"Morphometric evaluation of the Achilles tendon: a cadaveric study in Tamil Nadu population"

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Abstract:

Background:

The Achilles tendon is the largest and strongest tendon in the body that connects the calf muscles to the heel bone. It helps in taking of the hell from the ground in order to support walking and running. This tendon shows considerable differences in their dimensions among individuals across the world populations.

Aim of the study:

The aim of the present study was to determine the morphology and morphometric dimensions of the Achilles tendon in adult male south Indian cadavers.

Materials and methods:

The Achilles tendon specimens (n=40) were obtained from the Anatomy dissection hall at Panimalar medical college hospital and research institute after completion of lower limb dissection by their undergraduate medical students. The tendon length, proximal width, middle width, distal width, proximal circumference, middle circumference and distal circumference were measured using measuring tape. The statistical analysis was done by using "t" test.

Results:

The study found that the mean Achilles tendon length was 9 cm. The tendon length, width, circumference, and thickness showed no statistically significant difference between the right and left lower limbs.

Conclusion:

The present study has described the morphometry of the Achilles tendon concerning the risk of Achilles tendinopathy. The findings of this study can be considered during the management of Achilles tendinopathy and preoperative planning of surgical operations of the posterior compartment of the leg.

Introduction:

The Achilles tendon is the strongest tendon of the human body. It is also called as Tendo-calcaneus (TC). The tendon is mainly responsible for the plantar flexion of the ankle joint. It is formed by the fusion of the tendons of gastrocnemius and soleus muscles. The gastrocnemius and soleus muscles are the superficial calf muscles. The normal length of the tendon is about 10–15 cm. The strength and flexibility of this tendon are important for jumping, running, and walking [1]. Based on its usage this tendon is prone to rupture and would frequently undergo degeneration and inflammation. The morphological and morphometric variations of the TC are related to its functional requirements. Therefore, normal morphometric measurements of TC serve as an important landmark in its anthropometric evaluation and biomechanical characteristics.

There has been different opinion regarding morphometric changes of TC among various ethnicity and races. Knowledge regarding the normal measurements of the TC is important before determining any pathological variations associated with the tendon. There are many morphological studies regarding TC using MRI and ultrasound but cadaveric studies are very few. Due to the limited data available in this regard, the morphometric study of TC was undertaken using adult human cadavers fixed in formalin solution. Hence the aim of the present study was to determine the morphology and morphometric dimensions of the Achilles tendon in adult male south Indian cadavers.

Materials and methods:

A total of 40 isolated adult limbs preserved in formalin solution in the department of anatomy at Panimalar medical college hospital and research institute was used in this study. These limbs belonged to male cadavers, whose age ranged between 60 to 75 yrs. Out of the 40 limbs; 20 belonged to the right side while 20 were of the left side. These limbs were carefully dissected and cleaned to expose the tendo calcaneus. Diseased/fractured limbs, limbs with cuts or scars and limbs belonging to female cadavers due to its adequate unavailability was excluded from the study. Following parameters were measured for each tendon using a measuring tape and thread. With the measuring tape the width of the tendon was measured and using thread the circumference of the tendon was taken and finally the thread was measured with the measuring tape (Fig 1):

1. Total length (from the musculotendinous junction of the soleus muscle till its attachment to the posterior part of calcaneus) (Fig. A),
2. Proximal width and proximal circumference of the tendon (near its formation) (Fig B),
3. Middle width and middle circumference of the tendon (Fig C),
4. Distal width and distal circumference of the tendon (near its insertion) were measured and documented (Fig D).

These values were then tabulated using SPSS v 15.0 statistical package. Mann-Whitney U test was used for comparison of the parameters between two independent groups (right and left limb) to find whether there is statistically significant difference in the measurements between the two groups. P value less than 0.05 was considered as statistically significant.

A

B

C

D

Fig 1: Measurements of Achilles tendon (AT): A - Length of Achilles tendon, B - Proximal width and circumference of Achilles tendon, C - Middle width and circumference of Achilles tendon, D - Distal width and circumference of Achilles tendon.

Results:

The mean values of various morphometric parameters of Achilles tendon (AT) in the right and left limbs are shown in [Table 1].

