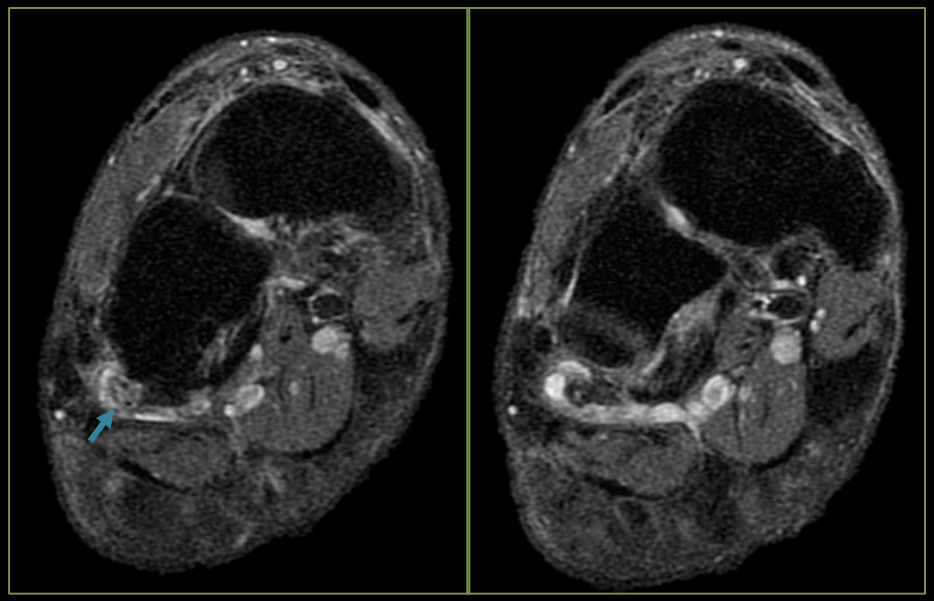
Os Peroneum Syndrome

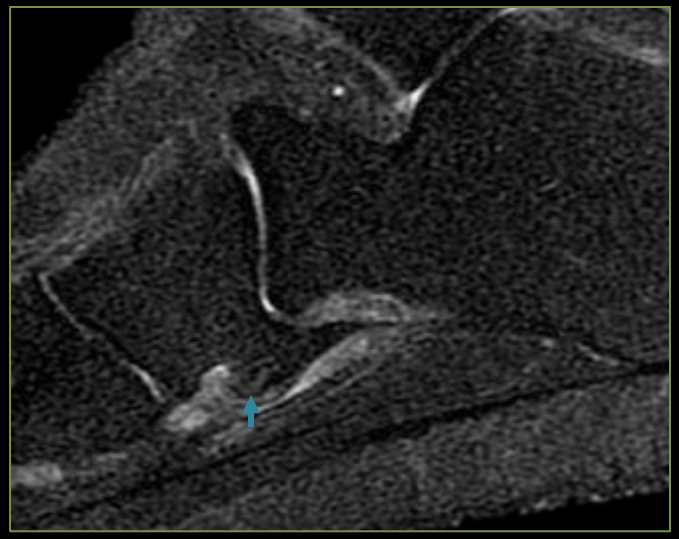
Varieties

1. Acute os peroneum fracture or diastasis of a multipartite os peroneum
   - May be associated with PL tear
2. Chronic os peroneum fracture or diastasis
3. PL tendon rupture proximal or distal to os peroneum
4. PL attrition or partial rupture proximal or distal to os peroneum
5. Large peroneal tubercle entraping PL tendon and/or os peroneum during tendon excursion

Symptoms

- Pain along distal course of PL tendon at peroneal tubercle or cuboid tunnel
- Pain may radiate proximally along PL muscle
- Pain and weakness with resisted plantarflexion of first ray and forced foot eversion
- Dysesthesia along sural nerve distribution
- Sensation of walking on pebbles



