

1-1-1998

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### Recommended Citation

SİNDEL, Muzaffer; DEMİR, Sevgi; YILDIRIM, Aydın; and UÇAR, Yaşar (1998) "Anatomy of the Lateral Ankle Ligaments," *Turkish Journal of Medical Sciences*: Vol. 28: No. 1, Article 10. Available at: <https://journals.tubitak.gov.tr/medical/vol28/iss1/10>

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## Anatomy of the Lateral Ankle Ligaments

Received: December 11, 1995

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**Abstract:** The lateral ligaments of talocrural articulation, namely anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament, are important in anatomic reconstruction. If reconstructed improperly, they are known to limit the movements of talocrural articulation and subtalar articulation (talocalcaneal articulation) Studies on anatomy of anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament known as the lateral ligaments have some discrepancies. Knowing

the importance of a more detailed discription of ankle ligament anatomy for reconstructing and fixing the ligaments, we studied 24 ankles and examined the width, length, attachment points of all three ligaments and their relationships with talocrural joint and subtalar articulation in Akdeniz University, School of Medicine, Department of Anatomy.

**Key Words:** Lateral ligaments, Ankle joint, Anatomy.

### Introduction

Anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament are the lateral ankle ligaments of talocrural articulation and they are altogether called the lateral ligament (1-4)(Fig.1). Anterior talofibular ligament begins at lateral malleolus of Fibula and ends on lateral surface of malleolus of Talus. It is the shortest one of the three lateral ligaments of talocrural articulation and extends to Talus lying horizontally on the anterior face of Fibula's lower segment. Occsionally, anterior talofibular ligament can be observed as two bands-superior and inferior bands-which are proximally attached to lateral malleolus.

The bundels which extend to the front and medial part are atatched to the lateral face of Talus and Facies malleolaris lateralis (5). Posterior talofibular ligament begins at lateral malleolus of Fibula and extends from Fossa malleoli lateralis to Processus posterior tali. It is the strongset one of the three lateral ankle ligaments and is found at the deepest plane (1-4). Calcaneofibular ligament is the longest one and lies between lateral malleolus and lateral face of Calcaneus. It is a cord-shape ligament extending further and somewhat behind the distal tip of Fibula. It is placed under the tendons of M. peroneus longus and brevis (1-4). Together with the midpart of deltoid ligament, lateral ankle ligaments fasten the foot to the lightly and prevent it from overmotion in all directions. The

anterior and posterior bundles limit extention and flexion, whereas the anterior ones also limit abduction. The posterior bundles, joining the mid portion of deltoid ligament, prevent the foot from sliding back. The front bundles provide safety in the front movement of the foot and take part in limited extention. Calcaneofibular ligament limits the movements of talocrural articulation together with deltoid ligament, calcaneofibular ligament and posterior talofibular ligament prevent the foot from sliding back and widens the concave ankle face. Another important ligament which prevents the foot from sliding forward is anterior talofibular ligament At the same time, it limits the lateral flexion (3). Together with calcaneofibular ligament, they provide the stability of lateral ankle in flexion (6,7). Calcaneofibular ligament takes part in adduction, whereas anterior talofibular ligament place a role in both adduction and supination (6,7). Anterior talofibular ligament is put under a strain in palantar flexion, inner rotation and inversion. Calcaneofibular ligament is put under a strain in dorsoflexion of Talus and inversion. The rupture of anterior talofibular ligament result in inversion, instabilization and forward sliding of the foot. The rupture of calcaneofibular ligament results in adduction and the weakness of the ankle and subtalar articulation (8). The aim of this study was to examine the anatomy o these specific ligaments for reconstruction techniques in order to enhance the ligament stabilization without sacrificing motion.

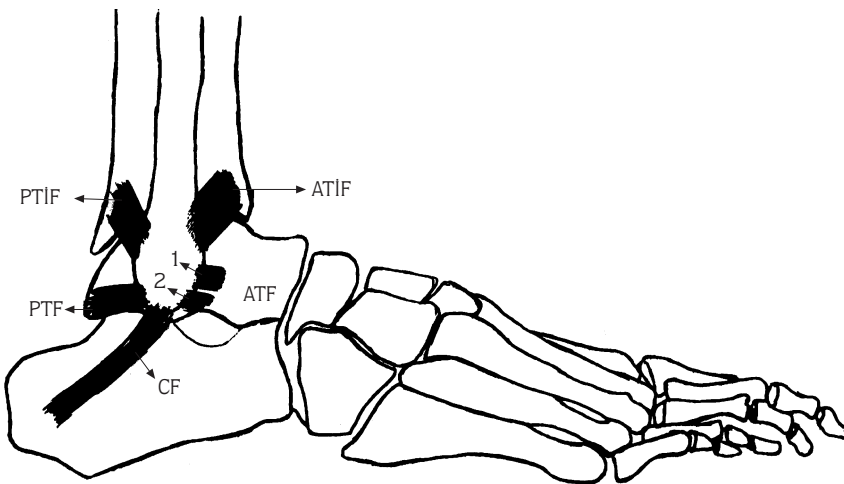


Figure 1. ATF : Anterior talofibular ligament  
 1) Superior band  
 2) Inferior band  
 PTF: Posterior talofibular ligament  
 CF: Calcaneofibular ligament  
 ATIF: Anterior tibiofibular ligament  
 PTIF: Posterior tibiofibular ligament

