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Morphometric Study of Anterior and Posterior Talofibular Ligament of Ankle by MRI

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Abstract: ***Ankle sprains are most common in atheletes and in other sports like basketball, soccer, football and volleyball. Ankle sprains occur frequently during plantar flexion, adduction and inversion of foot. Injuries may be soft tissue tears or avulsion fractures. It is estimated that 15- 20% of all sports injuries involve the ankle. The ligaments of the ankle joint are medial and lateral collateral ligaments. Magnetic resonance imaging is an excellent technique for imaging the tendons and the ligaments of the ankle owing to the advantage of detailed demonstration of soft tissue structures and capability for multiplanar demonstration of the ankle ligaments and tendons, MRI has been increasingly used in the evaluation of ligamentous and tendon injuries of the ankle. Knowledge of normal anatomy of MRI appearances is essential to recognize pathological appearances. 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. The length, Width, Thickness of Anterior talofibular ligament and Posterior Talofibular Ligament were measured. 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. 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.***

Keywords: Posterior Talofibular Ligament, Deltoid Ligament,MRI, Ankle sprains, Reconstruction

1. Introduction

Ankle sprains are most common in atheletes and in other sports like basketball, soccer, football and volleyball. Ankle sprains occur frequently during plantar flexion, adduction and inversion of foot. Injuries may be soft tissue tears or avulsion fractures. It is estimated that 15- 20% of all sports injuries involve the ankle.[1]

The ligaments of the ankle joint are medial and lateral collateral ligaments. The lateral ligaments has three discrete parts, Anterior Talofibular, Posterior Talofibular and Calcaneofibular ligaments.The medial collateral (deltoid) ligament is attached to the tip, anterior and posterior borders of medial malleolus. It has superficial anterior (tibionavicular), intermediate (tibiocalcaneal), posterior fibres (posterior tibiotalar) and deeper fibers anterior tibiotalar ligament.[2]

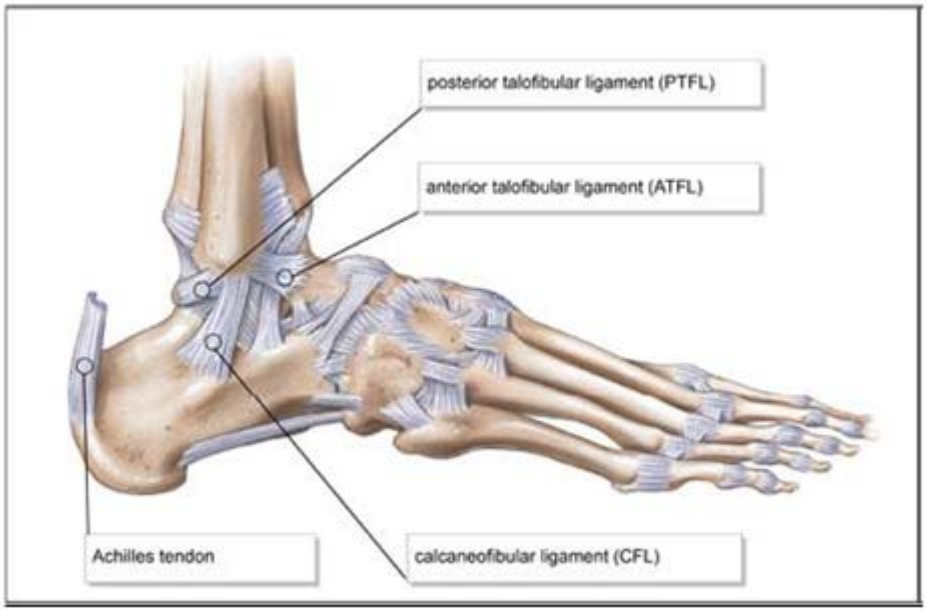


Figure 1: Normal lateral collateral ligament complex of ankle joint

Several diagnostic techniques are available for detecting acute injury to ankle ligaments such as arthrography, arthroscopy, stress radiograph and MRI. The primary requirement of all of them is exact knowledge of orientation to all ligaments. Stress radiography and arthrography rely on the observer's knowledge of anatomy of ligaments, as ligaments are not visible directly. MRI is more reliable, but its reliability varies with the position of the ankle, associated bony injuries and presence of blood. Limited study measuring the mean value of length, width and angle of the individual ligaments are available.[3]