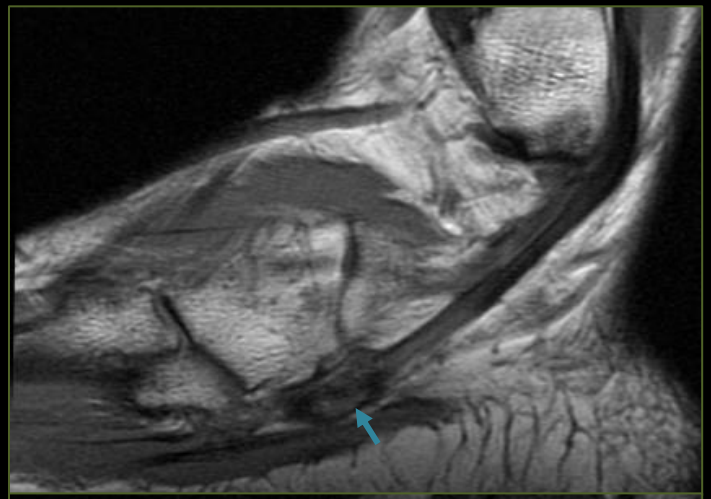


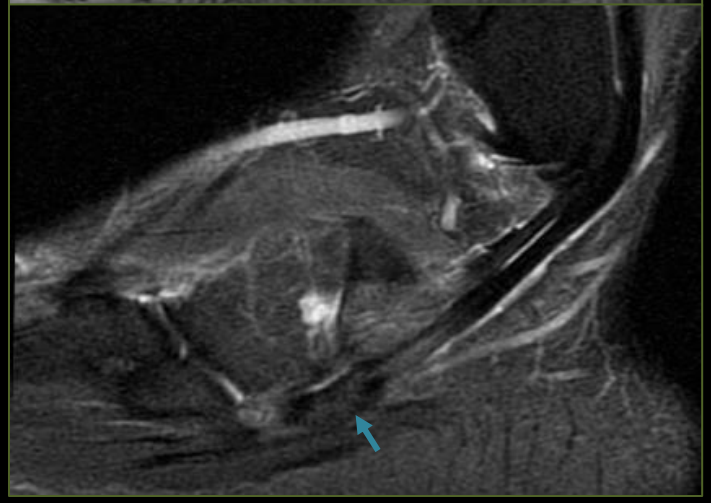
Edematous os peroneum

Low-grade intrasubstance tearing of peroneus longus

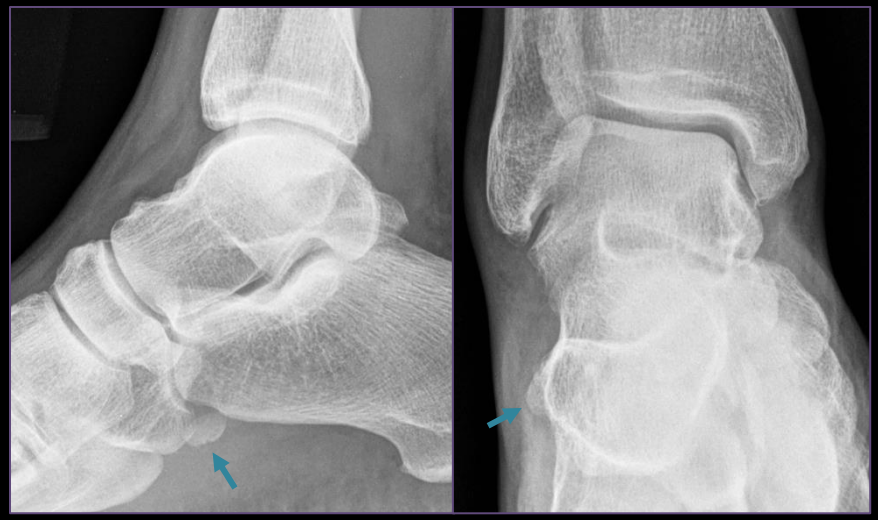
Tenosynovitis

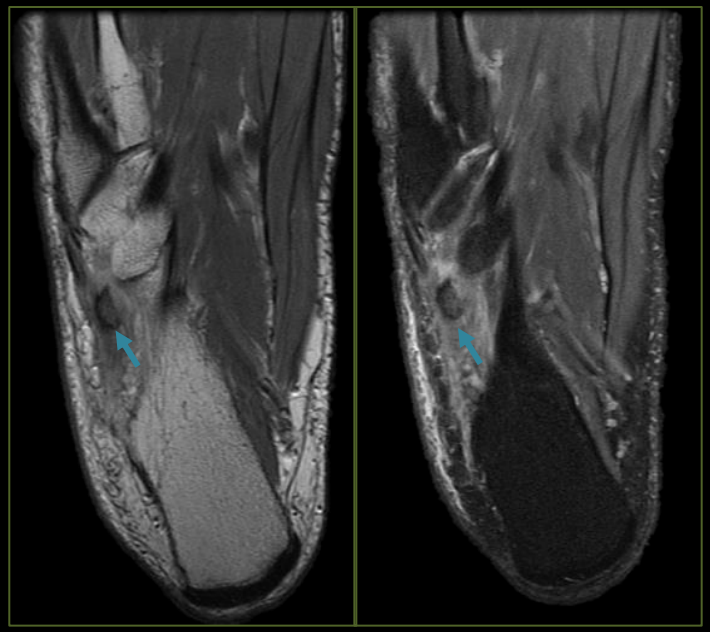
Sclerotic, enlarged os peroneum
PL tendinosis

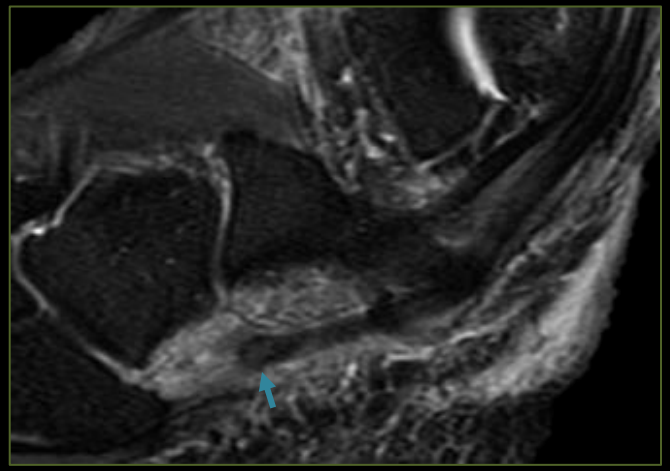




PL tear and proximally retracted os peroneum

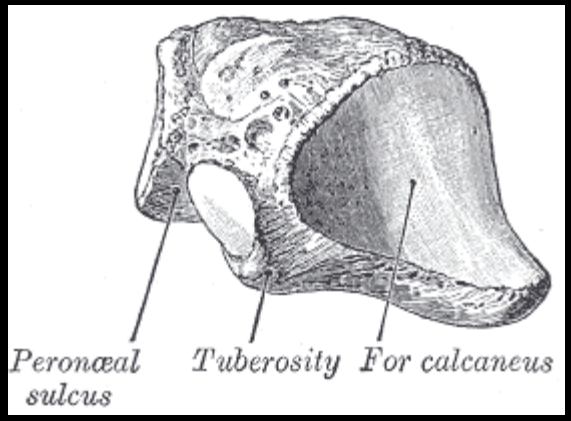






Cuboid Tunnel

- PL tendon runs obliquely in a fibro-osseous groove along plantar surface of cuboid, in a posterolateral to anteromedial direction
- Posterior border = Cuboid crest
  - Medial continuation of cuboid tuberosity
- Anterior border = Articular surface with MT4 and MT5 bases
  - A ridge of bone present in 70%



https://en.wikipedia.org/wiki/Cuboid_bone

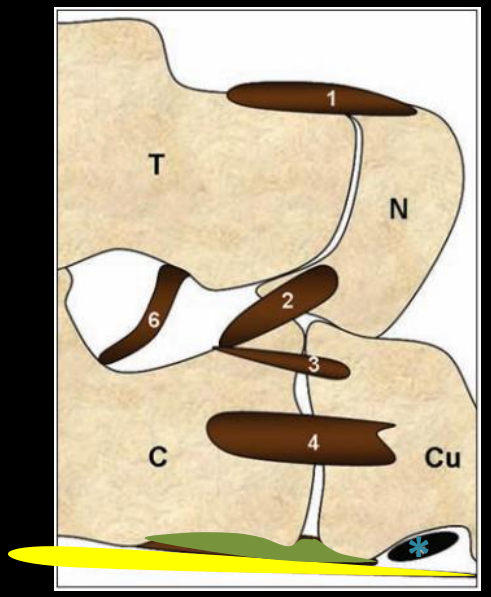
http://musculoskeletalkey.com/osteology/

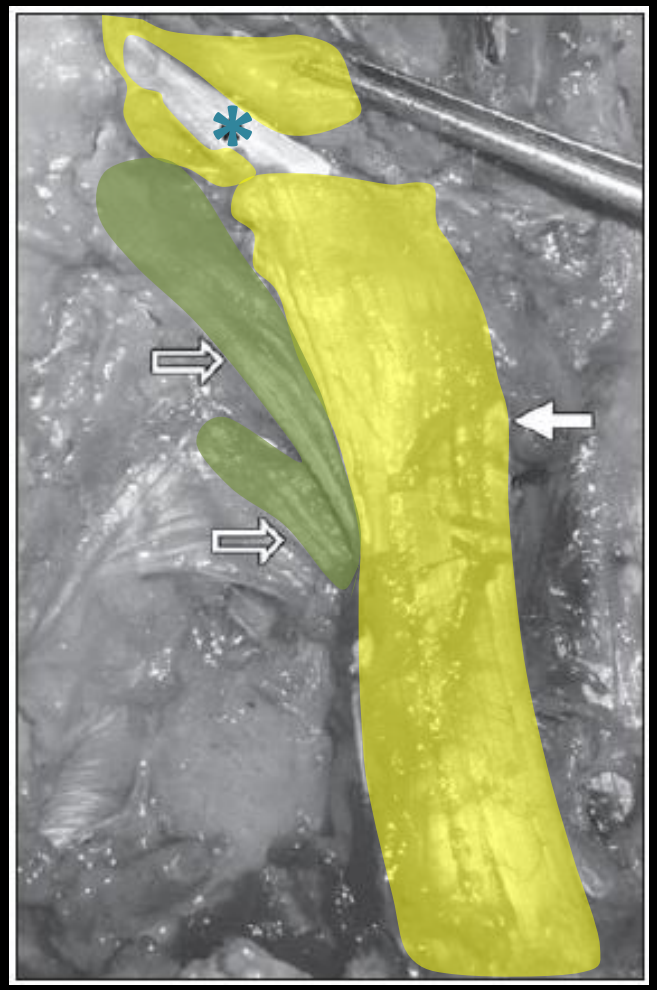
Long plantar ligament forms floor of cuboid tunnel.

