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Research Article

The morphological study of human deltoid ligament of Ankle joint in situ

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ABSTRACT

Background and Objectives: The deltoid ligament is a very tough and strong ligament of the ankle joint. Different studies had been done by many investigators to find out its involvement in different types of ankle trauma and diseases. There is scanty of paper in the study of morphology of deltoid ligament among Kyrgyz (Mangolion race) context, this study was carried out to fill this gap in the literature.

Material and Methods: Twenty-five limbs from cadevar and 32 of fresh dead (from freezer) bodies were selected for the study. Following the dissection, the parts, borders and the attachments of the superficial fibres of the ligament was identified and their attachments were established by inspection, palpation and by slight evertion of the ankle joint. The extents of their proximal and distal attachment were also measured. Mid way between the proximal and distal attachment of the anterior and posterior border ligament point were plotted through which the breadth of the respective ligament was measured again the vernier calipers. Data were entered in Excel and SPSS and were analyzed.

Results: The result showed that the longest ligament was the tibionavicular and the shortest was the tibiotalar ligament. Similarly the broadest ligament was found to be the tibiotalar and the narrowest was the tibiocalcaneal ligament. There was no significant variation found in the length, breadth and the attachment of the ligament in terms of the sex and side of the limb. The interesting result which was obtained from the correlation coefficient was that the lengths of the tibiocalcaneal and tibiotalar ligaments were found to be increased with increasing age.

Conclusion: The lengthening of the tibiocalcaneal and tibiotalar ligament, increased breadth of tibiotalar ligament and increased extent of origin of the ligament in old age which was evident in this study.

Keywords: Deltoid, Mongolion, Age, Ligaments

INTRODUCTION

The deltoid ligament is a very tough and strong ligament of the ankle joint. This ligament is also known as the medial collateral ligament of the ankle. It has two parts the superficial and the deep. The superficial is subdivided into three parts based on the inferior points of attachment viz. Anterior tibionavicular which stabilizes

anterior part of the joint. Tibiocalcaneal stabilizing the ankle joint as well as the sub-talar joint and Tibiotalar [1-3]. The deep part is short and has two portions, anterior and posterior and is attached on the tip of the medial mallows and medial side of talus [4]. The deltoid ligament often gets involved in sprain of the ankle joint. The sequence of tearing in planter flexion inversion injury is: a. Lateral capsule, b. Anterior tibiofibular, c. Calcaneofibular, d. Posterior talofibular ligament, e. Deltoid ligament

Complete tear of this ligament is unusual even in the dislocation of the joint. Avulsion of medial malleolus occurs prior to it tear, which proves its strength [5-9]. Different studies had been done by many investigators to find out its involvement in different types of ankle trauma and diseases.

Similarly, the normal morphology of the ligament is documented in different text books of anatomy. The degree of injury has been mentioned by different authors in clinical journals and the text books of orthopedics. However, there are very few literatures involving normal morphology in relation to clinical correlation. On top of that there has scanty of paper in the study of morphology of deltoid ligament among Kyrgyz (Mangolion race) context. So this study is carried out to fill this gap in the literature.

MATERIAL AND METHODS

A quantitative descriptive study was conducted for study of morphology of deltoid ligament among Kyrgyz (Mangolion race) context. Adult ankles without deformity were included in this study. Twenty-five limbs from cadevar and 32 of fresh dead (from freezer) bodies were selected. Out of these limbs 50 were of male and 7 were of female.

Following the dissection, the parts, borders and the attachments of the superficial fibres of the ligament was identified and their attachments were established by inspection, palpation and by slight evertion of the ankle joint. After defining their attachments the anterior and the posterior borders, each of the three parts of the ligaments was defined and measured using vernier calipers. Similarly the extents of their proximal and distal attachment were also measured. For measuring the extent of the proximal and distal attachment i.e the extent of origin and insertion, the point of attachment of the anterior and posterior borders of the entire fibers of the ligament to the medial malleolus and the navicular bone and the talus were plotted. Mid way between the proximal and distal attachment of the anterior and posterior border ligament point were plotted through which the breadth of the respective ligament was measured again with the vernier calipers. Data were entered in Excel and SPSS and were analyzed.