In MRI, the direct multiplanar imaging, high soft- tissue contrast, and absence of streak artifacts combined with the resolution attainable with surface coils result in excellent visualization of the anatomic structures. Magnetic resonance

imaging provides the best non invasive means of evaluating the deltoid ligament complex. However, the cost is prohibitive at this point. Ultrasound provides a less costly, non invasive way to evaluate the deep deltoid.[4]

2. Materials and Methods

Study was done on 30 Magnetic Resonance images of subjects between 18- 60 years of age group, irrespective of sex from the Department of Radiodiagnosis, Kempegowda Institute of Medical Sciences, Bangalore. 30 MR images of subjects between 18- 60 years of age irrespective of sex.

MR images with congenital abnormalities of ankle, sprains of the ligaments, any fractures or dislocations of foot were excluded from the study. All scans were obtained with a 1.5 T MRI. The pulse sequence analysed was both T1 and T2 weighted spin echo sequence. All examinations included sections in the coronal as well as axial images. Even though sagittal sections were present, they were of little help for the study as measurements couldn't be obtained from them.

Criteria for diagnosis of ligament abnormality/injury included the appearance of an irregular or wavy contour or laxity, increased signal intensity within the substance of the ligament, increased thickness, discontinuity of the substance of the ligament or non-visualization of the ligament.33 The following values were measured in both axial and coronal images using

In axial images
The length and the thickness of the ATFL and PTFL were measured.

In coronal images
The length and thickness of Posterior Tibiotalar Ligament were measured.

3. Results

Out of the total 30 MRI scans taken for study, the mean age of male and female in the study was 37 and 33 respectively. Out of 30 MRI images, 17 were of left ankle and 13 from right ankle. ATFL is best seen in the axial plane. It is seen as a triangular or flat band of low signal intensity on axial images arising from the anterior margin of the distal lateral malleolus and ends in the talar attachment anterior to the fibular articular surface. ATFL is the weakest and most frequently injured.