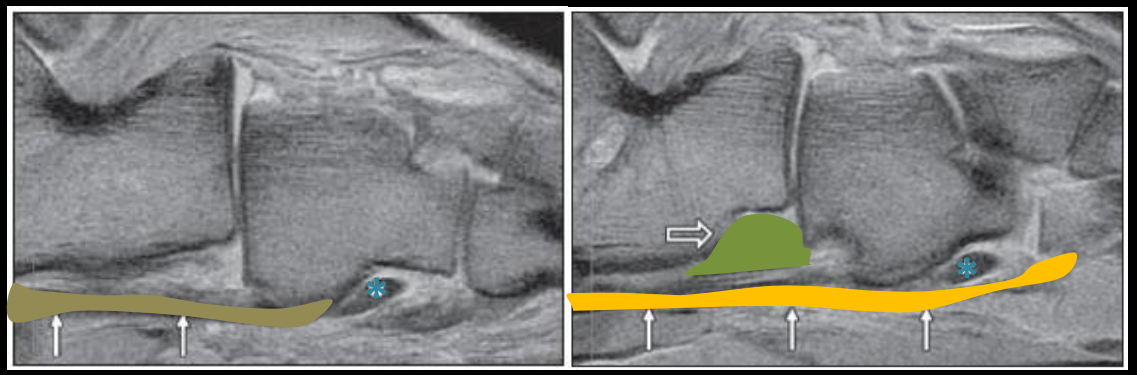
- Lateral and deep fibers insert on cuboid crest
- Medial and superficial fibers insert onto MT bases (3+4)

Short Plantar Ligament inserts onto cuboid proximal to PL tendon.

Asterisk = PL tendon





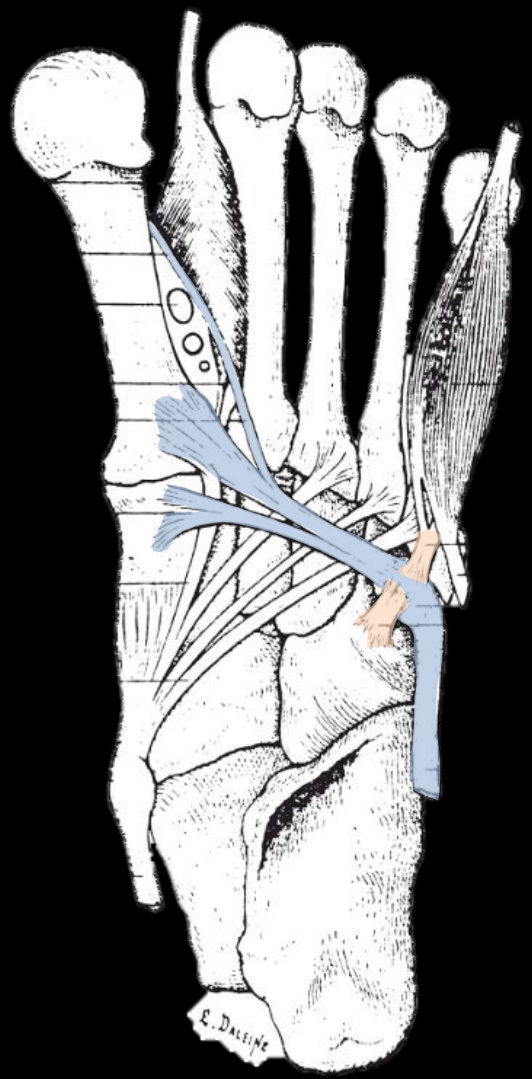


Melão L, Canella C, Weber M, Negrão P, Trudell D, Resnick D. Ligaments of the transverse tarsal joint complex: MRI-anatomic correlation in cadavers. AJR Am J Roentgenol. 2009 Sep;193(3):662-71.

Plantar Foot

- Variable anterior and posterior frenular ligaments at level of cuboid-sesamoid
  - Anterior → MT5 base
  - Posterior → Cuboid

- After passing cuboid, PL becomes enclosed by a second synovial sheath that terminates just before the tendon insertion.



Kelikian, Armen S., and Shahan K. Sarrafian. *Sarrafian's Anatomy of the Foot and Ankle: Descriptive, Topographical, Functional*. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins, 2011.

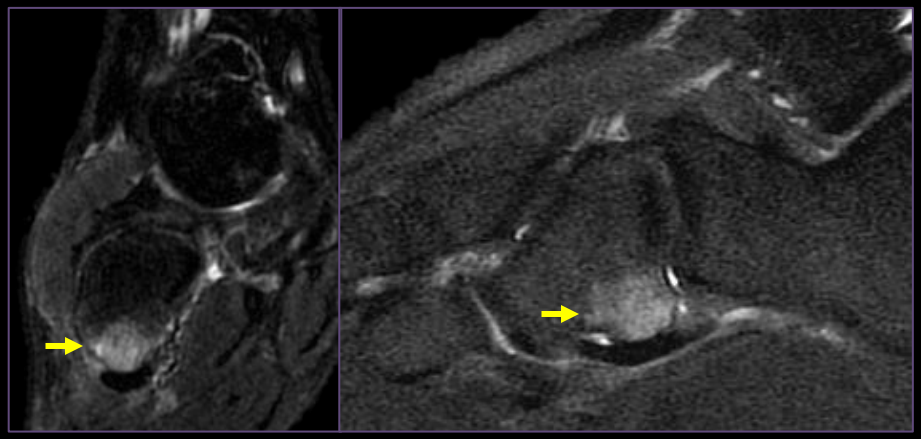
26yo M s/p right ankle injury

Mild edema surrounding distal PL tendon in cuboid groove , likely reflecting low-grade sprain of long plantar ligament.

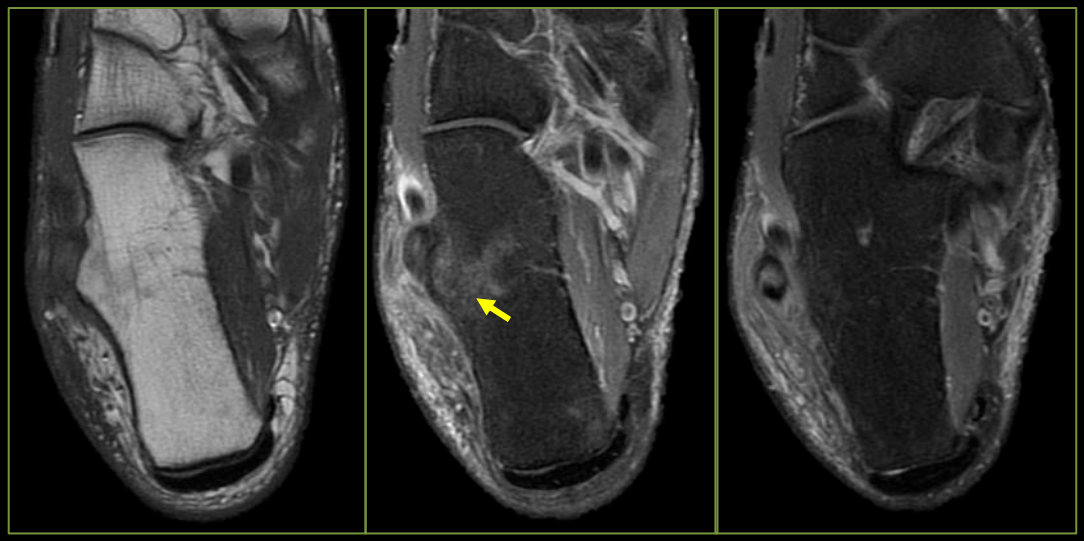
Cuboid syndrome

- Aka peroneal cuboid syndrome, subluxed cuboid, locked cuboid, etc.
- Minor subluxation of the calcaneocuboid joint, progressing to injury of joint capsule, adjacent ligaments and PL tendon
- Lateral foot pain
- Associations
  - Athletes: 4% prevalence (Newell and Woodle, 1981)
  - Professional ballet dancers: 17% of all reported foot and ankle injuries (Marshall and Hamilton, 1992)
  - Plantar flexion and inversion ankle injury (Jennings and Davies, 2005)
- Mechanism
  - Cuboid is a pulley for the PL tendon to plantarflex the first ray, which promotes stability and lateral-to-medial load transfer during late propulsive phase of walking.
  - Calcaneocubloid joint should be in maximal congruency ("locked") during propulsion.
  - PL exerts an eversion torque on the cuboid. Forceful eversion of cuboid leads to loss of congruence in the calcaneocuboid joint.
  - Effects may be magnified in pes cavus, 2/2 increased mechanical advantage of PL tendon.
- Difficult clinical and imaging diagnosis
  - Evaluation of short plantar ligament, bifurcate ligament, dorsal and plantar calcaneocuboid ligaments

