The ‘spring’ ligament and posterior tibial tendon function and dysfunction

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Calcaneonavicular (Spring) – Ligament Location, bony landmarks

- Tuberosity of the Navicular
- Plantar, medial aspect of the Talar Head
- Sustumtaculum Tali of the Calcaneus
The Spring Ligament ‘covers’ the medial and plantar articular surface of the Talar Head by ‘bridging’ the gap between the posterior/plantar navicular and the anterior calcaneus
‘Acetabulum Pedis’

• Early description by E.B Smith in 1896 cited in Mengiardi et al. 2005
‘Spring Ligament’ - function?

1. An important **static** stabiliser of the medial longitudinal arch forming the medial plantar articular surface for the talar head (Donato *et al.* 2013, Stadnick 2008)
2. Supports the talar head providing its medial and plantar articular surface (Mengiardi *et al.* 2005)
Other Ligamentous Static Stabilisers

1. (Medial) Deltoid Ligament comprising **superficially** – tibio-navicular, tibio-calcaneal and posterior tibio-talar ligaments and **deep** – anterior tibio-talar ligament

2. The Long and Short Plantar Ligaments
Other Static Stabilisers

3. The Talo-Calcaneal (interosseous) Ligament

4. The Plantar Aponeurosis
Dynamic Stabilisation of the Medial Longitudinal Arch

- Muscle Tibialis Posterior Tendon
- Navicular
- Spring Ligament

Stadnick 2008
Anatomy - Spring Ligament

A multi-ligament complex comprising 3 ligaments

- Superomedial ligament
- Medioplantar oblique ligament
- Inferoplantar longitudinal ligament

Comprises Type 1 collagen which confers the toughness through anisotropy (Sherman et al. 2015)

BUT has been found not to display elasticity or contain any elastic fibres (Davis et al. 1996) unlike ligaments which are generally viscoelastic, so the label ‘spring’ may be a misnomer (Mengiardi et al. 2005)
Schematic drawing of medioplantar aspect of the hindfoot shows the three components of the spring ligament complex

\[ iplCNL = \text{inferoplantar longitudinal CNL, } mCun = \text{medial cuneiform, } mpoCNL = \text{medioplantar oblique CNL, } nb = \text{beak of navicular bone, } nt = \text{tuberosity of navicular bone, } smCNL = \text{superomedial CNL, } sust = \text{sustentaculum tali, } tspL = \text{tibiospring ligament} \]

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Medioplantar view of spring ligament complex. Dissected cadaveric foot (left) and corresponding line drawing (right) show superomedial CNL (smCNL, solid arrows), medioplantar oblique CNL (mpoCNL, white arrowheads), and infero plantar longitudinal CNL (iplCNL, black arrowheads). " * = gliding floor of the PTT, which was removed. mCun = medial cuneiform, nb = beak of navicular bone, nt = tuberosity of navicular bone and insertion of medioplantar oblique CNL (open arrows), sust = sustentaculum tali.

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Superomedial ligament

- Strongest of the 3, most frequently injured – (Mengiardi et al. 2016)
- Histologically suited for significant load bearing (Davies et al. 1996)
- Proximal attachment – medial aspect of sustumtaculum tali
- Distal attachment – superomedial aspect of navicular (NOT THE TUBEROSITY)
- Mean thickness – 3.2mm (range 2-5mm) also widest (Patil et al. 2007)
- *Tendon of TP passes superiorly to ligament, articulates with it and is attached to it
- Ligament has a fibrocartilage layer covered with a single layer of synovial cells at the articular area of the TP tendon
- Deep portion has a fibrocartilage layer which articulates with the talar head

(Also attached to tibio-nav. ligament)

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View of the overlying tendon of muscle tibialis posterior

Navicular

Superomedial Ligament

Muscle Tibialis Posterior

Stadnick 2008
Medioplantar Oblique Ligament

- Proximal attachment – coronoid fossa of calcaneus (possible enthesis organ?)
- Distal attachment – medioplantar navicular
- Mean thickness – thinnest 2.8mm (range 1-5mm)
- Striated appearance – alternating bundles of collagen and fat – function unknown