RESULTS

In this study the total numbers of cadevar and other specimen were 57. Among them 50 male and 7 were female. The dissection was carried out on both of the limbs. 74 ankle joint were dissected and found that the cadevar specimens ligament were hard due to formalin. This hardness might have varied the breadth of the ligaments. So the cadaveric specimens were excluded from the study and only the frozen specimens were dissected. Total 32 frozen specimens were dissected. After tabulating statistical analyses were done in order to find out the mean length and breadth and the extent of the origin and

insertion of the ligament in terms of sex and side.

Table 1: Showing morphological study of human deltoid ligament of ankle joint

SN	AGE	SEX M/F	SIDE R/L	Mean length of the ligament in cm			Mean breadth of ligament in cm			Breadth of attachment of the ligament in cm	
				Tibionavicular	Tibiocalcaneal	Tibiotalar	Tibionavicular	Tibiocalcaneal	Tibiotalar	origin	insertion
1	41	M	R	1.45	1.35	1.15	0.9	0.7	0.6	1.8	3.5
2	50	M	R	1.12	1.65	1.25	0.8	0.9	0.9	1.9	3.6
3	42	M	R	1.4	1.7	1.15	0.9	0.8	0.7	2.2	4.1
4	35	M	R	1.85	1.95	1.45	0.8	0.8	1	2	5.3
5	52	M	R	1.81	1.85	1.55	0.9	0.9	0.8	2.1	5.2
6	56	M	R	1.8	2.05	1.45	1	0.9	0.8	1.9	4.7
7	38	M	R	1.85	1.7	1.5	1	0.9	0.8	2.5	3.9
8	46	M	R	1.8	1.35	1.5	1	1	0.7	2	3.9
9	61	M	R	1.55	1.65	1.25	1.1	0.6	0.6	2.4	4.3
10	67	M	R	2.15	1.75	1.4	1.1	0.7	0.7	2.1	3.3
11	49	M	R	1.65	1.55	2.1	1.1	0.8	1.2	2	3.1
12	54	M	R	1.85	1.75	1.4	1.2	1.5	1.3	2.2	3.2
13	68	M	R	1.95	1.6	1.8	0.7	1.6	0.9	2.1	3.8
14	56	M	R	1.8	1.35	1.5	0.9	1.2	0.9	2	4.3
15	63	M	R	1.8	1.6	1.6	0.7	1.2	1	1.9	2
16	56	M	R	1.75	1.6	1.7	1.4	0.6	1.2	2	2.6
17	67	M	R	2	2.05	1.5	0.9	0.9	1.1	1.8	4
18	64	M	R	1.9	2.2	1.65	0.8	0.7	1.1	1.9	3.9
19	60	M	L	2	1.9	1.5	0.9	0.9	1.1	1.9	3.9
20	56	M	L	2.55	1.95	1.95	1.1	1.1	1.4	2.1	4
21	54	M	L	2.6	1.85	1.55	1.1	1	1.2	1.5	3.3
22	49	M	L	2.8	1.85	1.65	1	0.6	1.3	2.1	4.9
23	55	M	L	2.6	1.95	1.65	1	0.9	0.9	2.2	3.4
24	63	M	L	2.1	1.95	2.25	1.4	1.4	1.1	1.9	3.5
25	67	M	L	3.15	1.85	2.35	1.3	0.8	1	3	3.6
26	56	M	L	1.75	2.05	1.85	1.3	1.1	1.5	3.1	3.9
27	53	M	L	1.8	2.15	2.1	1.5	0.7	0.9	1.9	2.8
28	51	M	L	1.9	1.35	1.25	1.2	0.8	0.9	2.5	2.9
29	46	M	L	2.7	1.7	1.7	0.9	0.7	1.2	2	3.6
30	54	F	L	2.8	1.65	1.75	1.1	0.8	1.4	2.1	4.8
31	61	F	L	3.05	1.85	1.7	1	1.3	1.6	2	3.7
32	54	F	R	2.15	1.85	1.9	1.3	1.3	1.5	2.2	4

Besides the length, breadth and the attachment of the ligament were correlated with the cadaver (specimen) by calculating the correlation coefficient. The result of the statistical analyses showed that the longest ligament was the tibionavicular and the shortest was the tibiotalar ligament. Similarly the broadest ligament was found to be the tibiotalar and the narrowest was the tibiocalcaneal ligament. There was no significant variation found in the length,

Table no.2: Showing the mean length of the ligament by sex

Ligament	Male		Female		Total	
	Mean	SD	Mean	SD	Mean	SD
Tibionavicular	2.0803	0.49166	1.6500	0.26548	2.0400	0.48897
Tibiocalcaneal	1.8172	0.22726	1.6833	0.05774	1.8047	0.22010
Tibiotalar	1.6586	0.30298	1.4000	0.13229	1.6344	0.29985