Subcortical Subtendinous Bone Marrow Edema



- Occasionally associated with nonarticular bone proliferation
- Significant association with tendinosis or tear



http://rebloggy.com/post/dog-nyc-new-york-city-cloud-empire-state-building/9504313072 8

Wrap-Around Tendon

- Term coined by Alexander and Dimery (1985)
- Any tendon that courses around a bony or fibrous pulley prior to insertion
  - Relationship may be constant or positional

- Many are Fibrocartilaginous
  - Spiral arrangement of small fascicles within tendon, interwoven with collagen fibers
  - Continuous spectrum of differentiation from dense fibrous connective tissue to hyaline cartilage throughout thickness of tendon

- Function
  - Fibrous tissue: flexibility and toughness
  - Cartilage: elasticity

Wrap-Around Tendon

- Fibrocartilage metaplasia is an adaptation to compression or shear.
  - Surgically translocated tendons develop fibrocartilage at pulley on side of compression.
  - Conversely, cartilage cells of wrap-around tendons disappear when surgically rerouted into a ‘direct’ tendon.

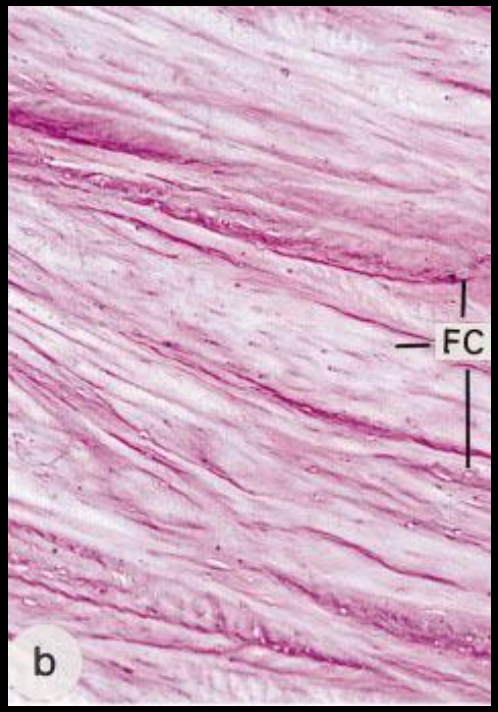
  (Ploetz 1938, Gillard et al 1938, Malaviya et al 1996)

- Debate on relationship between development of fibrocartilage and tendon degeneration

- Important role in healing

Wrap-Around Tendon

- **PL is the most fibrocartilaginous tendon in humans.**



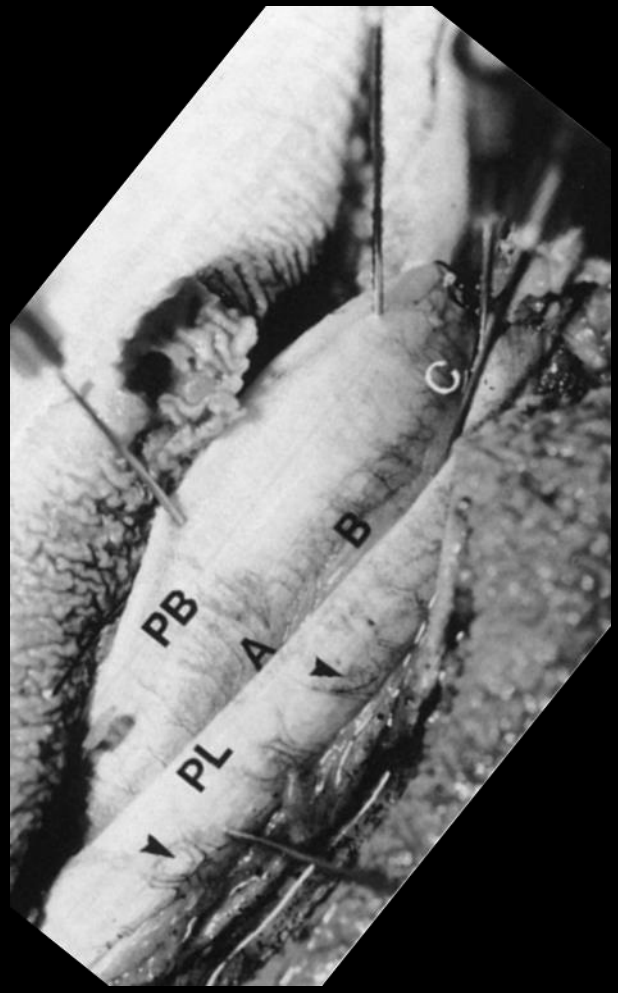
Benjamin M, Qin S, Ralphs JR. Fibrocartilage associated with human tendons and their pulleys. J Anat. 1995 Dec;187 (Pt 3):625-33.

Toluidine blue

- 3 wrap-arounds
  - Retromalleolar groove
  - Peroneal tubercle
  - Cuboid groove: most fibrocartilaginous pulley
- Locations correspond with areas of avascularity within tendon

Vascularity of the Peroneus Longus Tendon

- Posterior peroneal artery and branches of the medial tarsal artery
- Arborize into a network of vessels within two posterior mesotenon/vincula along the peroneal tendons
- Vessels penetrate the tendons and anastomose with an intratendinous arterial network, most oriented longitudinally



Sobel M, Geppert MJ, Hannafin JA, Bohne WH, Arnoczky SP. Microvascular anatomy of the peroneal tendons. Foot Ankle. 1992 Oct;13(8):469-72.

