

Original article

Study on the Length and the Breadths of Tendoachilles of Human Cadaver

Nahar L¹, Seraji A², Fahmi S³, Afreen KN⁴, Aktar M⁵, Any OH⁶

Abstract

Background: Tendoachilles is the chief plantar flexor of the ankle joint. The present study was conducted to find out the possible variations of tendoachilles between the right and the left leg of both male and female. **Materials and methods:** A cross sectional observational study was conducted in the department of Anatomy, Dhaka Medical College, Dhaka, from July 2013 to June 2014. The data were collected from both the right and the left tendoachilles of 60 human cadavers taken from Anatomy Departments of different Government and Nongovernment Medical Colleges in Dhaka city. Among the 60 cadavers, 30 were male and 30 were female. After dissection, the length of tendoachilles and the breadths at different levels of tendoachilles were measured and recorded. **Results:** The mean length of tendoachilles was significantly greater in the right than in the left leg of both male and female. The tendoachilles was longer in male than in female in both the right and the left leg ($P < 0.01$). There was significant positive correlation between the height of cadaver and the length of tendoachilles of both the right leg and the left leg in case of male. Positive correlation was also observed between the height of cadaver and the length of tendoachilles of both the legs in case of female, but that was not statistically significant. The mean breadths of tendoachilles were significantly greater in the right leg than in the left leg at its junction with gastrocnemius and at the level of its junction with calcaneus in both male and female and also in male than in female in both legs. Significant difference was observed between the breadth of right and left tendoachilles at the level of 4 cm above its junction with calcaneus in male but not in female ($P > 0.05$). **Conclusion:** Significantly greater values were observed in the length and in most of the breadths of tendoachilles in the right leg of both sexes and in male in both legs. There was significant positive correlation between the height of cadaver and the length of tendoachilles of both legs in case of male, but, not in female.

Keywords: Tendoachilles, Length, Breadth.

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Introduction

Tendoachilles is the largest, thickest and strongest tendon in the human body, situated in the lower part of the posterior portion of the leg. It is about 15 cm long¹ formed by

the conjoint tendon of insertion of gastrocnemius and soleus. It begins near the mid-level of the leg at its musculotendinous junction with the gastrocnemius^{2,3}. Its anterior surface receives muscle fibres from soleus almost at its distal end.

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It inserts into the posterior surface of calcaneus at its mid-level, a bursa separating it from the bone's proximal area⁴. Tendoachilles is the prime mover of plantar flexion of the foot at the ankle joint. Gastrocnemius provides force for propulsion in walking and running. Soleus acting from below is said to be more concerned with steadying the leg on the foot in standing⁵. It provides elastic energy storage in walking and running. It has been suggested that the absence of a well-developed Achilles tendon would preclude them from effective running, both at high speeds and over extended distances⁶.

The common pathology of Achilles tendon is rupture, degenerative changes and inflammation⁷. Rupture of Achilles tendon is common in young active people. Rupture occurs at the narrowest point, usually about 5 cm above the calcaneal insertion^{8,9}. Following rupture, patient cannot walk and run effectively. There is a wide anatomical variation in the exact location of the musculotendinous junction and the narrowest part of tendoachilles, which can lead to confusions among surgeons when trying to identifying the location of a rupture and planning for treatment. By the knowledge of the morphology, they may get great help in the treatment purpose¹⁰.

In this subcontinent, different tendons including tendoachilles are sometimes cut by terrorists to take revenge as sometimes seen in newspaper.

Tendoachilles undergo unique changes in some general diseases and even in the normal aging process. Ultrasonic measurement of the tendon thickness has been proposed as a useful noninvasive tool for detecting and monitoring cholesterol accumulation in hemodialysis related amyloidosis¹¹.

This study will be helpful for sports medicine physicians, orthopaedic surgeons, plastic surgeons and radiologists and will upgrade the knowledge in surgical procedure.

Materials and methods

A total of 120 tendoachilles of 60 human cadavers of different medical colleges in Dhaka city were studied. The medical colleges were – Dhaka Medical College, Sir Salimullah Medical College, Shaheed Suhrawardy Medical College, Z. H. Sikder Women's Medical College, Ibn Sina Medical College, Ad-Din Medical College, Moghbazar, Anwer Khan Modern Medical College and Delta Medical College. There

were 60 tendoachilles (30 male and 30 female) of right leg and 60 tendoachilles (30 male and 30 female) of left leg.