Table no.3: Showing the mean breadth of the ligament by sex

Ligament	Male		Female		Total	
	Mean	SD	Mean	SD	Mean	SD
Tibionavicular	1.0310	1.9839	0.9333	0.15275	1.0219	0.19466
Tibiocalcaneal	10.9586	0.26928	0.8667	0.05774	0.9500	0.250778
Tibiotalar	1.0621	0.27310	0.8333	0.15275	1.0406	0.27103

breadth and the attachment of the ligament in terms of the sex and side of the limb. However, the interesting result which was obtained from the correlation coefficient was that the lengths of the tibiocalcaneal and tibiotalar ligaments were found to be increased with increasing age.

Among 29 male and 3 female ankles the longest ligament was found to be the tibionavicular ligament, which is 2.04cm long (plus minus 0488cm) and the shortest was tibiotalar ligament with a length of 1.6344cm (plus minus 0.29985cm). There was no significant variation found in the length of the ligament between male and female.

Among 29 male and 3 female ankles the broadest ligament was found to be the tibiotalar ligament which is 1.0406cm (plus minus0.27103cm) and the narrowest is the tibiocalcaneal measuring 0.9500cm(plus minus 0.25778cm) without any significant variation between the sexes.

Table no 4: Showing the mean length of the ligament by side

Ligament	**Right**		**Left**	
	Mean	**SD**	**Mean**	**SD**
Tibionavicular	1.8121	0.38107	2.2172	0.49893
Tibiocalcaneal	1.7179	0.25766	1.8722	0.16290
Tibiotalar	1.5500	0.33512	1.7000	0.26009

Among 18 right and 14 left ankles the mean length of the ligaments compared by the side of the leg shows that the right tibionavicular is 1.8121cm(plus minus0.38107cm) and the left is 2.2172cm(plus minus 0.49893cm), right tibiocalcaneal 1,7179cm(plus minus 0.25766cm) and the left 1.8722cm(plus minus 0.16290)cm and the right tibiotalar 1.55cm(plus minus 0.33512cm) and the left being 1.7cm(plus minus 0.26009cm),there was no significant variation in the length of the ligament between the two sides.

Table no.5: Showing the mean breadth of the ligament by side

Ligament	Right		Left	
	Mean	SD	Mean	SD
Tibionavicular	1.0500	0.18292	1.0000	0.20580
Tibiocalcaneal	0.9357	0.27903	0.9611	0.24767
Tibiotalar	1.0143	0.29835	1.0611	0.25469

Similarly among 18 right and 14 left ankles the breadth of the ligaments show that the right tibionavicular is 1.05cm(plus minus 0.18292cm) and the left is 1cm(plus minus 0.2058cm),the right tibiocalcaneal 0.9357cm(plus minus 0.27903cm), and the left is 0.9611cm(0.24767cm) and the tibiotalar on the right ide being 1.0143cm(plus minus0.29835cm) and on the left 1.0611cm(plus minus 0.25469cm), without any significant variation between the sides of the ankle.

Table no. 6: Showing the correlation coefficient of the length and breadth of different ligaments with the age. (n=32)

Ligament	Correlation coefficient in age	P value
Tibionavicular length	0.144	0.431
Tibiocalcaneal length	0.377	0.033*
Tibiotalar length	0.390	0.027*
Tibionavicular breadth	0.078	0.670
Tibiocalcaneal breadth	0.12	0.506
Tibiotalar breadth	0.386	0.029*
Origin	0.505	0.003*
Insertion	0.176	0.336

Correlation significant at 0.05 levels

In this study the length of the proximal(origin) and distal (insertion) attachment of the ligament was also measured. The mean length of the origin is 2.084cm (plus minus0.3102cm) and that of the insertion is 3.781cm(0.7249)cm.

The correlation coefficient of the length and breadth of different ligament with age of the person (cadevar) has showed that the length increases with age of the person. Comparison between the length of deltoid ligament of human ankle (mean±SD) study vs. Seigler et al and Chimba et al's study is shown in table no. 7.

