

**MORPHOLOGICAL AND MORPHOMETRIC STUDY OF ANTERIOR TALOFIBULAR  
LIGAMENT OF ANKLE JOINT**Anukriti Singh<sup>\*1</sup>, Anju Pratap<sup>2</sup>, Kavita Negi<sup>3</sup> and Vanita Sharma<sup>4</sup><sup>1</sup>Junior Resident, Department of Anatomy, IGMC Shimla.<sup>2</sup>Professor and Head Department of Anatomy, IGMC Shimla.<sup>3</sup>Professor, Department of Anatomy, IGMC Shimla.<sup>4</sup>Assistant Professor, Department of Anatomy, IGMC Shimla.**\*Corresponding Author: Anju Pratap**

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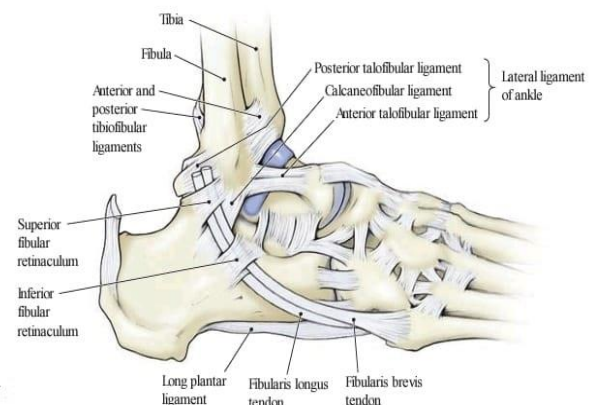
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**ABSTRACT**

The ankle joint (talocrural) is a hinge joint. The ligaments of the ankle joint are medial and lateral collateral ligaments. These two ligamentous complexes are the main stabilizers of the ankle joint, appreciated both in MRI and cadaveric dissections. The lateral collateral ligament consists of three discrete parts, Anterior Talofibular (ATFL), Calcaneofibular (CFL) and Posterior Talofibular ligaments (PTFL). Ankle sprains are most common in athletes and also occur in other sports like basketball, soccer, football, and volleyball. Lateral ankle sprains account for about 85% of all ankle sprains. The anterior talofibular ligament is the most frequently injured. Morphology and morphometry of ligaments of the ankle have not been well documented in the literature. Hence this study was taken up. The study was done by dissection on 40 (20 right and 20 left) cadaveric ankles, each ankle was carefully dissected to study the morphology and morphometry of the lateral collateral ligament. In the present study, we found, single-banded type I-14 (35%), double-banded, type II-a 9 (22.5%) and type II-b 17 (42.5%) ATFL, However, we didn't find any type III ATFL. The average length and width of ATFL irrespective of the side, and the mean length and width of single-banded ATFL were  $18.24 \pm 4.74$  mm and  $5.87 \pm 0.73$  mm respectively (Table 4). The Mean length and width of the superior and inferior bands of double-banded ATFL were  $17.62 \pm 2.29$ mm  $5.87 \pm 3.25$ mm and  $13.66 \pm 2.70$ mm  $4.02 \pm 0.97$ mm (Table 4). 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**

The ankle joint is a hinge joint, formed by the lower end of the 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. In about 10% to 15% of all inversion injuries, there is a rupture of the lateral ligaments of the ankle which involve the anterior talofibular ligament. This ligament plays an important role in limiting anterior displacement of the talus and plantar flexion of the ankle.<sup>[1]</sup> The ATFL is the weakest ligament of all the three lateral ankle ligaments, with the least elastic transformation properties. The ATFL is a flat, quadrilateral ligament incorporated in the joint capsule and passes from the distal area of the lateral malleolus's anterior margin to the talus's body 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. It is typically composed of two separate bands.<sup>[2]</sup>



**Figure 1: Normal anatomy of lateral collateral ligament complex of the ankle joint (right lateral view).**

**MATERIALS AND METHODS**

The study was conducted on 40 (20 right and 20 left) adult cadaveric ankles with no macroscopic deformity

and irrespective of sex in the Department of Anatomy, IGMC, Shimla. Each ankle was carefully dissected to study the morphology and morphometry of the lateral collateral ligament.