The body was placed on the dissection table in supine position. At first the height of cadaver was measured from the top of vertex up to heel. Then the body was turned into prone position. Back of thigh, leg and sole was cleaned. Then with the help of a scalpel, skin incisions were made. Skin, superficial fascia and deep fascia were reflected. Beneath the deep fascia, the contents of the most superficial compartment of the posterior portion of the leg was exposed. The contents were two heads of gastrocnemius, soleus and tendon of plantaris. These muscles were separated from their superficial and deep structures. Then, following the lower end of gastrocnemius, tendoachilles was identified and exposed. The length of tendoachilles was measured with the help of a flexible metallic tape from the musculotendinous junction with gastrocnemius upto the attachment to calcaneus. The breadths of tendoachilles were measured with the help of a digital slide calipers at the level of its junction with gastrocnemius, at the level of its junction with calcaneus and at the level which is 4 cm above its junction with calcaneus. After collecting the data, the findings of this study were analyzed by SPSS version 17. Comparison of the values between the right and the left leg was done by paired Student's 't' test. Comparison between the values obtained from male and female was done by unpaired Student's 't' test.

Ethical clearance

This study was approved by the ethical review committee of Dhaka Medical College.

Results

60 right and 60 left tendoachilles from 60 human cadavers (30 male and 30 female) were included in this study. The range of the height of the cadavers (both sexes) studied were from 144 cm to 165 cm with the mean \pm SD was 151.60 ± 5.47 cm. In male and in female, the mean \pm SD were 155.73 ± 4.39 cm and 147.47 ± 2.52 cm respectively (Table 1).

The length of tendoachilles (Table 2) was found significantly greater in the right leg than in the left leg in both male ($P < 0.05$) and female ($P < 0.001$). The tendoachilles was also found significantly longer in male than in female in both legs ($P < 0.01$).

In this study, the heights of the cadavers were correlated with the lengths of the tendoachilles, both with the right and with the left tendoachilles (Table

3). Regarding the correlation between the length of the right tendoachilles and the height of cadaver (Fig. 3), positive correlation was observed in both male and female. In male, the correlation was statistically significant ($r = +0.483$, $P < 0.01$) but not in female ($r = + 0.345$ $P > 0.05$). Regarding the correlation between the length of the left tendoachilles and height of cadaver (Fig. 4), statistically significant positive correlation was observed in male ($r = + 0.506$, $P < 0.01$). In female, the correlation was positive but not statistically significant ($r = 0.307$, $P > 0.05$).

The breadth of tendoachilles at the level of its musculotendinous junction (Table 4) was found significantly greater in the right leg than in the left leg in both male ($P < 0.05$) and female ($P < 0.001$). At this level, the tendoachilles was also found significantly broader in male than in female in both legs ($P < 0.001$).

Regarding the breadth of tendoachilles at the level of 4 cm above its junction with calcaneus (Table 5), it was found significantly greater in the right leg than in the left leg in male ($P < 0.001$), but there was no significant difference in breadth at this level between the right and the left leg in female ($P > 0.05$). Moreover, statistically no significant difference was observed in the breadth of tendoachilles in any leg between male and female ($P > 0.05$).

The breadth of tendoachilles at the level of its junction with calcaneus (Table 6) was found significantly greater in the right leg than in the left leg in both sexes ($P < 0.001$). At this level, the tendoachilles was also found significantly broader in male than in female in both legs ($P < 0.01$).

Discussion

In the present study, the length of tendoachilles was found longer in the right leg than in the left leg in both male and female which was statistically significant. The value was greater in the tendoachilles of male than the corresponding leg in female ($P < 0.001$). Williams et al.⁴ reported that the human tendocalcaneus is of 15cm length. This value is close to the value of the length of the right tendoachilles in male of the present study. In 2009, in the University of Melbourne, Chen et al.⁸ dissected 20 cadavers and recorded that the length of tendoachilles was 14.8 ± 1.2 cm. Statistically non significant difference was observed when the length of tendoachilles recorded by Chen et al. was compared with the length of tendoachilles of male of the present study ($P > 0.05$) and significant difference was observed when compared with the length of tendoachilles of female of the present study