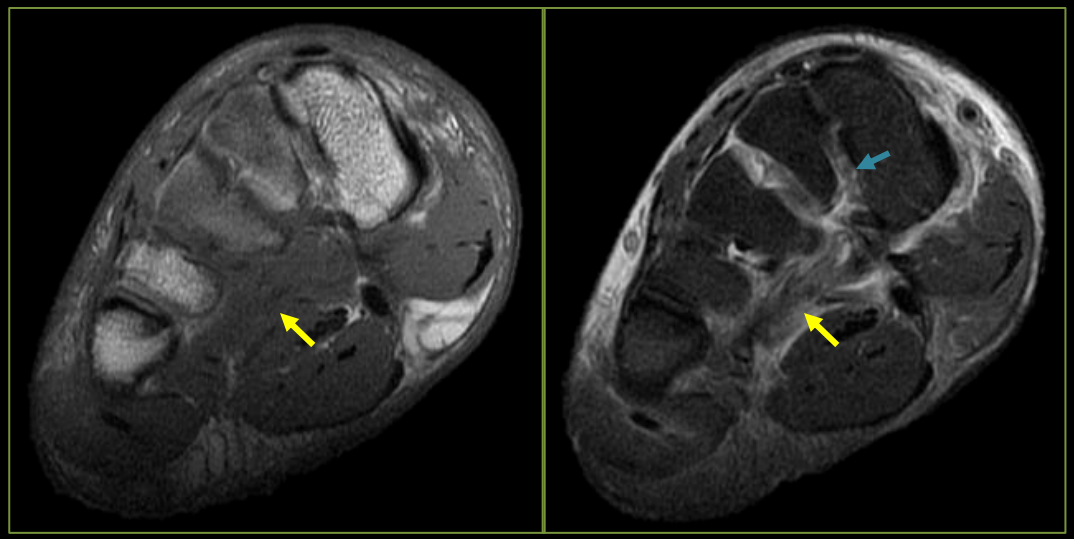
Avascular Zones

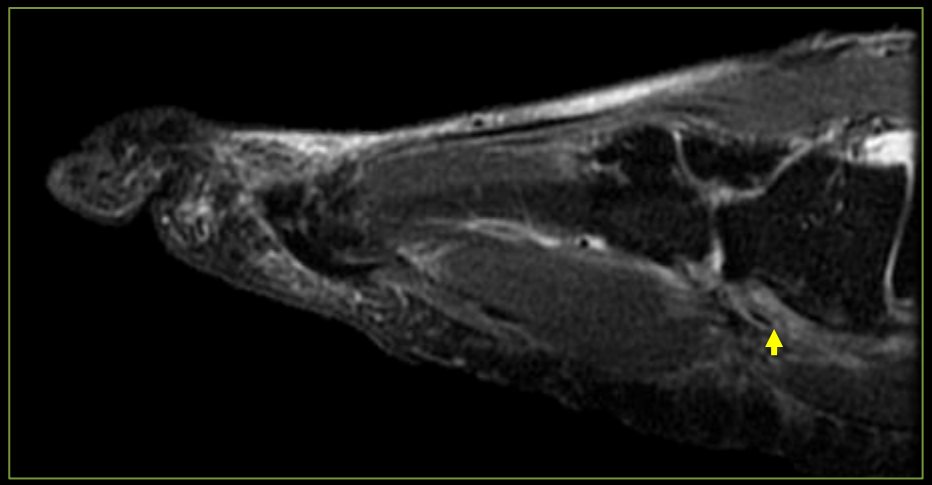
Petersen W, Bobka T, Stein V, Tillmann B. Blood supply of the peroneal tendons: injection and immunohistochemical studies of cadaver tendons. Acta Orthop Scand. 2000 Apr;71(2):168-74.

- Continuous network of intratendinous vessels posteriorly
- Interrupted anteriorly at level of
  - Retromalleolar groove to peroneal tubercle: 38 - 63 mm
  - Cuboid: 18 - 31 mm length
- Avascular zones correspond with most frequent sites of tendinopathy

Peroneus Longus Tendon Tears

- Longitudinal tears >> Transverse
  - Length of tear varies, does not appear to affect outcome
- Chronic tears >> Acute
- Etiology
  - Attritional
    - Shallow, convex, or irregular fibular groove
    - SPR disruption and PL subluxation over sharp posterior edge of fibula
    - Peroneus quartus
    - Enlarged peroneal tubercle
    - Gliding under cuboid bone
    - Hindfoot varus → increased force through peroneal tendons
  - Inversion, sports-related injury
- Less common than peroneus brevis tears





42yo M, sudden onset severe right forefoot pain and swelling associated with a loud pop while pushing off during running exercise followed by difficulty bearing weight

- High-grade tear of PL just distal to cuboid groove
- Tendinosis
- Low-grade sprain of Lisfranc ligament complex

http://www.suggestedpost.eu/diy-dog-bouquet/

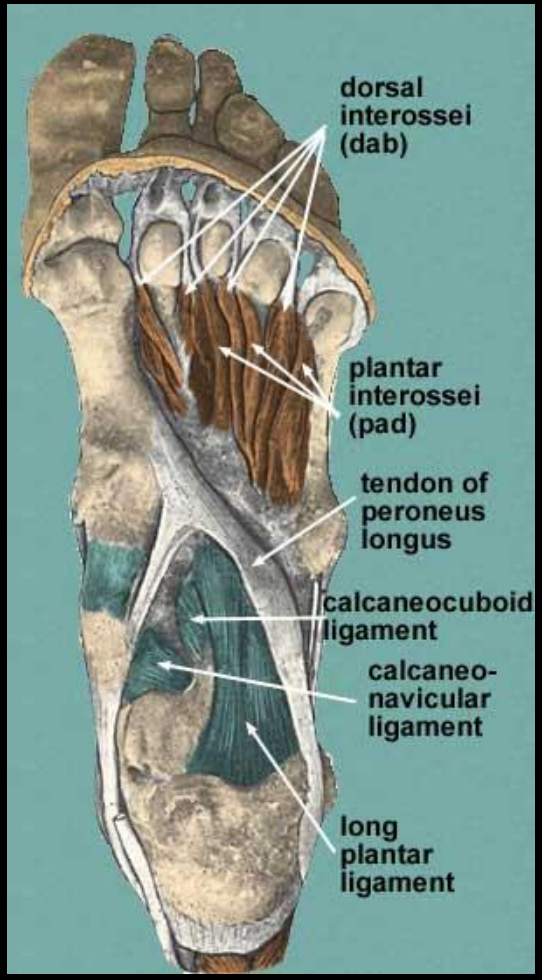
Peroneus Longus Insertion

Two major divisions

- Plantar-lateral aspect of MT1 base
  - Consistent, strong band
  - Arises from superficial, plantar portion of tendon
- Plantar-lateral aspect of medial cuneiform
  - 86.6%
  - Deep, dorsal portion of tendon

Divisions can be seen extending proximally to level of calcaneocuboid joint

- Fan-shaped, striated

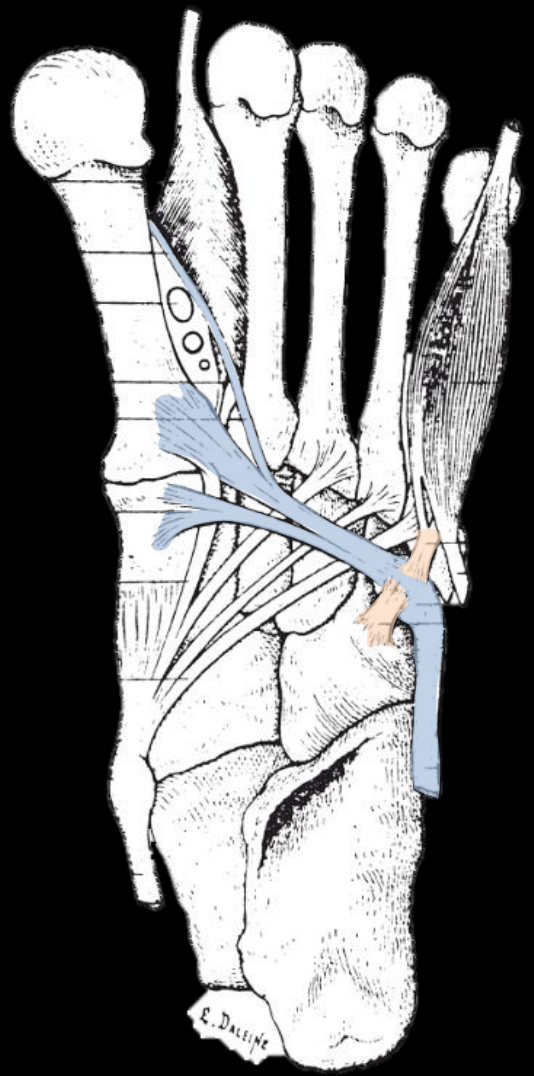


http://www.wesnorman.com/soleoffoot.htm

Peroneus Longus Insertion

Additional slips

- MT2-5 bases
- MT1 neck
- First dorsal interosseus muscle
- May receive a contribution from PTT



