Contribution to the Anatomical Description of the Medial Ankle Ligament Complex

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Abstract. The medial collateral ligament of the ankle has two planes: superficial and deep. It is more resistant than the lateral collateral ligament and its damage is most often accompanied by malleolar fractures. Our work focuses on the anatomical characteristics of this ligament. *Material and methods.* Twenty-four fresh ankles were dissected. The number of bundles, dimensions and relationships with neighbouring structures were studied. *Results.* The medial collateral ligament consisted of two layers; deep and superficial. The tibio-navicular, tibio-spring, tibio-calcaneal ligaments in the superficial plane and the anterior and posterior tibiotalar ligaments in the deep plane are always present. The posterior tibio-calcaneal is the longest, the tibio sprig the thinnest and the tibio navicular the widest. The flexor tendons cover this ligament. In 65% of cases, the superficial layer completely covers the deep layer. In 35% of cases, the deep layer is visible through a posterior angle. *Conclusion.* The medial collateral ligament is stretched in plantar flexion; its rupture is rare and is usually accompanied by a malleolar fracture. Macroscopic and morphometric knowledge of this ligament can serve as a basis for understanding the mechanisms of injury and for surgical reconstruction.

Key words: Anatomical dissection, ankle, medial ligament, description

Introduction

The ankle is a highly congruent joint, formed by the talocrural and distal tibiofibular (Kamina, 2009; Lee et al. 2019; Mengiardi, Pinto, & Zanetti, 2016; Paturet, 1951). Its congruence is passively ensured by the collateral ligaments, which are the real means of restraint (Frank, 2004). The medial collateral ligament is one of the stabilising factors. It consists of two planes, superficial and deep.

The deltoid ligament, representing the superficial plane, is triangular, hence its name from the Greek Delta. It is solid and indispensable for the medial stability of the ankle *and thus crosses two joints; the subtalar and the talocrural.*

It is a multifascicular ligament is inserted between the medial malleolus, the talus, the calcaneus and the navicular bone; the classic works most often describe three to four fascicles for this plane (Chevallier, 1998; Earll et al., 1996; Frank, 2004; Kamina, 2009; Lee et al., 2019; Mengiardi, Pinto, & Zanetti, 2016; Paturet, 1951; Rouviere & Delmas, 2002):

- A posterior tibio-calcaneal bundle, a middle bundle, an anterior tibio-navicular bundle, and a superficial posterior tibio-talar bundle.

According to Testut and Latarjet (1902), only the ventral and middle fibres form the deltoid ligament, which Farabeuf called the tibio-naviculo-glenoid-sus-tacular ligament. It is covered in its entirety by the flexor retinaculum except for its ventral part, which is covered by the tendon of the tibialis anterior muscle. The tendon of the posterior tibialis and the flexor hallucis longus cross and cover the middle and posterior bundles.

The deep plane is a short, thick ligament, separated from the superficial layer by a cellular interstice, and consists of two bundles: an anterior and posterior bundle.

The deep ligament runs through a single joint, the talocrural.

Injury to the medial collateral ligament is most often accompanied by a fracture of the lateral malleolus and damage to the tibiofibular syndesmosis (Benassayag et al., 2010;

Chevallier, 1998; Earll et al., 1996; Frank, 2004; Kamina, 2009; Lee et al., 2019; Mengiardi, Pinto, & Zanetti, 2016; Paturet, 1951; Rouviere & Delmas, 2002; Omar et al., 2016).

The surgeon is thus faced with several diagnostic and therapeutic challenges and most current repair techniques involve direct repair of capsular and deltoid injuries (Lee et al., 2019).

The prevalence and size of its components are variable in the literature and there is no established consensus regarding its exact description.

Our work is a contribution to the anatomical description of this ligament.

Material and Methods

We worked on twenty-four specimens between fresh and formaldehyde embalmed ankles, the number of bundles, the dimensions, the relationships with the neighbouring structures were studied.

The equipment used was a basic dissection kit (forceps, scalpels...), a millimetre ruler, a scale protractor, a camera.

Results

Anatomical dissection of twenty-four ankles with an average age of 78 ± 2.85 revealed:

Three bundles in 100% of the cases formed the superficial plane (Figure 1):

1. The posterior tibiocalcaneal bundle, the strongest, attaches to the tubercle on the medial side of the calcaneus (sustentaculum tali). It is the shortest: 18.8 ± 2.03 mm in length.