($P < 0.05$). Chen et al. worked with the Australian population. In Australia, a mixture of European, Asian and Oceanian people lives. Bangladeshi population is a mixture of Negroid, Caucasoid and Mongoloid population. In spite of different race, why the findings of Chen et al. Matched with the findings of tendoachilles of male of the present study could not be explained. In case of female, significant difference was observed between the present study and the study done by Chen et al. Here the difference between the two studies may be due to different race. In Hong Kong, Pang and Ying¹² carried out a study on 40 subjects by ultrasonography and reported that the length of tendoachilles in right leg was 11.972 ± 2.28 cm and that in left leg was 11.57 ± 2.47 cm. Statistically significant difference was observed when the length of tendoachilles recorded by Pang and Ying compared with the length of the right and the left tendoachilles of male of the present study. In case of female, non-significant difference was observed in both the right leg and the left leg. In Hong-Kong a mixture of Han, Manchu, Mongol, Turkish and Tibetan people lives. In spite of two different races, why the findings of Pang and Ying matched with the findings of the female group of the present study, could not be explained. Abdel-Ghany and Abo-ollo² dissected 25 lower limbs of cadavers in Alexandria and found that the length of tendoachilles was 22.18 ± 3.12 cm. Their values were greater than the values of the present study. Abdel-Ghany and Abo-ollo worked on population of Alexandria. The difference in length may be due to the difference in race. In Finland, Stenroth et al.¹³ conducted a study on 100 subjects by ultrasonography. They observed that the length of tendoachilles was 19.2 ± 2.4 cm in male and 16.3 ± 2.0 cm in female. Both the values of male and female were greater than the corresponding values of the present study. Stenroth et al. worked on the population of Finland. The people of Finland are a mixture of Sweden, Norway, Russia and Europe. The difference in length may be due to different race and different method of measurement by which Stenroth et al. carried out their studies.

In the present study, the height of cadavers correlated with the length of tendoachilles in case of both the right leg and the left leg of male. There was significant positive correlation observed between the length of tendoachilles and the height of cadaver in case of both the right leg ($r = +0.483$) and the left leg ($r = +0.506$) of male. This finding indicates that, the length of tendoachilles will increase with the increasing body height in the both legs of male. On

the other hand, although there was a poor correlation between the height of cadavers with the length of tendoachilles in the both legs of female, but this positive correlation was statistically non significant (right leg, $r = +0.345$) and (left leg, $r = +0.307$). This finding indicates that, the body height is not a factor in the variation of the length of tendoachilles in the both legs of female. This difference of findings between male and female may be due to small sample size. In Hong Kong, Pang and Ying studied 80 legs of 40 persons by ultrasonogram and stated that, there was a low correlation observed between the length of tendoachilles and the body height in the right leg ($r = +0.28$, $P > 0.05$) as well as in the left leg ($r = +0.26$, $P > 0.05$)¹². So, the findings of the study of Pang and Ying were similar with the findings of the present study in case of female, but different from the findings of male of the present study.

In the present study, the breadth of tendoachilles at its junction with gastrocnemius was found wider in the right leg in both male and female, which was statistically significant. The value was greater in male than the corresponding leg in female ($P < 0.001$). In a study in Australia, Chen et al.⁸ dissected 20 cadavers and reported that the breadth of tendoachilles at its junction with gastrocnemius was 4.0 ± 0.52 cm. Statistically significant difference was observed when the breadth of tendoachilles recorded by Chen et al. compared with the breadth of right tendoachilles of both male and female of the present study. The difference may be due to different race between the two studies. Abdel-Ghany and Ollo² dissected 25 lower limbs of cadavers in Alexandria and reported that the breadth of tendoachilles was 6.62 ± 0.52 cm at this level. The findings were greater than the findings of the present study (In male $P < 0.0001$ and in female $P < 0.0001$). This may be due to the different race on which Abdel-Ghany and Ollo carried out their studies.

In the present study, the breadth of tendoachilles at the level of 4cm above its junction with calcaneus was found wider in right leg in male but not in female. (In male $P < 0.001$ and in female $P > 0.05$). Though the mean breadths of right and left tendoachilles in male were found wider than the corresponding values

in female, but the differences were not statistically significant (In right $P > 0.05$ and in left $P > 0.05$). In a study on 20 cadavers in Australia, Chen et al.⁸ reported that the breadth of tendoachilles was 1.1 ± 0.17 cm at the level of 4cm above its junction with calcaneus. This value was smaller than the value found in our study in both male ($P < 0.0001$) and female ($P < 0.0001$). This may be due to the different race group on which Chen et al. carried out their studies.

