

MORPHOMETRIC STUDY OF CALCANEOFIBULAR LIGAMENT OF ANKLE

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ABSTRACT: The ligaments of the ankle joint are medial and lateral collateral ligaments. Medial deltoid ligament has superficial and deep components. Lateral collateral ligament has Anterior Talofibular (ATFL), Calcaneofibular (CFL) and Posterior Talofibular ligaments (PTFL) as three discrete parts. Ankle sprains are most common in athletes and in other sports like basketball, soccer, football and volleyball. Lateral ankle sprains account for about 85% of all ankle sprains; with anterior talofibular ligament being the most frequently injured. A total rupture involves the calcaneofibular ligament and the posterior talofibular ligaments as well. An eversion injury will cause damage to the deltoid ligaments. Morphometry and variations of ligament of ankle has not been well documented in literature. Hence this study has been taken up. Study was done by dissection on 60 cadaveric lower limbs, irrespective of sex from the Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore. The mean values of length, width, and thickness of CFL was found to be 27.00mm, 5.45 mm, 1.64mm respectively. The detailed anatomical knowledge of these ligaments, variations and their relations with osseous structures may provide a foundation for understanding the basic mechanism of injury, diagnosis and reconstructive procedures.

KEYWORDS: Ankle joint, Calcaneofibular Ligament, Morphometry.

INTRODUCTION: Ankle joint (talocrural) is a hinge joint, formed by the lower end of tibia, its medial malleolus, together with the lateral malleolus of the fibula and inferior transverse tibiofibular ligament, forms a deep recess for the body of the talus.¹ The ligaments of the ankle joint are medial and lateral collateral ligaments.¹ Medial deltoid ligament has superficial and deep components. Lateral collateral ligament has Anterior Talofibular (ATFL), Calcaneofibular (CFL) and Posterior Talofibular ligaments (PTFL) as three discrete parts. These two major ligamentous complexes are the main stabilizers of ankle joint which are appreciated both in MRI and cadaveric dissections.



Fig. 1: Normal lateral collateral ligament complex of ankle joint

Ankle injury varies among sports and is highest in basketball, ice-skating and soccer. There appears to be no relationship between the type of sport and risk of ankle injury in collegiate athletics (at least among men). However, an athlete's sex, foot type and generalized joint laxity may affect his or her risk of ankle injury.²

The CFL is a cord like ligament, arises from the distal part of the anterior margin of the lateral malleolus, just below the origin of the inferior band of the ATFL centred 8.5 mm from the distal tip. The origin does not extend to the tip of the lateral malleolus, which is left free. Near the origin, archi form fibres may unite the CFL and the inferior band of the ATFL. In some cases, the CFL attaches predominantly to the ATFL.

The CFL runs obliquely downwards and backwards to be attached to the lateral surface of the calcaneus. The bony landmarks on the calcaneus for the attachment of the CFL are vague; therefore, many physicians do not know the precise anatomic points where this should be attached. The CFL inserts on a small tubercle, located on the posterior aspect of the lateral calcaneal surface, postero superior to the processus trochlearis of the peroneal muscles.³ CFL crosses the posterior subtalar joint and is separated from it by the lateral talocalcaneal ligament (TCL). The interval between the two ligaments is filled with adipose tissue.⁴

The fibres connecting ATFL and CFL ligaments can be observed. In the neutral ankle position, the ligament runs obliquely downwards and backwards and gets attached to the posterior region of the lateral calcaneal surface. This ligament is superficially crossed by the peroneal tendons. The CFL becomes horizontal during extension and vertical in flexion, remaining tense throughout its entire arc of motion.