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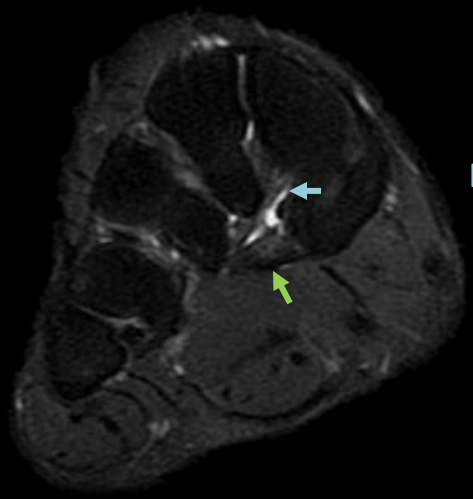
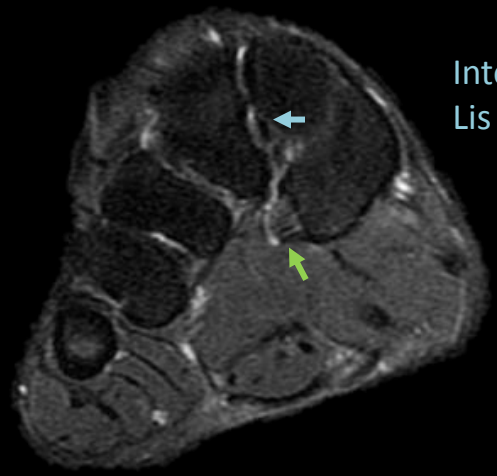
Normal Peroneus Longus Insertion