Dissection of the ankle region was done according to Cunningham's manual.

#### (A): Morphology and Morphometry of Anterior talofibular ligament

i) ATFL was studied for the presence of a number of bands as per Edama Met al.<sup>[3]</sup>

Type I: Ligament with one fiber bundle

Type II – a: Two fiber bundles with incomplete separation

Type II – b: Two fibre bundles with complete separation  
Two bundles are named as the superior band and the inferior band.

Type III: Ligament with three fiber bundles' these fiber bundles are further named as superior band, middle band and inferior band.

ii) The ligament length was measured from the most proximal attachment to the most distal attachment.

Values were compared with previous studies for their statistical significance. The statistical analysis was carried out using a statistical package for social sciences (IBM SPSS Statistics Inc., Chicago, IL, version 23 for Windows). For all quantitative variables mean and standard deviations were calculated.

#### RESULTS

Both double and single-banded ATFL were found in the present study. Double-banded ATFL had superior as well as inferior bands, typed as per Edama et al.<sup>[3]</sup>

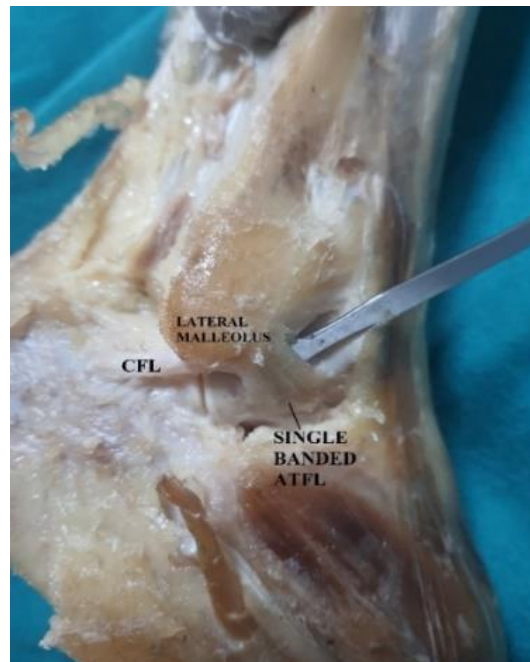
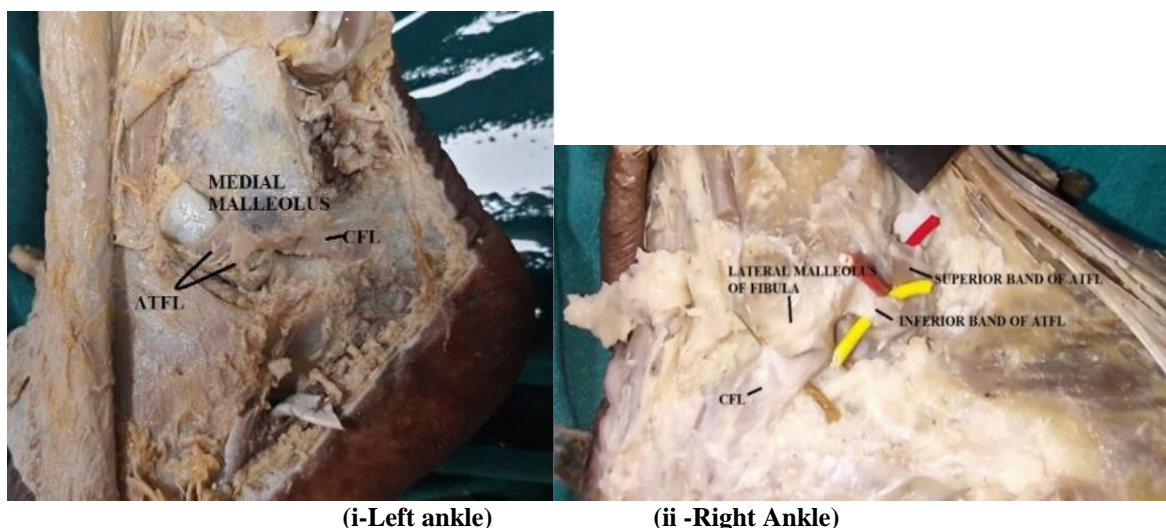


Figure 2: Showing single-banded (type I) ATFL in Right Ankle (lateral view).