### Materials and Methods

Anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament which construct the lateral ankle ligaments were examined in 24 cadaveric ankles at Department of Anatomy in Medical School of Akdeniz University. Antero-lateral and postero-lateral dissections were performed in all the ankles. In antero-lateral dissection, skin, Rete venosum dorsale pedis, small saphenous vein, dorsolateral cutaneous nerve, sural nerve, superior extensor retinaculum, A. malleolaris anterior lateralis and inferior extensor retinaculum were removed consecutively. The tendons of M. tibialis anterior, M. extensor hallucis longus, M. extensor digitorum longus and M. peroneus tertius were also removed. On the lateral side, superior and inferior peroneal retinaculum through which the peroneal muscles course were cut, so that M. peroneus longus and brevis were dissected. On the posterolateral part, after the dissection of Rete calcaneum with its branches and dorsolateral cutaneous nerve, tendocalcaneum were dissected and the adipose tissues around were removed until the lateral ankle ligaments were completely exposed. The width and length of each of the ligaments were measured. Measurements were made at the areas of insertion of each of these ligaments. Specific measurements were made with regard to orientation and distance from the center of the attachments of anterior talofibular ligament and calcaneofibular ligament to the subtalar articulation and tip of the Fibula.

The same kind of specific measurements were also made for posterior talofibular ligament, so that the distance between the centre of attachments on



Figure 2. ATF : Anterior talofibular ligament  
 1) Superior band 2) Inferior band

Fossa malleoli lateralis to the tip of the Fibula was measured. Its area of attachment on Fibula was also measured. Consequently, the characters of attachment areas for lateral ankle ligaments and their relationships to the ankle joint were all examined.

### Results

#### Anterior talofibular ligament:

In all 24 ankles examined, anterior talofibular ligament was determined as having two bands (Fig.2). Superior band had an average length of  $19.1 \pm 2.28$  mm and an average width of  $6.7 \pm 1.06$  mm. The length of the inferior band was measured as  $15.2 \pm 2.62$  mm, and the width as  $4.5 \pm 1.09$  mm. Anterior talofibular ligament is attached to the anterior edge of the lateral malleolus just in front of the attachment area of calcaneofibular ligament. Anterior talofibular ligament extends anterolateral covering Sinus tarsi and is attached

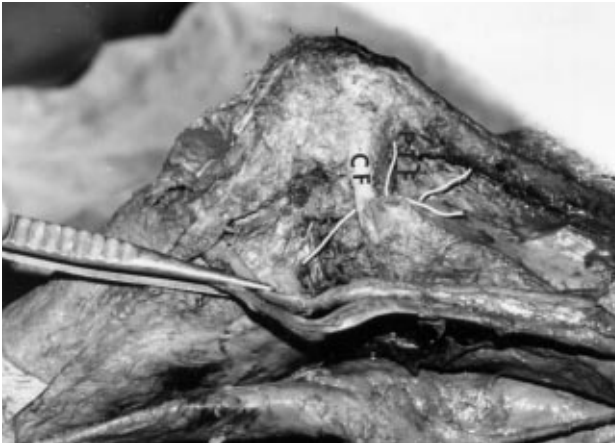


Figure 3. PTF : Posterior talofibular ligament  
CF : Calcaneofibular ligament

to Facies malleoli lateralis on the lateral side of neck of talus. The average attachment area of anterior talofibular ligament bands on the lateral malleolus was  $7.5 \pm 1.32$  mm in the proximal-distal dimension and  $5.4 \pm 0.8$  mm in the medial-lateral direction. The average proximal-distal dimension of the anterior talofibular ligament attachment to the Talus was  $6 \pm 0.99$  mm and the medial-lateral dimension was  $4.9 \pm 1.12$  mm. The center on the Fibula was an average  $10 \pm 1.3$  mm proximal to the tip of the Fibula. The center of the insertion on the Talus was an average  $14.2 \pm 1.78$  mm proximal to the subtalar joint.

#### Posterior talofibular ligament:

The attachment area of posterior talofibular ligament was on the medial edge of the lateral malleolus on Fibula (Fig.3). The insertion point of posterior talofibular ligament was on Tuberculum laterale processus posterior tali and this ligament coursed transversally in the Fossa malleoli lateralis transversally. The long attachment of posterior talofibular ligament on the posterior portion of the talus was measured as  $20.7 \pm 2.15$  mm. The whole length of the ligament was  $41 \pm 2.81$  mm, and the width was  $6.1 \pm 0.77$  mm. The proximal-distal diameter of the fibular attachment averaged  $6.9 \pm 0.69$  mm and the medial-lateral diameter averaged  $8.2 \pm 0.46$  mm. The fibular attachment was centered as average  $8.2 \pm 1.43$  mm proximal to the distal tip of Fibula.