The angle formed by the ligament and the longitudinal axis of the fibula considerably changes with valgus or varus position of the talus. This explains the potential for injury even without dorsiflexion – plantar flexion movement in the ankle.⁵ Study on the maximal elongation of the ligament during extreme inversion and simultaneous dorsal flexion verified that women presented a greater elongation compared to men.⁶

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MATERIALS AND METHODS: Study was conducted on 60 formalin fixed adult cadaveric lower limbs, irrespective of sex from the Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore. Cadavers with congenital abnormalities of ankle like club foot or congenital Talipes Equino Varus were excluded from the study. The study was done by dissection according to Cunningham's manual.

The ligament length was measured from one insertion point to another on the opposite borders of the ligament, i.e., free length. Width was measured at three points; proximal insertion site, the distal insertion site and midway between the two. Values were compared with previous studies for their statistical significance.

RESULTS: The insertion averages 8.2 mm in the sagittal direction and 6.2 mm in the coronal direction. The origin does not extend to the tip of the lateral malleolus, which is left free. Near the origin, archi form fibres may unite the CFL and the inferior band of the ATFL. In some cases, the CFL attaches predominantly to the ATFL.

CFL	MIN	MAX	MEAN	< MEAN		> MEAN	
				n	%	n	%
Length	18.96	36.42	27	29	48	31	52
Width	3.3	7.4	5.5	30	50	30	50
Thickness	0.76	2.83	1.65	33	55	27	45

Table 1: Maximum. Minimum and Mean values of CFL in dissected specimens

The mean values of length, width, thickness of CFL irrespective of side were 27 ± 3.89 , 5.5 ± 1.12 and 1.65 ± 0.43 respectively. The mean CFL length in left ankle and right was found to be 26.72 ± 3.52 mm and 27.22 ± 4.25 mm respectively. The mean CFL width in left and right ankle was found to be 5.33 ± 0.26 mm and 5.55 ± 0.17 mm respectively. The mean CFL thickness in left and right ankle was found to be 1.68 ± 0.07 and 1.62 ± 0.09 respectively.



Fig. 2: Calcaneofibular ligament in one of the dissected specimen

We didn't find any multifascicular form of CFL in our dissections.

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Parameters of CFL	Side	N	Mean	Std Dev	SE of Mean	Mean Diff	T	p
Length	Left	26	26.72	3.52	0.69	-0.501	-0.487	0.628
	Right	34	27.22	4.25	0.73			
Width	Left	26	5.33	1.30	0.26	0.226	-0.767	0.446
	Right	34	5.55	0.98	0.17			
Thickness	Left	26	1.68	0.35	0.07	0.052	0.449	0.655
	Right	34	1.62	0.50	0.09			

Table 2: Comparison of CFL dissection parameters-between right and left ankles

No significant differences was observed between right and left side with respect to mean of various parameters of CFL dissection ($P>0.05$). Out of total 60 specimens, we found in 10 ankle specimens, calcaneofibular ligament had a common origin with the anterior talofibular ligament amounting to 16.6%.

DISCUSSION: Ankle sprains are common: one estimate is that there is one per day per 10 000 of the population. Rupture of ligaments is more common in sportsmen. It is known that the anterior talofibular ligament is almost always the first or only ligament to rupture. It was found that combined ruptures of the anterior talofibular and calcaneofibular ligaments occurred in 20% of cases and that the calcaneofibular ligament alone very rarely ruptured.⁷

The Calcaneofibular ligament is strong and important for joint motion and is involved in 50- 75 % of acute lateral ankle sprains. It originates from the lower segment of the anterior border of the lateral malleolus and after a posterior, inferior and medial course inserts on a small tubercle on the lateral calcaneal surface. The ligament is extra capsular and cord like. Its appears to limit talar tilting in dorsiflexion and Talocalcaneal adduction while the CFL and the Tibiocalcaneal ligament fibers along with the relevant bones guide the ankle motion, being isometric during passive flexion.⁶ The comparison of length and width of CFL of present study with the previous study has been listed and discussed below.