(i-Left ankle)

(ii -Right Ankle)

Figure 2: (i) and (ii): Showing double-banded (Type II-a and b) ATFL (lateral view).

**Table 1: The type and number of bands of ATFL on the right and left side.**

BANDS	Types	Right side	Left side	Total	%
SINGLE	Type-I	6	8	14	35
DOUBLE	Type-II	a	3	9	22.5
		b	9	17	42.5
TRIPLE	Type-III	0	0	0	0
	<b>Total band</b>	20	20	40	100

**Table 2: The comparison of the mean value of Length and width of single banded ATFL between the right and left ankle.**

	Right ankle specimens - 6	Left ankle specimens - 8
Length in mm (mean ± SD)	16.61±0.54	19.91±4.94
Width in mm (mean± SD)	5.99±0.66	5.78±0.39

**Table 3: The comparison of mean values of superior and inferior bands of DOUBLE BANDED ATFL length and width between right and left ankles.**

	Right ankle -14 Length & width in mm(mean ±SD)	Left ankle-12 Length & width in mm (mean ±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 4: The mean values of length and width of single as well as superior and inferior bands of DOUBLE BANDED ATFL in dissection.**

The banding pattern of ATFL	Length in mm (Mean ±SD)	Width in mm (Mean ±SD)
Single band	18.24 ±4.74	5.87±0.73
Superior band	17.62 ±2.29	5.87 ±3.25
Inferior band	13.66 ±2.70	4.02±0.97

## DISCUSSION

### I) Morphology of Atfl

In literature, numerous anatomical variations have been given, varying from a single up to three bands.<sup>4</sup>So, the

banding pattern of the present study has been compared with the previous studies below.

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

Studies	Single band	Double band	Triple band
Milner&Soames <sup>4</sup> (1997, British)	38 %	50%	12 %
Ugluru M al <sup>5</sup> (2010, Turkish)	23 %	59 %	18 %
Kakegawa A et al <sup>6</sup> (2019)	23.3%	70%	6.7%
The present study (2022, Indian)	35%	65%	NOT FOUND

In the present study (Table 5) out of 40 ankle specimens, single banded was noted in 14(35%) and double banded in 26(65%) which is consistent with Milner and Soames. Milner and Soames<sup>[4]</sup> studied 40 ankles and suggested

the occurrence of unilateral and bilateral distribution of single or bifurcate forms of ATFL. Also, they described the presence of trifurcate form as an additional variation.

However, in the present study, we did not find any trifurcate forms of ATFL (Table 5).

### ii) Morphometry of Atfl

**Table 6: Comparison of length and width of single banded ATFL with other studies.**

Studies	ATFL length in mm	ATFL width in mm
Burks and Morgan <sup>7</sup> (1994, American)	24.8	7.2
Siegler et al <sup>8</sup> (1998, American)	17.81±3	---
Milner and Soames <sup>4</sup> (1998, British)	13.0±4	11.0±3.3
Taser F et al <sup>9</sup> (2006, American)	22.37± 2.5	10.77± 1.6
Ugurlu M et al <sup>5</sup> (2010, Turkish)	14.38-20.84	7.61- 12.98
Raheem OA, O'Brien M <sup>10</sup> (2011, Ireland)	15.5	---
The present study (2022, Indian)	18.24 ±4.74	5.87±0.73

Ugurlu M et al<sup>[5]</sup>(2010, Turkish) performed a study on 22 limbs and reported ATFL length in mm 14.38-20.84 and ATFL width in mm 7.61- 12.98, Thus Our study coincided with Ugluru M et al.<sup>[5]</sup>

**Table 7: Mean length and width of the superior and inferior band of DOUBLE BANDED ATFL in the present study compared with the previous study.**

STUDIES	Superior band length in mm	Superior band width in mm	Inferior band length in mm	Inferior band width in mm
Sindel M et al, <sup>[11]</sup> (1998, Turkish)	19.1±2.28	6.7±1.06	15.2± 2.62	4.5±1.09
Ugurlu M et al <sup>[5]</sup> (2010, Turkish)	18.74	5.39	15.33	4.92
In the present study (2022, North India)	17.62 ±2.29	5.87 ±3.25	13.66 ±2.70	4.02±0.97

The present study is in congruence with previous studies.