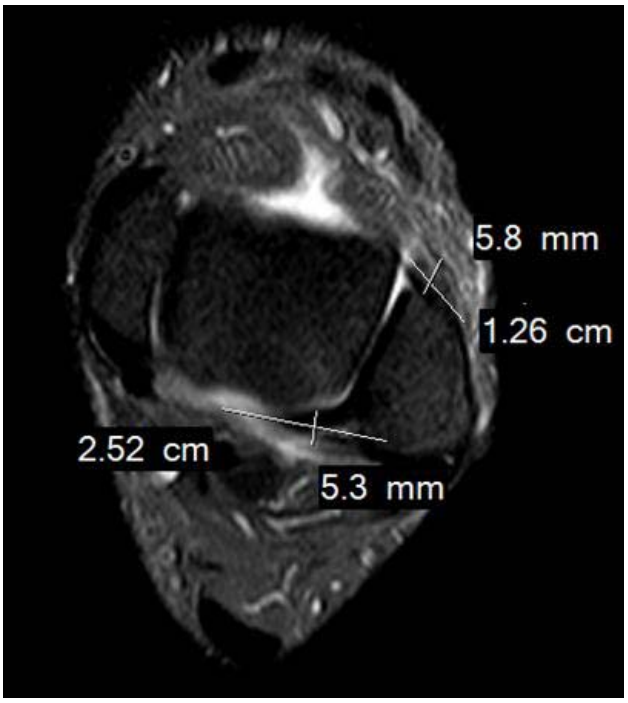
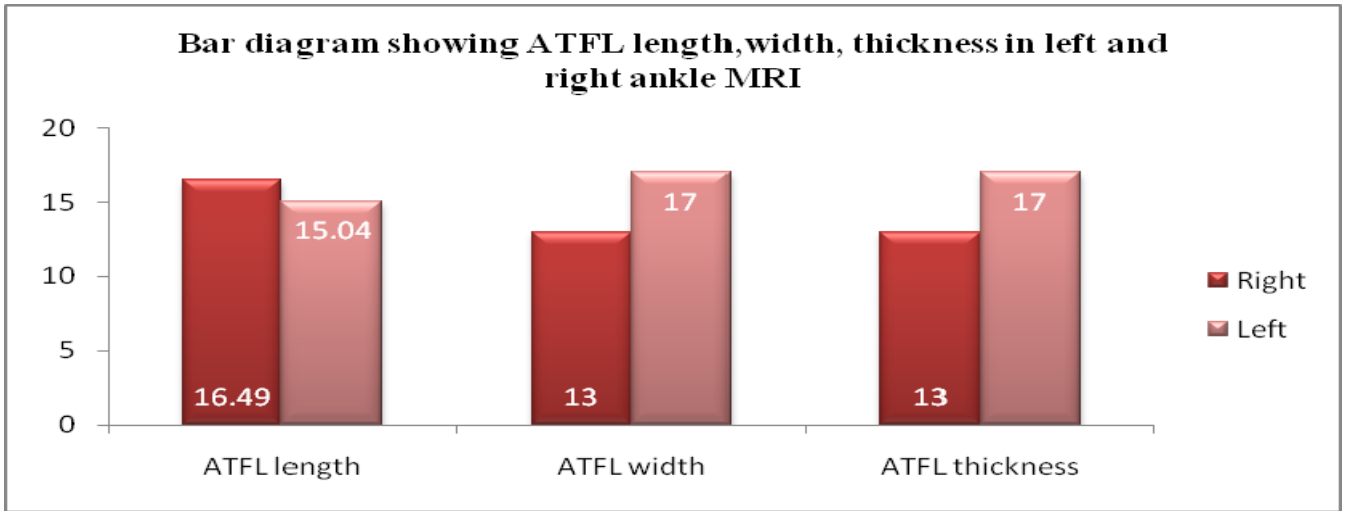


Figure 1: Length and thickness of ATFL and PTFL measured in axial image section

Table 1: Comparison of ATFL parameters between left and right side as measured from MR images

ATFL	*Side*	*N*	*Mean*	*Std dev*	*SE of Mean*	*Mean Difference*	*t*	*P-Value*
Length	Left	17	15.04	3.13	0.76	-1.457	-1.162	0.255
	Right	13	16.49	3.74	1.04			
Thickness	Left	17	6.38	2.08	0.50	0.661	0.889	0.382
	Right	13	5.72	1.93	0.54			
Width	Left	17	14.89	2.68	0.65	1.279	1.089	0.285
	Right	13	13.62	3.75	1.04			

No significant difference was observed between left and right side with respect to any of the parameters in MRI lateral ligament (P>0.05)



Graph 1: Comparison of length, width, thickness of ATFL of right and left ankle MR images

Table 2: Max & Min values, percentage of specimen showing less than & more than mean values of ATFL in ANKLE MRI

ATFL	*Min*	*Max*	*Mean*	*<Mean*		*>Mean*	
				n	%	n	%
Length	9.8	22.7	15.67	18	60	13	40
Width	8	18.8	14.34	13	43	17	57
Thickness	2.7	12	6.09	16	53	14	47

About 60% of the specimens had their length less than and 40% more than their mean value. About 43 % of the specimens had their width less than and 57% more than their mean value. About 53% of the specimens had their thickness less than and 47% more than mean value.

PTFL

The PTFL originates with a broad base from the concave surface of the fibular fossa, courses transversely and has a broad attachment to the posterior aspect of the talus. It has an inhomogeneous appearance on MR images because of individual fibres separated by fatty tissue.