Donato et al. 2013
Inferoplantar Longitudinal Ligament

- Proximal attachment – coronoid fossa of the calcaneus
- Distal attachment – inferior beak of the navicular
- Separated from medioplantar ob. lig. by fat layer 9the 2 ligs were originally thought to be one lig.
- Least likely to be injured
Muscle Tibialis Posterior (Tendon)

- **Origin** - posterior surface of the interosseous membrane; from the lateral portion of the posterior surface of the tibia, and from the upper two-thirds of the medial surface of the fibula.

- **Insertion** – *inferior aspect of navicular tuberosity*, strong fibrous slips to all tarsal bones except the talus, and attachment to the base of middle three metatarsals.

Romanes 1987
Pull of muscles around stj, ankle and long axis of the foot
Initial Contractions

- Action - active primarily/ eccentrically at contact of 5th met.head to footflat
- to powerfully control /alter timing of pronation moment at the sub talar joint
Tarsal Cross Bracing

- Phasic contraction of muscles peroneus brevis (and longus) occur after forefoot loading takes place
- Continues to centre weight medially throughout stance phase – antagonised by tibialis posterior
- Whilst ‘mid-tarsal locking’ is unclear, the stabilisation of the mid foot allows for increased power generation by gastrosoleus at heel off (Gluck et al. 2010). If the TP Tendon is damaged and/or the muscle is weak then this power may generate forces through the talonavicular joint and spring ligament rather than the met heads (Gazdag and Cracchiolo 1997)
Tibialis Posterior

• Resisting expansion at the distal tib./fib. joint (fibrous, syndesmotic joint, occasionally synovial) assists in providing ankle joint stability during plantarflexion.

• Allows movement (via quiescence) of the fibula superiorly during ankle joint dorsiflexion
Relationship between the spring ligament and the tendon of muscle tibialis posterior dysfunction

• Balen and Helms (2001) report a superom medial ligament thickness of above 5mm to be present in cases of tibialis posterior (TP) tendon dysfunction

• Mengiardi *et al.* (2005) found that this is nearer 4mm and also identified spring ligament injuries having a high association with TP tendon tears

• Jennings and Christensen (2008) spring ligament is a major stabiliser of the Medial Longitudinal Arch at mid-stance and the tendon of tibialis posterior cannot fully accommodate any insufficiency in it

• Orr and Nunley (2013) cautioned against rare cases where the TP tendon was normal but adult acquired flat foot existed – here spring ligament injury should be suspected

• Williams *et al.* (2014) identifies a strong association between spring ligament deformity (unspecified) and radiographic plano-valgus foot position

• Mengiardi *et al.* (2016) report that in most cases, spring ligament lesions are secondary to the tendon of tibialis posterior dysfunction
Clinical Symptoms of Spring Ligament damage

• Clinical symptoms - similar to stages of posterior tibial dysfunction. Usually poor heel lift test and everted heel position but powerful TP resisted concentric contraction

• Acute stage - vague, activity-related pain at medial ankle and foot with too many toes sign on standing

• Difficulty with balance and walking on uneven ground.

• Chronic - (as pes planovalgus deformity progresses) - activity related pain in the sinus tarsi at the lateral malleolus,

• Resistant to treatment interventions for TP tendon dysfunction
Testing for Spring Ligament Integrity – Neutral Heel Lateral Push Test

• Pasapula et al. 2015 – describe a clinical test to apply if there is suspicion of isolated spring ligament damage when persistent mid foot pain is present following trauma and consequent pes planus
Stages

- Stage 0 – Spring ligament failure/laxity/give but no tendonopathy or planovalgus
- Stage 1 – Spring ligament give with tendonopathy but normal tendon length and no deformity
- Stage 2 – Spring ligament failure with tendon lengthening and flexible planovalgus deformity
- Stage 3 – Spring ligament failure with tendon lengthening and fixed planovalgus deformity