**Table 8: Comparison of superior and inferior band length and width between right and left ankles of present and previous studies.**

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
Yildiz S Yalcin B. <sup>[12]</sup> (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

Yildiz S and Yalcin B,<sup>[12]</sup> studied 46 ankles, They didn't find any statistically significant difference in the length between the right and left ankles. However, there was a statistically significant difference in their width between right and left ankle values. In the present study, we didn't find any statistically significant difference in the length and width between the right and left ankles.

## CONCLUSION

In the present study, we found, single-banded type I 14 (35%), as well as double-banded, type II-a 9 (22.5%) and type II-b 17 (42.5%) ATFL. However, we didn't find any type III ATFL (Table 8). The mean length and width of single band ATFL were 18.24 ±4.74 mm and 5.87±0.73 mm respectively irrespective of the side (Table 4). The Mean length and width of the superior and inferior bands were 17.62 ±2.29mm 5.87 ±3.25mm and 13.66 ±2.70mm 4.02±0.97mm (Table 4). The mean length of the superior band in the right and left ankle was found to be 19 ±2.55 mm and 18.46 ±2.54mm respectively. The mean width of the superior band of ATFL in the right and left ankle was found to be 7.36 ±1.32 mm and 7.25 ±1.20 mm respectively. The mean length of the inferior band of ATFL in the right and left ankle was found to be 16.24 ±2.55 and 17.33 ±2.26 respectively. The mean width of the inferior band in the right and left ankle was found to be 6.1±1.16 and 6.55±1.08 respectively (Table 8).

From the results of the study discussed it can be concluded that several anatomical parameters such as length, and width should be taken into account during ankle reconstruction surgeries. The dimensions of lateral 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.

## REFERENCES

- Klenerman L. The management of sprained ankle. The Journal of Bone and joint surgery. British volume, 1998 Jan; 80(1): 11-2.
- Van Den Bekerom MP, Oostra RJ, Alvarez PG, Van Dijk CN. The anatomy in relation to injury of the lateral collateral ligaments of the ankle: a current concepts review. Clinical anatomy, 2008 Oct; 21(7): 619-26.
- Edama M, Kageyama I, Kikumoto T, Nakamura M, Ito W, Nakamura E, et al. Morphological features of the anterior talofibular ligament by the number of fiber bundles. Ann Anat, 2018; 216: 69-74.
- Milner CE, Soames RW. "Anatomical variations of the anterior talofibular ligament of the human ankle joint". J Anat, 1997; 191: 457-8.
- Ugurlu M, Bozkurt M, Demirkale I, Comert A, Acar HI, Tekdemir I. Anatomy of the lateral complex of the ankle joint in relation to peroneal tendons, distal fibula and talus: a cadaveric study. Jt Dis Relat Surg, 2010; 21: 153-8.
- Kitsoulis P, Marini A, Pseftinakou A, Iliou K, Galani V, Paraskevas G. Morphological study of the calcaneofibular ligament in cadavers. Folia morphologica, 2011; 70(3): 180-4.
- Burks RT, Morgan J. "Anatomy of the lateral ankle ligaments". Am J Sports Med, 1994; 22: 72-77.
- Siegler S, Block J, Schneck CD. The mechanical characteristics of the collateral ligaments of the human ankle joint. Foot Ankle, 1988; 29: 234-42.

9. Taser F, Shafiq Q, Ebraheim NA. Anatomy of lateral ankle ligaments and their relationship to bony landmarks. *Surg Radiol Anat*, 2006; 28: 391-7.
10. Raheem OA, O'Brien M. Anatomical review of the lateral collateral ligaments of the ankle: a cadaveric study. *Anat Sci Int.*, 2011; 86: 189-193.
11. Sindel M, Demir S, Yildirim A, Ucar Y. "Anatomy of the Lateral Ankle Ligaments". *Tr. J. of Medical Sciences*, 1998; 28: 53-56.
12. Yıldız S, Yalcın B. The anterior talofibular and calcaneofibular ligaments: an anatomic study. *Surg Radiol Anat*. 2013; 35: 511-6.