2. The middle bundle; the tibiospring is vertical and attaches to the beak of the calcaneal process. It is the thinnest ligament: 10.3 ± 1.03 mm wide.

3. The anterior bundle, the tibionavicular, ends on the posteromedial part of the navicular bone. It is the widest ligament: 12.4 ± 1.42 mm.

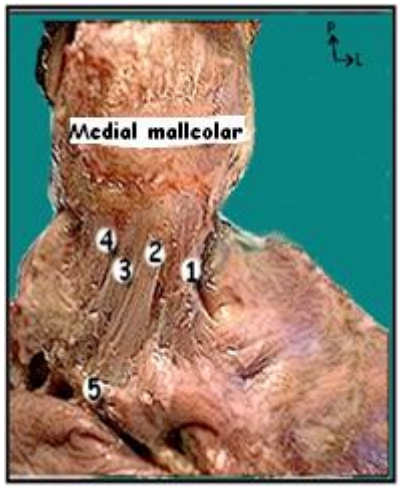

Figure 1. Medial views of a left ankle showing the bundles of deltoid ligament

Note: 1- Anterior bundle of the deltoid ligament; 2- Middle bundle of the deltoid ligament; 3- Posterior bundle of the deltoid ligament; 4- Posterior beam of the deep plane; 5- Sustentaculum tali

The deep plane comprises 02 bundles in 100% of cases:

- An anterior bundle: the anterior tibiotalar ligament, extending from the ventral border of the medial malleolus to the medial part of the talus collar.

- A posterior bundle: the posterior tibiotalar ligament, oblique posteriorly, stretching from the distal part of the medial malleolus to the medial tubercle of the dorsal aspect of the talus (Figure 2).

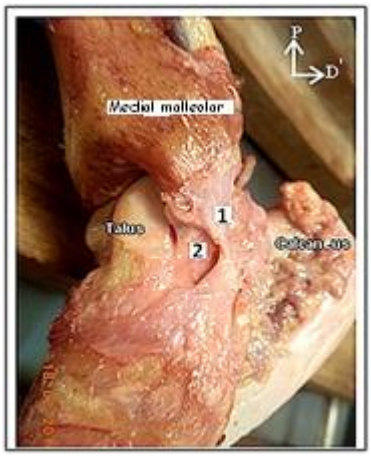

Figure 2. Medial views of a right ankle showing the deep plane of the medial collateral ligament (2) after section of the deltoid ligament (1)

The flexor tendons cover the medial ligament complex (MLC). In 65% of cases, the superficial layer completely covers the deep layer.

- In 35% of cases, the deep layer is visible through a posterior angle (Figure 3).

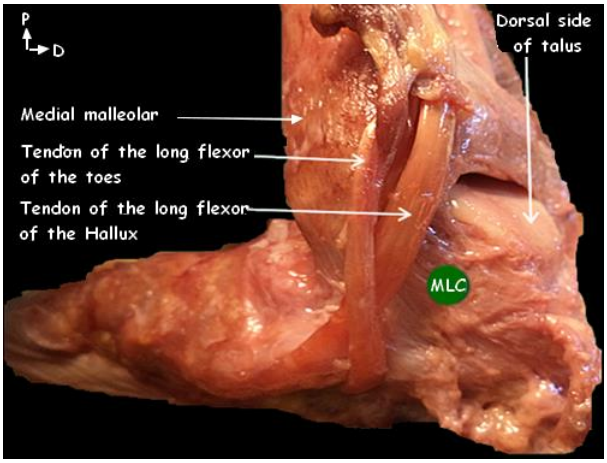

Figure 3. Medial view of the ankle showing the relationship of the medial collateral ligament to the tendons of the flexor muscles

The dimensions of the deltoid are shown in Table 1 and Figure 4.