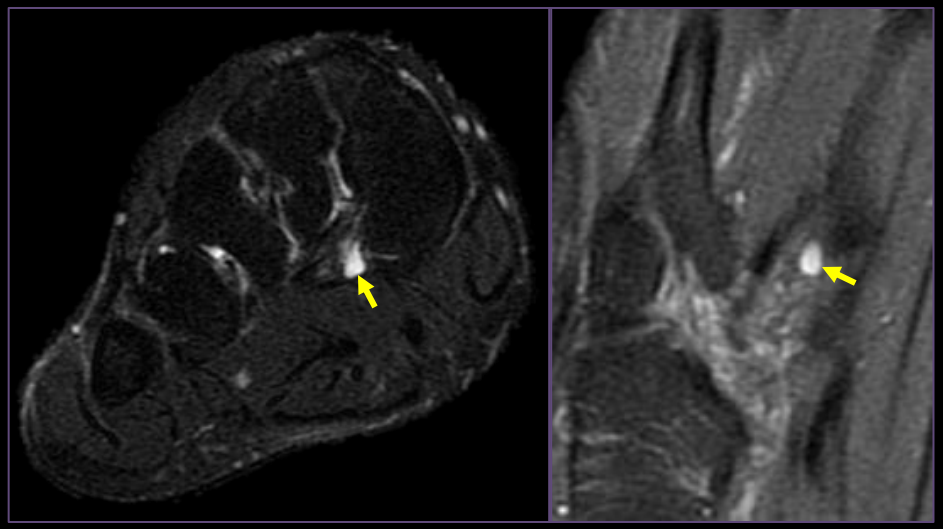


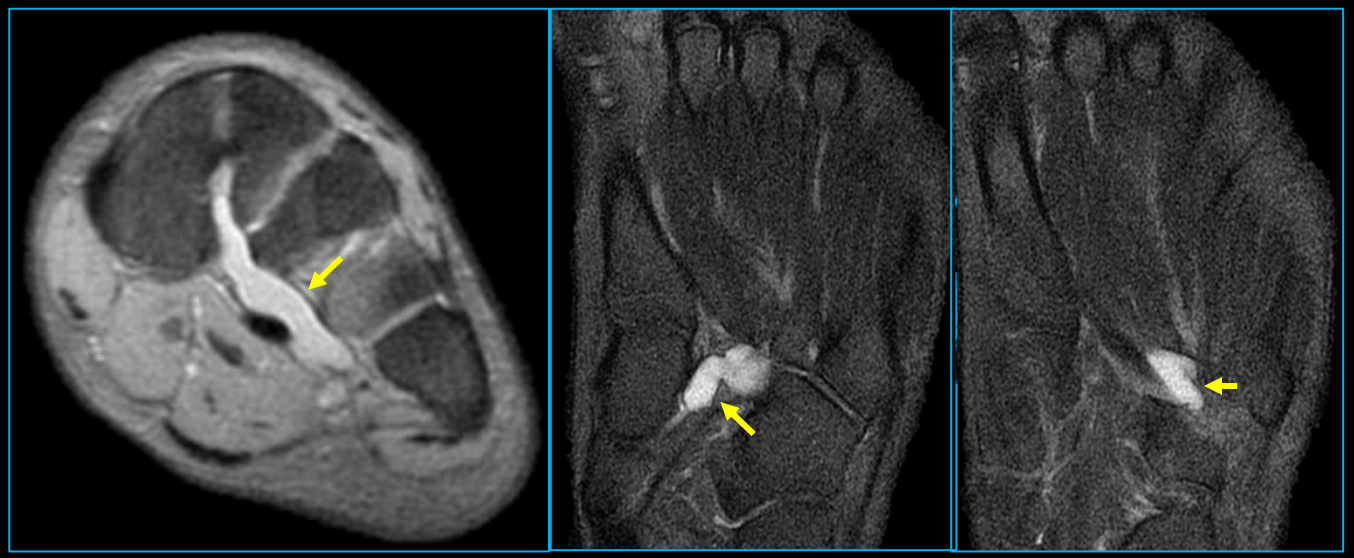
Plantar Lis franc lig



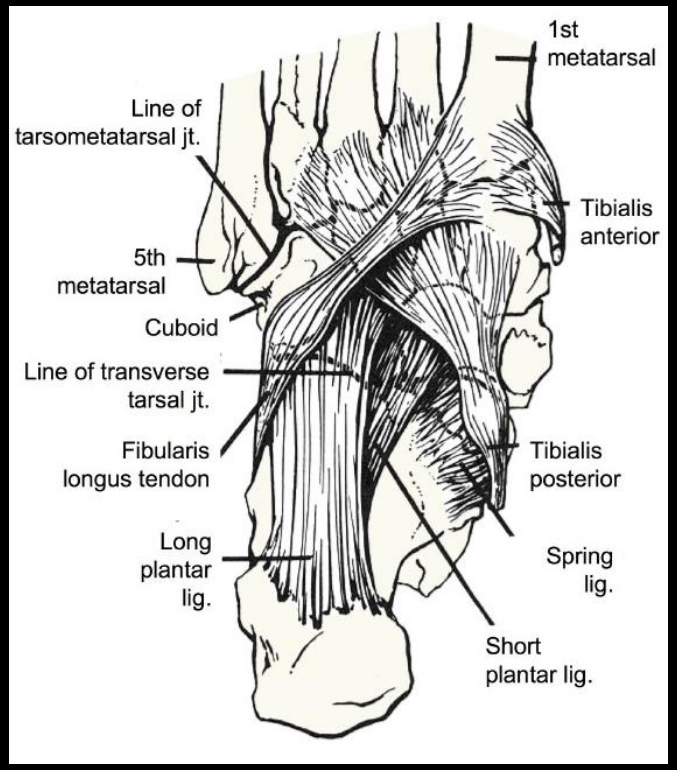
Interosseous
Lis franc lig

Ganglion Cyst





Sling concept



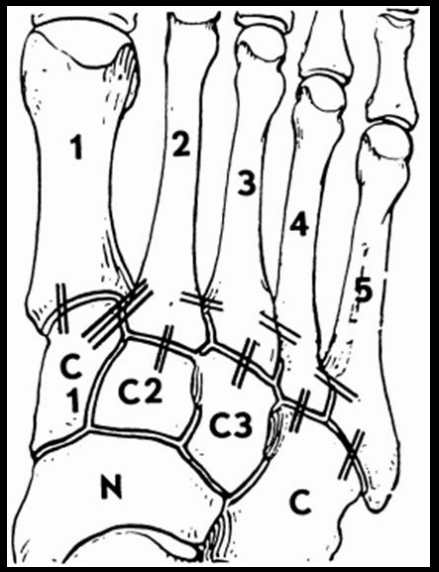
https://www.dartmouth.edu/~humananatomy/figures/chapter_17/17-8.HTM

- Peroneus longus and Tibialis anterior insert at their respective tuberosities at the *inferolateral* and *inferomedial* bases of MT1.
- Both also insert onto medial cuneiform.
- Insertions of the two tendons do not interdigitate.

- Antagonistic effects
  - PL: Plantarflex (weak) and Evert (strong) ankle, Plantarflex first ray
  - TA: Dorsiflex ankle, Adduct and Supinate foot

First Metatarsocuneiform Joint

- Has its own synovial encapsulation
- Dorsal and plantar ligaments
  - Plantar stronger
- No interMT ligament btw MT1 and MT2
- Weightbearing
  - MT1 bears 1/3 of static stress, rest divided among lesser MT's
- Generally considered immobile
- No consensus about what is considered hypermobile on either the direction or amount of movement (Mason 15-19)



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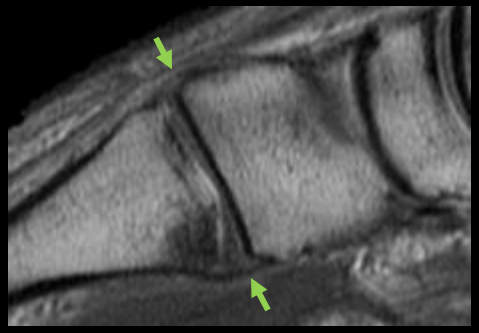


Where does Peroneus Longus Fit?

- Young et al (1910) - Described hypertrophy of the tuberosity to which PL inserts in setting of hallux valgus
- Bohne et al (1997) - Study of 10 cadaveric feet showed PL to be more important than any other component (skin, interMT lig, adductor hallucis brevis) in resisting varus displacement of MT1.
- Faber et al (1999) - Study of 9 cadaveric feet showed that PL resists dorsal displacement of MT1, but not against medial displacement.

Motion at the First Metatarsocuneiform Joint

	Sample size	Medial-Lateral (Transverse)	Dorsi-Plantar (Sagittal)	Inversion-Eversion (Coronal)	Intermetatarsal Joint/Facet
Faber et al 1999	9	TMT1 contributes 82% to 2.2° medial displacement of the first ray.	TMT1 contributes 57% to 2.4° dorsal displacement of the first ray.	--	Found no correlation btw TMT1 angular displacement and presence of interMT facet.
Fritz et al 1995	100	--	ROM 4.37° in sagittal plane.	--	--
Geng et al 2015	40	Medial 0.96° vs. 2.65° in healthy vs. hallux valgus.	Dorsiflexion 1.18° vs. 2.91° in healthy vs.	° in s.	--
		No lateral motion.		sion.	
Lundberg et al 1989	8	Medial 2.3°		ersion 1.6°	--
		Lateral 2.4°		Eversion 2.9°	
Mizel et al 1993	12	--	ificant dorsal displacement (5.9mm) only after cutting the plantar first metatarsocuneiform ligament.	--	--
Ouzounian et al 1989	10	--	ROM 3.5°	ROM 1.5°	--
Wanivenhaus et al 1989	100	Motion in 11 of 100 feet.	Dorsiflexion in 9 of 100 feet, 4.3°.	Negligible. Motion only with ligament or joint degen.	Present in 53 feet.
		4.4° abduction, 5° adduction.	No plantarflexion or plantar displacement.	92 feet showed 6.2° eversion only after dorsal displacement of MT1 by 2.6mm.	Impedes adduction.
				6 feet showed 4.1° inversion.	

THE CONTROVERSY

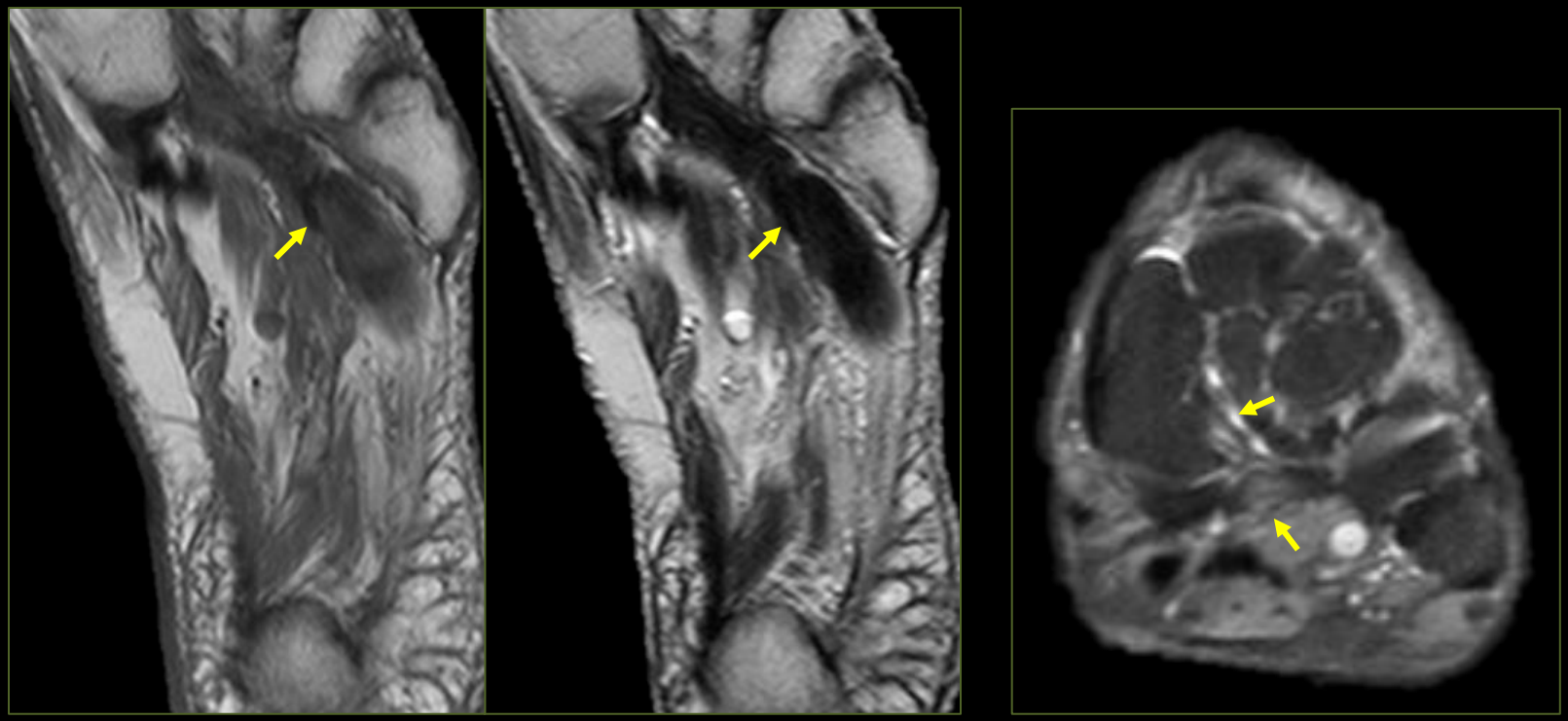
Hypermobility at TMT1 Joint as a Result of Hallux Valgus, rather than a Cause?