Table no.7: Showing the comparison between the lengths of the ligament with the result of former studies

Comparison between length of ankle ligaments(mean±SD) in cms			
Ligaments	This study	Siegler et al	Chimba et al
Tibionavicular	2.04±o.48897	----------	2.409±0.803
Tibiocalcaneal	1.8047±0.2201	----------	3.745±0.274
Tibiotalar	1.6344±0.2998	1.186+0.396	2.668±0.499

DISCUSSION

The ankles which were dissected for the study were normal in their ankle mortice. However, during the selection of the specimen (limbs) some of the ankles were deformed and were excluded.

Regarding the origin and insertion of the ligament all the three components of the ligament viz. tibionavicular, tibiocalcaneal and tibiotalar were found to be same in the dissected limb as it was described in the text books like Gray's anatomy; Cunningham's Manual of Practical Anatomy by G.J Romanes; Clinically Oriented Anatomy by Keith L. Moore and Arthur F. Dalley; Grant's Method of Anatomy by J.V Basmajian [10-13].

In the morphometric measurement of this study the data were variable from that of the data previously reported by Chimba Mkandawire et al [14-16]. The differences

were basically seen in the length of tibiotalar and tibiocalcaneal ligament. The measurement of the length was consistently shorter than Chimba et al's. The difference in measurement was conceivably may be because of the load they applied on the ligament during their study. In this study no tension was applied and the measurement was taken from the dissected ligament in situ. Therefore due to the lack of applied tension it was believed to get a shorter measurement of the ligament in this study.

Siegler et al. has not documented the length of tibionavicular and tibiocalcaneal ligaments. The length of tibiotalar ligament is not very much different from that of Seiglers study but is significantly shorter than that of Chimba et al's result. But tibionavicular tibiocalcaneal were significantly shorter than the result of Chimba et al. This difference may be due to the application of load in their study, the advance method of bone ligament preparation [16, 17].

One interesting result of this study is that the lengths of the ligaments were found to increase with increasing age of the person. The proportional increase in the length of the ligament in elderly may be due to reduction in collagen synthesis leading to the laxity of ligament. The other cause for that may also be resorption of the bones leaving lengthened ligament.

Due to the above postulated reasons the dimension of the ligament may be distorted producing an increase in the extent of origin and an increase in the breadth of the tibiotalar ligament, which can be proved by continuing this study in future.

The indirect morph-metric measurement in living subject was also done by some workers in past. Most of the former investigator's work was to establish the relation of the length of the deltoid ligament with ankle mortice especially in ankle trauma [18, 19]. According to the study done by Neilson JH et al. a medial clear space greater than 4mm was correlated with the disruption of the deltoid ligament [20]. But in this study that kind of radiological measurement of the ankle joint was not included o it could not be done. If x-ray of the ankle joint had done during this study the medial clear space in an ankle joint with intact or divided deltoid ligament could be compared and the result of the ligament disruption would have been possible. However, due to lack necessary facilities and time constraints this could not be carried out.

In this study a very simple method was applied to measure the attachments (origin & insertion), length, and breadth of the deltoid ligament of the ankle joint. Though there were not much variation found in the origin and insertion of the ligament in comparison with text books despite uneven attachments of ligament were noticed.

The morphometric measurement of the deltoid ligament has its own limitations because of lack of modern equipments and facilities. On the top of that, the morphometric measurement was carried out only by mere inspection and palpation without using any dye or colouring agents. Therefore, there can be queries in the technique and quality of the work. Similarly, use of traction or bone ligaments preparation was not possible due to the lack of budget and time.

The uneven attachment of the ligaments, intermingling of the fibers of the ligaments and the similarity of colure of the ligaments and the bone due to lack of use of dye were the constraints faced during this study. These

limitation had pointed out the necessity of a good bone ligament preparation. However, surprisingly some useful results were obtained. When the results were compared with the other studies the shortness in length of the ligament in this study was found. This may be due to lack of tractional force applied on the ligament in this study.

CONCLUSION

Finally, the lengthening of the tibiocalcaneal and tibiotalar ligament, increased breadth of tibiotalar ligament and increased extent of origin of the ligament in old age which was evident in this study has opened a new horizon for the forth coming investigators to prove the fact. The morphometric study of the ligament is also possible in living subject using the tools like MRI. As every tool and technique have their own limitations and constraints as mentioned by Chimba et al, the results of these two kinds can be compared in the days to come.

The accurate morphometric measurement thus obtained can be useful guide for the clinicians in dealing with various types of trauma and surgery of the deltoid ligament and ankle. As this was probably a first morphometric study of its own kind, further modification in the methodology is the challenge of modern day medicine.

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