Table 1: Comparison of measurement values of the Achilles tendon's length, width and circumference between the right and left lower limbs:

S.no	Parameters	Right lower limb N=20	Left lower limb N=20	P-value	Significant
1	Length (cm)	9.22±1.42	9.01±1.38	0.61	NS
2	Proximal width (cm)	1.98±0.28	1.93±0.23	0.54	NS
3	Middle width (cm)	1.63±0.20	1.58±0.23	0.46	NS
4	Distal width (cm)	2.25±0.25	2.19±0.42	0.58	NS
5	Proximal circumference (cm)	3.81±0.34	3.94±0.60	0.40	NS
6	Middle circumference (cm)	3.17±0.41	3.33±0.47	0.25	NS
7	Distal circumference (cm)	3.66±0.36	3.69±0.50	0.82	NS

AT length, width and circumference showed no statistically significant differences between the right and left side tendons. The average length of the tendon was 9 cm. The mean length of the tendon on right side was 9.2 cm whereas on left side was 9 cm. The proximal width of the tendon on the right side was 1.98cm and on left side 1.93, proximal circumference on right side limb was 3.81cm and left side 3.94cm, middle width on the right side measured 1.63cm and left side 1.58cm, middle circumference on the right side was 3.17cm and left side 3.33cm, distal width from right to left ranges 2.25 to 2.19 cm and distal circumference from right to left ranges 3.66 to 3.69 cm. No statistically significant difference was observed in these measurements between the right and left limbs.

Discussion:

The tendo calcaneus or Achilles tendon (AT) is the thickest and strongest tendon of the body. It is about 15cm long. It begins near the middle of the leg, but its anterior surface receives fleshy fibers of the soleus almost up to its lower end. It is narrow and thick in the middle, and expanded at both ends and is attached to posterior surface of calcaneum. The action of the tendon is plantar flexion of the foot at the ankle joint [2]. The morphometric values of AT may vary based on anatomical and ethnic considerations. Thereby the present study reports a cadaveric morphological evaluation of AT in south Indian male population.

The length of the AT observed in the present study was 9cm which was corroborated with the studies done by Maria Francis Y et al, Patel and Labib. Maria Francis Y et al done on 60 dissected cadaveric lower limbs and found the length of the AT as 8.91cm on right side and 8.09cm on the left side [3]. Similarly, Patel and Labib reported 9.32cm on right side and 9.39cm on the left side by dissecting out about 50 lower limbs [4].

A study done by Manju singhal et al., have dissected 108 male cadaveric lower limbs and reported the proximal width of the tendon as 1.45cm, middle width as 1.23cm and distal width as 2.33cm which was similar to the findings of the present study. The correlation of the similar results reported by Maria Francis Y et al, Manju singhal et al and the present study

could be due to the same racial group. According to them there were no statistically significant differences in the AT length of the left and right sides, which is similar to the findings of the current study were there was no significant difference between the left and right sides [5].

Emmanuel Peter et al reported the proximal, middle and distal circumference of the AT ranged from 3.4 - 4.6cm, 3.2 - 4.7cm and 4.2 - 5.8cm respectively which was nearly similar to the findings of the present study. Moreover, the authors have reported that the circumference of AT is greater at the origin, decreases at the middle and increases at the insertion. These morphological changes of the AT give a knowledge to the surgeons and clinicians that they should expect the AT´s size to be greater at the origin, decrease at the middle, and increase at the insertion [6].

Naveen kumar et al in their study showed no statistically significant differences between the right and left side lower limbs measurement, of the total length of AT, width and circumference. However significant correlation was observed between proximal width and distal widths, proximal circumference and distal circumference, proximal width and proximal circumference and distal width and distal circumference of the tendon [7].

Various studies have been reported the significant changes in the length and thickness of AT between dominant and non-dominant feet as well as between right and left side. Similarly, studies have showed the changes in the morphometric measurements of AT among the individuals who are active in sports and sedentary life style [8,9,10]. Conbolat et al found the average width, thickness and length of the Achilles tendon in male subjects were significantly higher than females. Tendon width and length showed no significant difference between the right and left side. Achilles tendon measurements of subjects engaged in sportive activities were significantly larger than those with sedentary lifestyle [11]. In another study conducted in Brazilian population reported no significant differences between left and right-side tendons [12].

The AT is crucial for walking, running and jumping. If the tendon is under constant and excessive strain due to overuse or exposure to repetitive trauma, the microtears in the tendon increases and is vulnerable to hypertrophy [13]. Hypertrophy of the AT may also occur in cases of regular exercise. Running is also associated with physiologic hypertrophy of the tendocalcaneus and over-weight runners could also develop tendon abnormalities [14]. Body mass index plays an important role in the development of Achilles tendonitis as obesity is considered as an intrinsic risk factor for Achilles tendonitis [15].

Therefore, the morphometric evaluation of AT in cadavers is a most reliable and standard measuring tool which gives a detailed knowledge for the surgeons who operates on it.

Conclusion:

The present study reports the normal values of AT which would be very helpful to sports medicine physicians for diagnosis and treatment of Achilles tendon overuse injuries and pathology associated with tendinopathy.

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