- Coughlin and Shurnas (2003) found normal first ray mobility (5mm) following TMT1 joint-sparing surgery for hallux valgus.
- Coughlin et al (2004) cadaveric study found normalization of first ray sagittal mobility (11mm to 5mm) following TMT1 joint-sparing surgery for hallux valgus.
- Rush et al (2000) showed that decreasing the first intermetatarsal angle improved first ray stability without a joint sacrificing procedure.
- Sarrafian (1987) raised importance of plantar aponeurosis in first ray stability.
- Grimes and Coughlin (2006) found generalized ligamentous laxity, including TMT1 joint, following MTP1 arthrodesis for hallux valgus, but clinical improvement. But Coughlin et al (2005) found that patients did not develop ligamentous laxity.

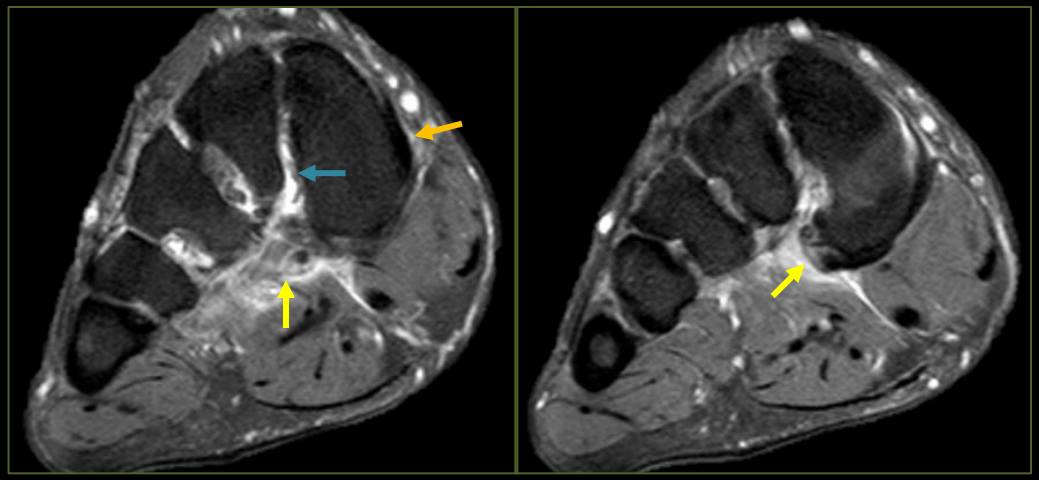
- Difficulty isolating motion at TMT1 joint for measurement

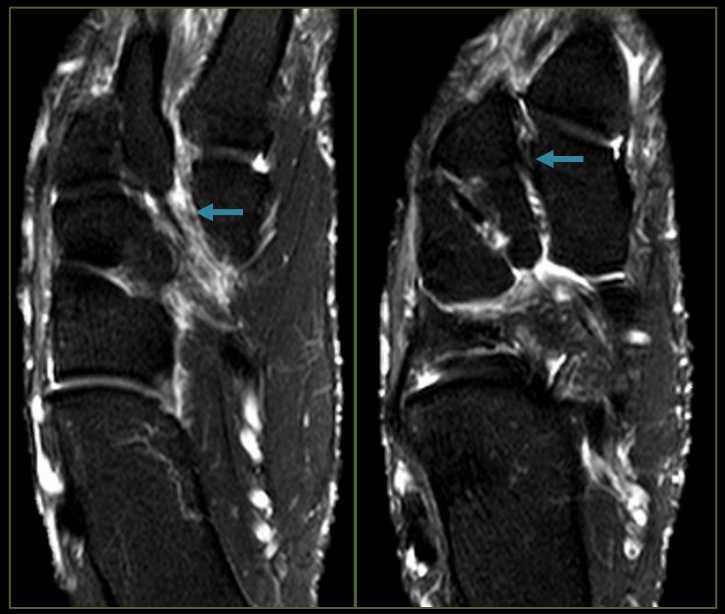
- Variation of osseous anatomy
  - Presence of interMT facet at MT1 base
  - Shape of MT1 base articular surface

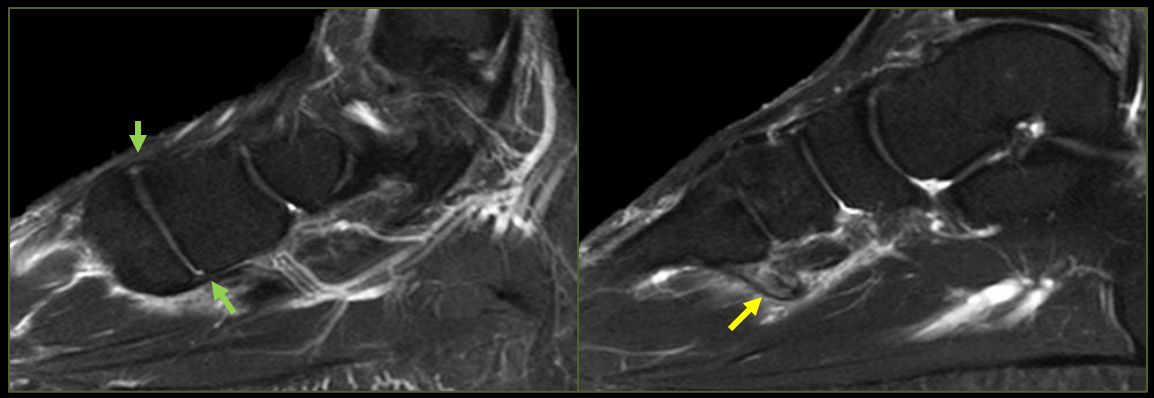
Tendinosis



PL Avulsion + Lisfranc Ligament Injury







Summary

- PL origin has tendinous and muscular components, and forms a musculotendinous arch for CPN.
- Muscle tear uncommon, but caution lateral compartment syndrome.
- Long tendon traverses 3 fibro-osseous channels.
  - Enclosed by tendon sheaths (common sheath with PB, separate sheaths at cuboid and plantar foot). Tenosynovitis may occur from multiple causes (stenosis, injury, systemic…).
  - Anchored by SPR and IPR, although intrasheath subluxation may occur
  - Fibrocartilaginous composition at pulleys is an adaptive feature that has implications for tendon degeneration, injury, and repair.
  - Variations of bone morphology predispose to tendinosis and tears.
- Tendon tears usually occur from level of fibula to cuboid, longitudinal split, chronic attritional.
- Tendinopathy may also involve distal PL, which contributes to TMT1 joint stability and has a close anatomic relationship with Lisfranc ligament complex.

Thank You

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