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Neutral heel lateral push test: The first clinical examination of spring ligament integrity

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HIGHLIGHTS

- Spring ligament is the primary supporting structure against planovalgus deformity.
- We examined 21 cadaveric specimens in a standardised and reproducible manner.
- Mean lateral translation increased most significantly when spring ligament released.
- Neutral heel lateral push test can determine spring ligament integrity.

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ABSTRACT

Introduction: The spring (calcaneonavicular) ligament is an intricate multiligament complex whose primary role is to stabilise the medial longitudinal arch and head of talus. Clinical suspicion of a spring ligament injury in isolation is roused when persistent medial midfoot pain is present with associated pes planus following trauma.

Method: We undertook a cadaveric study on 21 specimens to assess the use of a neutral heel lateral push test to examine the spring ligament in a standardised procedure, measuring lateral translation with graduated antegrade and retrograde defunctioning of surrounding structures and the spring ligament.

Results: In all specimens, a significant displacement occurred on incision of the spring ligament regardless of order of dissection. The degree of displacement increased by an insignificant amount as surrounding structures were incised at each incremental force applied.

Discussion: The neutral heel push test is the first clinical examination to be described to determine integrity of the spring ligament complex. Our study objectively demonstrates that lateral displacement in relation to the mid and hind-foot is influenced most significantly by the integrity of the spring ligament and to a lesser extent by tibialis posterior and flexor digitorum longus.

1. Introduction

The spring ligament (calcaneonavicular ligament) is an intricate and substantial multiligament complex comprising of 3 main components including the inferoplantar, medioplantar and superomedial calcaneonavicular ligaments. Its primary function is to stabilise the medial longitudinal arch and head of the talus [1,2].

Clinical suspicion of a spring ligament injury in isolation is roused when persistent medial midfoot pain is present with associated acute pes planus following trauma. The typical mechanism is forceful landing on a flatfoot [1,3].

Furthermore, spring ligament deficiency is often present but not specifically tested for clinically in tibialis posterior (TP) tendon dysfunction which results in the adult acquired pes planus. The senior author believes that planovalgus occurs primarily due to spring ligament (SL) rupture and TP dysfunction may occur as a consequence of this failure and subsequently becomes tendinopathic with tears and synovitis. In assessing for different components of TP dysfunction such as tight gastrocsoleus with Silfverskiolds test and medial column instability at the TMT joint with Klaus's criteria and fixed supination deformity, we believe that the SL function can be isolated and tested for [4]. There are no specific tests to date to assess the integrity of the SL and reliability of MRI and US in assessing the

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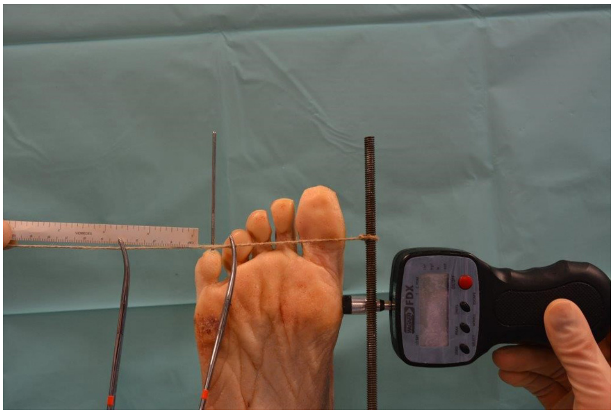

Fig. 1. Photo of the procedure setup.

SL is not proven and often not looked for. Early ability to recognise this without MRI/US to aid diagnosis may allow earlier treatment and prevent secondary planovalgus and TP dysfunction.

Previous cadaveric studies show the anatomic complexity of the SL and its importance in supporting the medial longitudinal arch of the foot but none have proposed a clinical examination to diagnose suspected SL disruption in the acquired flatfoot [1].

A cadaveric based study was therefore undertaken to assess the use of the neutral heel lateral push test to examine the SL.

2. Methods

We undertook a cadaveric laboratory based study on 21 through knee fresh frozen cadaveric specimens in a standardised and reproducible method. This also ensured the proximal integrity of the origins of the long flexors.