Studies	CFL length in mm	CFL width in mm
Siegler et al (1988)	27.69±3.3	--
Burks and Morgan (1994)	35.8	5.3
Milner and Soames (1998)	19.5±3.9	5.5±1.6
Muzaffer Sindel et al (1998)	26.8	6.0
Taser et al (2006)	31.94±3.7	4.68±1.3
Mahmut ugurlu et al (2010)	26.67	4.57
P Kitsoulis et al (2011)	31.8	4.4
Present study	27.0±3.89	5.45±1.11

Table 3: Comparison of length and width of Calcaneofibular Ligament (CFL) in mm in different studies

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Studies	CFL thickness in mm
Dimmick S Kennedy et al (2009)	2.13±0.5
P Kitsolis et al (2011)	1.58
Present Study	1.64±0.43

Table 4: Comparison of CFL thickness of the present study with the previous studies

Variable insertion for CFL was noted in a study on 750 calcanei. The location of calcaneal insertion of CFL was typically located in 67.5%, anterior location in 24.5%, posterior location in 5.5% and downward location in 4.5%. Taser et al concluded that the variable insertion of CFL to calcanei results in variable obliquity and angles of the ligaments relative to the long axis of the fibula, coronal and sagittal planes.

Calcaneal insertion points and the exact location of the ligaments may guide surgeons during ligament reconstruction surgeries.⁸ The mean length of the present study 27.0±3.89mm was close to reported values of Siegler et al (1988) which was 27.69±3.3mm and the width of the present study 5.45±1.11mm was close in accordance with the study by Milner & Soames (1998) which measured 5.5±1.6mm and also with Burks and Morgan which was 5.3mm.

Thickness of CFL in the present study measuring 1.64±0.43 mm was almost in accordance with the study of P. Kitsolis et al which measured 1.58mm. The length measurements by Burks and Morgan were taken differently than other investigators mentioned. They measured the longest fibers of the ligament and not from one insertion site to another insertion site. As a result the dimensions reported by Burks and Morgan are longer than those observed in this study measuring 35.8mm.

The number of bands forming the CFL plays an important role in the ligament's function. Kitsouli et al found 52 cases of single band, 16 cases of double band and 3 cases of triple banded specimens in his 72 dissections.²³ In the present study, we found no multiple fascicles, which is in accordance with the previous study by Muhle et al who found no multiple fascicles in six cadaveric specimen study using MRI depiction.

Found that women presented a statistically significant greater elongation of calcaneofibular ligament than did men measuring 3.32mm and 2.63mm respectively. This could be explained by the fact that women have differences in the foot anatomy and are expected to have more lax ankle joints. It is also known that tendons contain oestrogen receptors and thus can be affected by female hormones.

It is proven fact that calcaneofibular ligament elongation is critical for the stabilization of the subtalar and ankle joint during ankle sprains. They also concluded that male and female ankle joints differ in several anthropometric characteristics and thus the gender differences in the ligament elongation are of great interest. (Kitsoulis) The obliquity of the ligament is also variable with the position of the ankle joint and is separated from it by the lateral talocalcaneal ligament.

The interval between the two ligaments is filled with adipose tissue.⁸

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The ligament length is the most critical factor affecting talar tilt and ankle joint instability after an injury.⁹ Knowledge of ligament orientation is critical for the detection of ankle ligament injuries via arthrography, arthroscopy, stress radiographs and MRI.

CONCLUSION: The mean length, width and thickness of CFL were found to be 27.0 ± 3.89 mm, 5.45 ± 1.11 mm and 1.64 ± 0.43 mm respectively. There was no statistical significance in the length, width and thickness parameters of any of the lateral collateral ligaments between right and left ankles.

These data may be of value when considering surgical repair or reconstruction of traumatized collateral ligaments, especially because any undue foreshortening of the ligaments may reduce the range of motion possible at either the ankle or subtalar joints, or both. It is possible that in extreme cases, such a reduction in the range of motion may modify gait patterns and the transmission of stresses across the joints of the foot and the lower limb.

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