#### Calcaneofibular ligament :

Calcaneofibular ligament was attached to the lateral malleolus,  $6.1 \pm 0.44$  mm on the anterior-distal part of Sulcus malleolaris lateralis (Fig.3). The ligament

running deep to the peroneal tendon sheaths, was placed  $14.1 \pm 3.13$  mm. Posterior and upper to Trochlea peronealis of Calcaneus (TP) and  $29.5 \pm 2.86$  mm. Anterior to processus lateralis tuberis calcanea (TC) when we connected these two points with the attachment center of the ligament on Calcaneus (TP-attachment center-TC), vertex angle of the resulting triangle averaged  $49.2 \pm 8.25^\circ$ . The calcaneofibular ligament measured as average  $26.8 \pm 4.91$  mm in length and  $6 \pm 0.8$  mm in width. The insertion of the ligament on the anterior edge of to distal fibula averaged  $6.8 \pm 1.4$  mm. In the proximal-distal direction and  $5.7 \pm 1.06$  mm. In the medial-lateral direction. The area of calcaneal insertion on the lateral face of the calcaneus averaged  $7.7 \pm 1.15$  mm. in the proximal-distal direction and  $7 \pm 1.1$  mm. in the medial-lateral direction. The calcaneal attachment center an average  $12.8 \pm 1.61$  mm. distal to the subtalar articulation and the fibular insertion began an average  $7.3 \pm 1.49$  mm. to the distal tip of fibula.

#### Discussion

Certain problems exist in different reconstruction of the lateral part of the ankle joint. Various results have been described using multiple different reconstructions and some authors have stressed the importance of anatomical knowledge of the ligaments in obtaining good results (5,9). Shibata et al (8) reported the significance of lateral ankle ligaments in ankle stabilization and they stated that unlimited motion could be obtained with a good reconstruction in their study done on 16 amputated legs. Burks and Morgan (5), who worked on 10 ankles, emphasized the importance of original anatomic sites in reconstruction and stated that loss of inversion and restricted motion were the results of unsuccessful reconstruction of the lateral ankle ligaments. The diagnosis and the therapy of ligamental ruptures resulted in various forcing accidents are only possible with the detailed anatomic knowledge of the ligaments (5,10). Even the anatomical reconstruction of the ligaments can result in a subtle loss of motion in the subtalar joint (5). Depending on these data, we examined the macro-anatomy of the ligaments important in ankle reconstruction. Even though the anatomic structure is known to be important, we couldn't find any literature on the subject except the textbooks of Anatomy and Orthopedics. Burks and Morgan (5) made the direct measurements of lateral ankle ligaments and compared normal anatomy with various ligament reconstructions.

Table 1. Results of the measurements for anterior talofibular ligament

		Our Results(mm)	Results of Burks and Morgan(mm).
Length	Sup.band	19.1	24.8
	Inf.band	15.2	20.0
Width	Sup.band	6.7	7.2
	Inf.band	4.5	4.6
Dimensions of the fibular attachment area	prox.dist.	7.5	8.2
	med-lat.	5.4	5.4
The distance between The fibular origin and fibular distal tip		10.0	10.1
Dimensions of the Talar attachment area	prox-dist.	6.0	8.7
	med-lat.	4.9	5.6
The distance between The talar origin and Subtalar joint		14.2	18.1

Table 2. Results of the measurements for posterior talofibular ligament

		Our Results(mm)	Results of Burks and Morgan(mm).
Length		20.7	24.1
Width		6.1	6.0
Dimensions of the fibular attachment area	prox.dist.	6.9	6.9
	med-lat.	8.2	10.1
The distance between The fibular origin and fibular distal tip		8.2	9.7

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Table 3. Results of the measurements for calcaneofibular ligament

		Our Results(mm)	Results of Burks and Morgan(mm).
Length		26.8	35.8
Width		6.0	5.3
Dimensions of the fibular attachment area	prox.dist.	6.8	8.2
	med-lat.	5.7	6.2
The distance between The fibular origin and fibular distal tip		7.3	-
Dimensions of The calcaneal attachment area	prox-dist.	7.7	10.0
	med-lat.	7.0	8.2
The distance between the calcaneal origin and Subtalar joint		12.8	-

They stated that anterior talofibular ligament rarely had inferior and superior bands; however we determined both bands in all our 24 cadaveric ankle. Our results and the results of Burks and Morgan are given in Tables 1,2 and 3. As can be seen, our data are in good agreement with the literature. Our results showing anatomy of the ligament for the reconstruction techniques can enhance the ligament stabilization without sacrificing motion.