In performing this examination, the tibiotalar joint must be held in dorsiflexion or within 20 degrees of neutral dorsiflexion. A preliminary attempt of the test showed large variability in results when the heel was plantarflexed. We believe this was due to a lack of referencing point on the tibia and the fact that a thinner part of the talus was engaged in the mortise resulting in increased mediolateral movement of the foot, which could not be isolated from the give of the spring ligament. The heel was held in neutral with the second toe aligned to the tibial shaft or in slight varus. This would help defunction the medial supporting structures of the tibialis posterior and flexor digitorum longus and help isolate the spring ligament. The tibiotalar joint was held in neutral/slight plantarflexion using cross Kirschner wires for the purpose of the study (see Figs. 1 & 2).

At this point any lateral movement of the midfoot by applying lateral force to the medial midfoot is hypothesised to be due to failure of the spring ligament only and not the long tendons.

2.1. Procedure

Each specimen was clamped onto the dissecting table with a calcaneal rod perpendicular to the calcaneum so toes were pointing vertically. The proximal leg was stabilised as proximally as possible to the table in order not to tether the long flexor tendons. The tibiotalar joint was stabilised with two 2 mm crossed Kirschner wires. A 1.6 mm Kirschner wire was inserted into the little toe vertically to enable accurate measurements of translation to be made from the point of entry into the toe. A vertical rod adjacent to the big toe was clamped in place with a piece of string attached at the same vertical level that the Kirschner wire enters the little toe, allowing measurements to be made in the same plane to reduce measurement error. The starting point was marked on the string for each specimen (represented in Fig. 1).

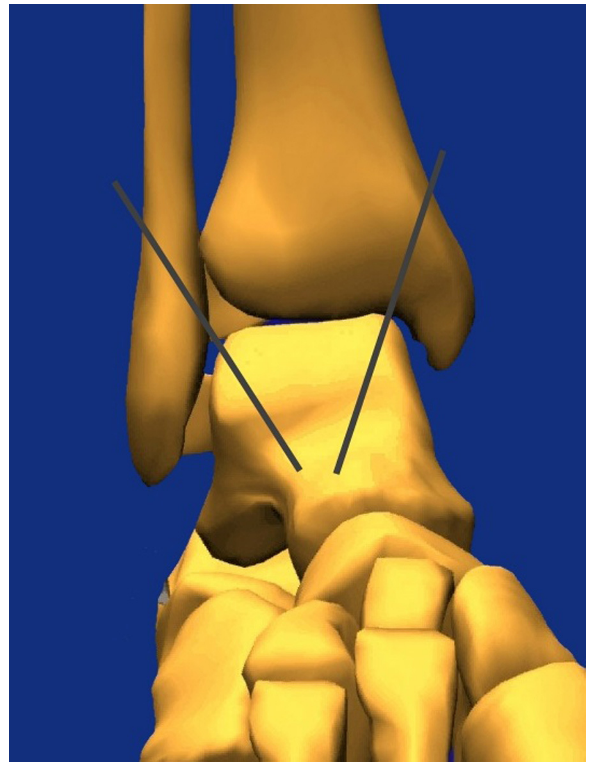

Fig. 2. Picture of Kirschner wire positioning.

Translation was measured from neutral resting point to maximal displacement with a controlled medial force at the metatarsophalangeal joint of the big toe applied with a digital calibrated algometer (tekscan). Any pre-existing first ray pathology such as hallux valgus would not make a difference as this would be absorbed in the force applied.

The foot was then ensured that it returned to the same position prior to the test.

The force was applied in increments of 5 Newtons (N) up to 25 N to ensure translation end-point had been achieved. A 25 N force represents 2.5 kg weight acting downwards. We still consider this to be quite small compared to the actual forces that go through the spring ligament of 70 kg/700 N. This was repeated 3 times for each reading and a mean was taken for each value. The person applying the pressure was blinded from the person recording the translation.

Readings were taken in the following scenarios of sequential sectioning:

1. All supporting ligaments and tendons intact.
2. As 1 with tibialis posterior (TP) incised.
3. As 2 with flexor digitorum longus (FDL) incised and TP incised.
4. As 3 with spring ligament (SL) complex incised as well as the FDL and TP.

This was then done in reverse with:

1. All supporting ligaments and tendons intact.
2. As 1, with SL complex incised.
3. As 2, with SL and FDL divided.
4. As 3, with TP divided.