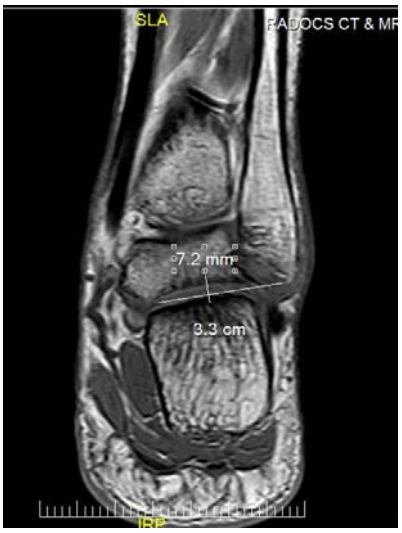


Figure 3: PTFL- length and width measured

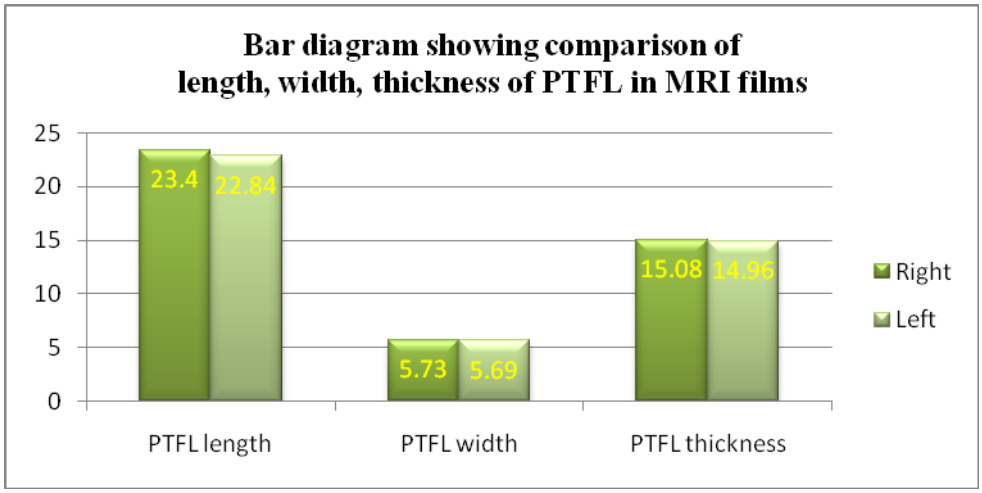
Table 3: Comparison of mean values of right and left side of PTFL in MR images

Parameters of PTFL	*Side*	*n*	*Mean*	*SD*	*SE of mean*	*Mean difference*	*t*	*p value*
Length	Left	17	24.4	6.45	1.56	3.6	1.45	0.16
	Right	13	20.8	7	1.94			
Width	Left	17	5.36	1.30	0.31	0.69	1.19	0.24
	Right	13	6.05	1.84	0.51			
Thickness	Left	17	14.6	2.31	0.56	0.9	1.07	0.29
	Right	13	15.5	2.48	0.69			

The mean difference between right and left values of length, width and thickness of PTFL was found to be 3.6, 0.69 and 0.9 respectively. No significant difference was observed between left and right side with respect to any of the parameters of PTFL (P>0.05)

Table 4: Max &Min values, percentage of specimens less than and more than mean values of PTFL in ANKLE MR images

PTFL	*Min*	*Max*	*Mean*	*<Mean*		*>Mean*	
				n	%	n	%
Length	11	36	22.85	16	53	14	47
Width	9.8	19.2	14.96	15	50	15	50
Thickness	3.5	9.7	5.66	18	60	12	40



Graph 2: Comparison of length, width, thickness of PTFL of right with left ANKLE MR images

NOTE: CFL parameters could not be measured on MRI films. Because the MRI films taken up for study were axial and coronal images of T1 and T2 weighted images. But for the CFL study in MRI, oblique axial images were required. Thus, only ATFL, PTFL parameters on the lateral ligament complex were measured.

