ORIGINAL ARTICLE

MORPHOMETRIC STUDY OF ANTERIOR TALOFIBULAR LIGAMENT OF ANKLE

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ABSTRACT: Ankle joint (talocrural) is a hinge joint. The ligaments of this 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. These two major ligamentous complexes are the main stabilizers of ankle joint which are appreciated both in MRI and cadaveric dissections. 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. Morphometry and variations of ligaments of ankle has not been well documented in literature. Hence this study was 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. By dissection, both single (18%) as well as double banded (82%) ATFL were found. The average length and width of ATFL irrespective of side was noted. There was no statistical significance in the values between the right and the left ankles. The data represented in this study may be important when considering surgical repair or reconstruction of traumatized or attenuated collateral ligaments.
KEYWORDS: Ankle joint, Anterior Talofibular Ligament, Ankle Sprains, Morphometry.

INTRODUCTION: "Ligament" most commonly refers to a band of tough, fibrous dense regular connective tissue bundles, made of attenuated collagenous fibres; with said bundles protected by dense connective tissue sheaths. Ligaments connect bones to other bones to form a joint. Some ligaments limit the mobility of articulations, or prevent certain movements altogether.

The ankle or talocrural region is the region where the foot and the leg meet.[1] The ligaments of this 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 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. Acute injuries of the ankle are the most common type of injury seen by general practitioners and emergency departments. They involve about 25% of all injuries of the musculoskeletal system with over 20000 cases occurring in USA every day. Inversion trauma constitutes a large percentage of these injuries. In about 10% to 15% of all inversion injuries, there is rupture of the lateral ligaments of the ankle with involvement of the anterior talofibular ligament.[2]

The Anterior TaloFibular Ligament (ATFL) is the most frequently injured ligament of the ankle. This ligament plays an important role in limiting anterior displacement of the talus and plantar flexion of the ankle.[3]

The ATFL is the weakest of the three lateral ankle ligaments, having the least elastic transformation properties. The ATFL is a flat, quadrilateral ligament that is incorporated in the joint capsule and passes from the distal area of the anterior margin of the lateral malleolus to the body of the talus just in front of the cartilaginous margin of its lateral articular surface. The ligament is approximately 6-10 mm in width, 15–20 mm in length and 2 mm in thickness.[4]

The Centre of the ligament is on an average of 10mm proximal to the tip of the fibula as measured along the axis of the fibula. The overall width does not appear to vary greatly irrespective of the number of bands present, suggesting that the variations observed do not modify the ligaments function. They also described that, in plantar flexion, the inferior band of the ligament remains relaxed while the upper band becomes taut. In dorsiflexion, the upper band becomes relaxed and the inferior band becomes tight.[5]

It is typically composed of two separate bands. The bands are separated by vascular branches from the perforating peroneal artery and its anastomosis with the lateral malleolar artery. The ligament is virtually horizontal to the ankle in the neutral position but incline upward in dorsiflexion and downward in plantar flexion.

There is a proven connection between the hormone estrogen and ligament injuries. More than other ligament injuries elsewhere in the body, knee ACL (anterior cruciate ligament) injuries are more common in women. Because of the presence of high estrogen and its receptors at the joints there are more chances of ligament injury under load and pressure in women.

The estrogen hormone affects collagen synthesis – specifically formation of fibroblasts, which are cells that make up collagen. This has been studied in another area of high ligament activity, the wrist, linking carpal tunnel syndrome prevalence to women with estrogen and progesterone receptor activity. Sex hormones such as estrogen and progesterone also affect water retention, and this can increase swelling within the synovium, which is the soft tissue found between joints.[6]

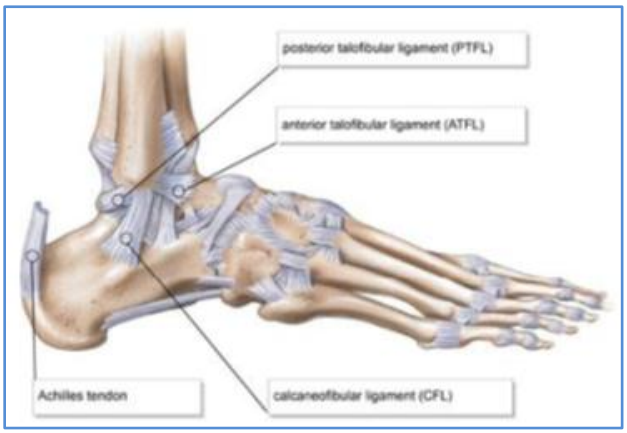

Fig. 1: Normal lateral collateral ligament complex of ankle joint

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 Talipus EquinoVarus were excluded from the study. Dissection of ankle region was done according to Cunningham's manual.

Variations of the ligament were noted. The length and breadth were measured. 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 for ATFL. Values were compared with previous studies for their statistical significance. The data obtained was analyzed by computing descriptive statistics arranged in tabular form and compared with the other studies available in the literature and conclusions were drawn.

RESULTS: Both double as well as single banded ATFL were found in the present study. Double banded ATFL had superior as well as inferior bands.

Fig. 2: Ankle specimens with single and double banded ATFL

Banding pattern of ATFL	N	%
Single banded	11	18
Double banded	49	82
Total specimens	60	100

Table 1: Total number and percentage of single and double banded ATFL

Out of 11 single banded 8 were found in right ankle and 3 in left ankle. Out of 49 double banded, 26 were found in right ankle and 23 were found in left ankle.

The average values of length and width are calculated by mean±SD.