Table 1. Dimensions in mm of deltoid's bundles

Deltoid ligament	Length	Width
Posterior bundle	18,8 ± 2,03 mm	11,4 ± 1,62 mm
Middle bundle	21,4 ± 2,22 mm	10,3 ± 1,03 mm
Anterior bundle	19,5 ± 2,50 mm	12,4 ± 1,42 mm

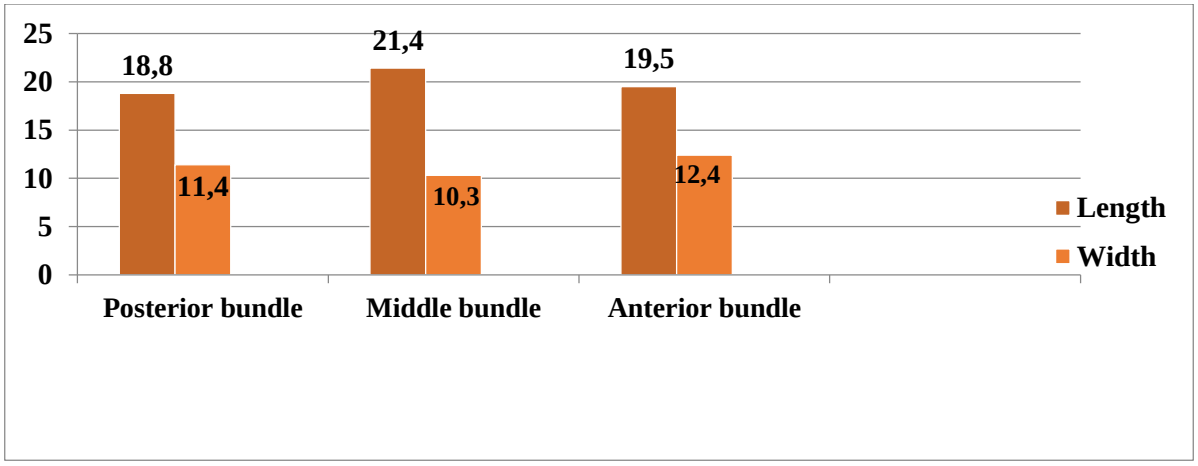

Figure 4. Dimensions in mm of the superficial layer bundles of the MCL

Note: The middle bundle is longer than the other bundles due to its vertical direction from the medial malleolus to the sustentaculum tali of the calcaneus

Discussion

The anatomical description of the medial collateral ligament varies widely, but there is agreement that it is composed of two planes, superficial and deep. For some, the deltoid represents the superficial plane, and for others it is the medial complex. It is a multifascial ligament comprising 03 to 04 bundles on the surface, and 02 bundles in depth.

Some studies classify the medial ligament into four types according to the combinations of these components (Won, Koh, & Won, 2016):

Type I: all components were present (48.3%),

Type II: the tibionavicular ligament was absent in (36.7%),

Type III: only the superficial posterior tibiotalar ligament was absent in (6.7%),

Type IV: only the anterior tibiotalar ligament was absent in (8.3%).

In our study, only the superficial posterior tibiotalar ligament was absent, and according to the classification, our medial ligament would be type III. This is in line with the Meta-analysis by Yammine (2017), who concludes that it is the ligament of the month.

The possible absence of a component, especially the superficial layer, could compromise joint stability in acute ankle injuries (Yammine, 2017).

The tibionavicular ligament was the thinnest of all the components of the deltoid ligament in our study, which corroborates with the findings of Yammine (2017).

The tibiocalcaneal ligament is the shortest and strongest. It plays the most important role in lateral stability by acting in conjunction with the calcaneofibular ligament according to Benassayag et al. (2010).

On the other hand, according to some studies, sectioning of the tibiocalcaneal fibres results in the most significant tibiotalar changes ($P < 0.0001$) compared to sectioning of the other deltoid ligament bundles (Earll et al., 1996).

The dimensions are highly variable and our results are similar to those of Benassayag et al. (2010), Omar et al. (2016).

The tibiospring was the thinnest and longest

The tibiocalcanean was the shortest and the tibio-navicular the widest.

The deep bundles, although present, were intricate and poorly individualised in our study.

Medial collateral ligament injuries are most often associated with lateral collateral ligament injuries and tibiofibular syndesmosis, as well as malleolar fractures, and reparative and reconstructive treatment strategies can be used for complex acute injuries or chronic medial ankle instability (Mengiardi, Pinto, & Zanetti, 2016).

Conclusion

Knowledge of the morphological and morphometric characteristics of the medial ligament is useful not only for surgical interventions on the ankle but also for radiological explorations of this very often-traumatized region.

Declaration of Interest

The authors declare that they have no links of interest.

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