4. Discussion

Magnetic resonance imaging is an excellent technique for imaging the tendons and the ligaments of the ankle. Owing to the advantage of detailed demonstration of soft tissue structures and capability for mutiplanar demonstration of the ankle ligaments and tendons. MRI has been increasingly used in the evaluation of the ligamentous and the tendon injuries of the ankle. Knowledge of the normal anatomy and of MRI appearances are essential to recognize pathological appearances.[5] Normal measurements of length, width, thickness of ATFL and PTFL, also length and thickness of Tibiotalar part of medial deltoid ligament have been obtained at the end of the study. These have not been well described in the previous literatures. It is envisaged that these findings will assist in the MRI assessment of ankle ligaments.

4.1 Lateral Collateral Ligaments

a. Anterior talofibular ligament

Table 5: Comparison of length, width, thickness of the present study with the previous study

STUDIES	ATFL		
	LENGTH in mm	WIDTH in mm	THICKNESS in mm
Mc Dermott et al (2004)	15±2.85		--
S Dimmick et al (2009)	--	--	2.19 ±0.6
Present study	15.66±3.36	14.34±3.14	6.09±1.98

Mc Dermott in his MRI study on 100 consecutive adult, retrospectively reviewed for the length of the Anterior Talofibular ligament. For anatomic confirmation, ATFL length was also measured in 20 fresh amputed specimens, measurements made using digital tool function on the workstation and recorded on photographic hard copy images. The same 20 fresh cadaver specimens were also imaged using T1 weighted MRI technique. Now evaluation of ATFL length was done. Correlation between the imaging measurement of the ATFL length and the cadaveric dissections were made using radiographic values and direct anatomic measurements. They found discrepancies between direct anatomic and MRI measured length values. They concluded that it may be due to difficulty in imaging. Correlation between the exact angle of the ligament as well as its degree of variation i.e out of plane, split, thick and attenuated.[6]

But in the present study, we couldn't correlate the MRI values of ligament length with the direction measurement values of dissection as the specimens chosen for both of them were not the same. The present study value of ATFL length measuring 15.66±3.36mm is almost in accordance with the Mc Dermott et al measurements which measured 15±2.85mm.

The length of ATFL of the present study measuring 15.66±3.36mm is almost in accordance with the previous study by Mc Dermott which is about 15±2.85mm.(table 6.12)

The ATFL is known to have many variations. It varies in the angle of insertion from the fibula to the talus and in the form i.e normal size, attenuated thin sizes, short or long thick sizes and split ligaments. However, till date no correlation has been reported between ligament form and a propensity for ankle instability.[6]

As per the table 5.28, the p value for length, width and thickness of ATFL between right and left ankle was found 0.255, 0.382 and 0.285 respectively showing no statistical significance. (p > 0.05)

b. Posterior talofibular ligament

Muhle et al found an inhomogeneous appearance of the medial collateral and the posterior talofibular ligaments on T1 weighted images that correlated with the areas of fatty tissue located between the ligamentous fibers. **The mean values of length, width and thickness of PTFL was found**

to be 22.85±6.71, 14.96±2.35 and 5.66±1.54mm respectively.

As per table 5.31, the p value for the length, width and thickness of PTFL between right and left ankle was found to 0.16, 0.24 and 0.29 respectively showing no statistical significance between right and left side.($p>0.05$)

Since, there is no any previous MRI study on the length, width, thickness of the PTFL, comparison of the present study couldn't be done with the previous ones. Thus, further studies are needed for MRI evaluation of PTFL.

5. Conclusion

The mean length, width, thickness of ATFL was found to be 15.66 , 14.34 and 6.09mm respectively. The mean length, width, thickness of PTFL was found to be 22.84, 14.96 and 5.69mm respectively. Additional studies may be necessary, especially to describe the histological and biomechanical properties of these ligaments. 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.

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