Sl. No	Banding pattern of ATFL	Length in mm(Mean±SD)	Width in mm(Mean±SD)
1.	Single band	21.00± 3.38	6.91±1.02
2.	Superior band	18.75±2.54	7.31±1.25
3.	Inferior band	16.75±2.46	6.31±1.13

Table 2: Mean values of length and width of single as well as superior and inferior bands of double banded ATFL

The mean length of single banded ATFL in right and left ankle was 22.03±3.32 and 18.13±1.27 respectively. The mean width of single banded ATFL in right and left ankle was 6.65±1.01 and 7.6 ± 0.76 respectively.

	Right ankle- 26 Length & width in mm(µ±SD)	Left ankle-23 Length & width in Mm(µ±SD)
Superior band length	19±2.55	18.46±2.54
Superior band width	7.36±1.32	7.25±1.20
Inferior band length	16.24±2.55	17.33±2.26
Inferior band width	6.1±1.16	6.55±1.08

Table 3: Length and width of superior and inferior bands of double banded ATFL

Parameters of ATFL	Side	n	Mean	Std. dev	SE of mean	Mean diff	t	P value
Superior band length	Left	26	18.57	2.35	0.46	-1.045	-1.436	0.156
	Right	34	19.61	3.08	0.53			
Superior band width	Left	26	7.32	1.16	0.23	0.141	0.442	0.660
	Right	34	7.18	1.27	0.22			
Inferior band length	Left	26	17.34	2.27	0.47	1.100	1.589	0.119
	Right	24	16.24	2.54	0.50			
Inferior band width	Left	26	6.57	1.08	0.23	0.490	1.528	0.133
	Right	34	6.08	1.15	0.23			

Table 4: Student T Test to evaluate The Level Of Significance In different parameters Of ATFL between right and left ankles

No significant difference is observed between right side and left side with respect to the mean of various parameters in ATFL – dissection (P>0.05). Also, since the study was done on disarticulated lower limbs irrespective of sex, variation of the morphometry of anterior talofibular ligament between males and females couldn't be done.

DISCUSSION:

A) **Banding pattern of ATFL:** In literature, numerous anatomic descriptions have been given, varying from single up to three bands[7]. Thusbanding pattern of the present study has been compared with the previous studies below.

Studies	Single band	Double band	Triple band
Milner a&Soames(1997)	38 %	50%	12 %
MuzafferSendel et al (1998)	-	100%	-
Mahmut et al(2010)	23 %	59 %	18 %
Present study (2013)	18 %	82%	---

Table 5: Comparison of banding pattern of ATFL with previous studies

Sarrafian reported that two bands of ATFL had always been present, along with occasional presence of three bands.[8] Burks and Morgan observed a distinct inferior band of ATFL with one or two bands, but has not mentioned about any trifurcate forms of ATFL.[9] Taser et al studied insertion points of lateral ankle ligaments and their relationship to bony landmarks.

They concluded that precise knowledge of the location of the ligaments show the way to surgeons during ligament repair and is significant to reconstruct the normal anatomy in so far as is possible. In a study by P Kitsouli et al, there were 4 cases of ATFL being absent on dissection study conducted on 72 embalmed human ankles. In contrast, in the present study none of the cases showed absence of ATFL.[10]

B) Length of ATFL irrespective of band and side:

Studies	ATFL length in mm	ATFL width in mm
Burks and Morgan (1994)	24.8	7.2
Siegler et al (1998)	17.81±3	---
Milner and Soames (1998)	13.0±4	11.0±3.3
Taser et al (2006)	22.37± 2.5	10.77± 1.6
MahmutUgurlu et al (2010)	14.38-20.84	7.61- 12.98
Raheem& O Brein(2011)	15.5	---
Present study	19.59	7.23

Table 6: Comparison of length and width of ATFL with other studies

Several articles conclude that due to different measuring points, the length of the ligaments was reported variable. d. Comparison of length and width of double banded ATFL between right and left ankles.

Studies	SUPERIOR BAND LENGTH IN MM		SUPERIOR BAND WIDTH IN MM			INFERIOR BAND LENGTH IN MM		INFERIOR BAND WIDTH IN MM
RIGHT	LEFT	RIGHT	LEFT	RIGHT		LEFT	RIGHT	LEFT
SELDA YILDIZ (2013)	12.31 ±2.55	12.57 ±2.14	4.90 ±1.53	6.57 ±1.64	10.04 ±2.45	10.78 ±4.14	4.65 ±2.33	3.36 ±1.27
PRESENT STUDY	19 ±2.55	18.46 ±2.54	7.36 ±1.32	7.25 ±1.20	16.24 ±2.55	17.33 ±2.26	6.1 ±1.16	6.55 ±1.08

Table 7: Comparison of superior and inferior band length and width between right and left ankles of present and previous studies

It was found out that variation in its length does not show any co relation to its vulnerability in ankle sprains.[11]

CONCLUSION: The length and width may be important to estimate the loss of ligament before and after surgery, also useful for the appropriateness of the reconstruction to the normal anatomic structure. The data presented in this study are a valuable addition to the small pool of data that exists concerning the dimensions of the ligaments of the human ankle joint.

From the results of the study discussed, it can be concluded that the several anatomical parameters such as length, width should be taken into consideration during ankle reconstruction surgeries. The dimensions of lateral and medial collateral ligaments determined in this study are in general agreement with those reported by other investigators with minimal variations. This suggests that they are a reasonable reflection of population values present in the average population.

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