In the present study, the breadth of tendoachilles at the level of its junction with calcaneus was found wider in the right leg in both male and female which was statistically significant. The breadth was wider in male than in female in case of both right and left tendoachilles ($P < 0.01$). In their study, Abdel-Ghany and Ollo² found that the breadth of tendoachilles was $2.55(\pm 0.34)$ cm at this level. Statistically significant difference was observed when the breadth of tendoachilles recorded by Abdel-Ghany and Ollo compared with the breadth of right tendoachilles of male of the present study. The reason for this difference may be due to different race between the two groups of population of the two studies. In case of female, non-significant difference was observed. The reason for these findings could not be explained. Chen et al.⁸ reported that the breadth of tendoachilles was $2.2(\pm 0.29)$ cm at the level of its junction with calcaneus. The values were smaller than the values of the present study (In male, $P < 0.001$ and in female $P < 0.01$). The difference may be due to the difference in race between the two groups of population.

Conclusion

The study revealed that, the mean length of tendoachilles was significantly greater in right leg in both sexes and in male in both legs. There was significant positive correlation between the height of cadaver and the length of tendoachilles of both legs in case of male, but, non-significant positive correlation was observed in case of female. The mean breadths were greater at the beginning and end of tendoachilles in the right leg in both sexes and in male in both legs. Further ultrasound study of living tendoachilles and comparison of the ultrasound findings with the cadaveric length and breadths of tendoachilles might be beneficial in this regard.

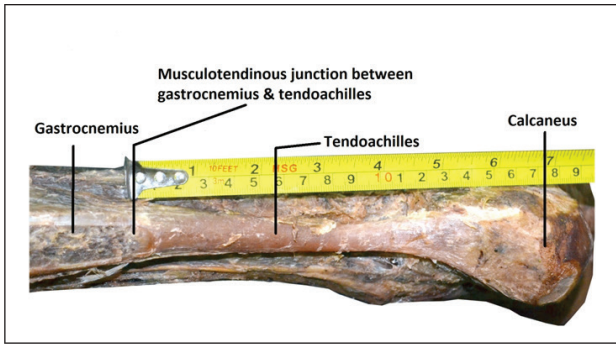


Fig. 1: Method of measurement of the length of tendoachilles

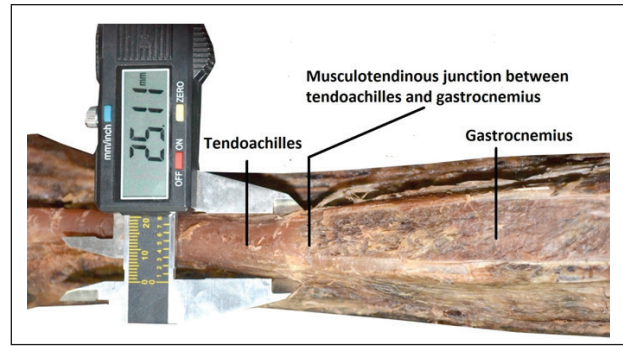


Fig. 2: Method of measurement of the breadths of tendoachilles

Table 1 The range and the mean of the height of cadavers.

	Range of height in cm	Mean±S D
Male	147-165	155.73 ±4.39
Female	144-153	147.47 ±2.52
Total	144-165	151.60 ± 5.47

Table-2 Length of tendoachilles from its musculotendinous junction with gastrocnemius.

Sex	Length in cm Mean±SD (Range)		<i>P</i> value
	Right leg	Left leg	
Male (n=30)	14.74±2.25 (9.20-19.10)	14.62±2.46 (8.00-19.10)	0.048*
Female (n=30)	12.77±2.11 (8.60-16.00)	12.56±2.21 (8.00-16.00)	0.0001***
<i>P</i> value	0.001**	0.001**	

* = significant at $P < 0.05$, ** = significant at $P < 0.01$, *** = significant at $P < 0.001$.

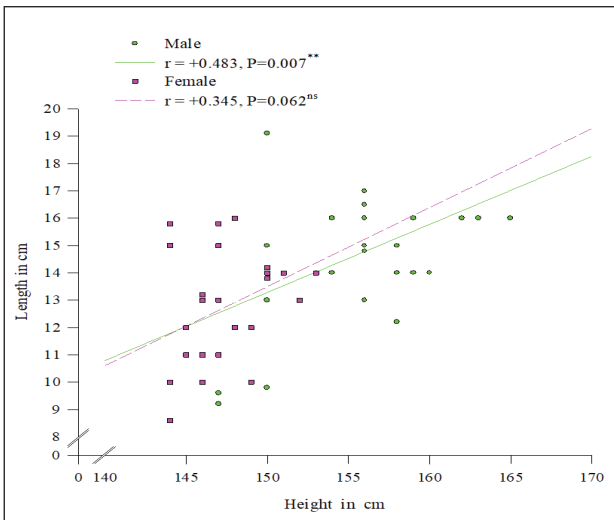


Fig. 3 Correlation of the body height of cadaver with the length of right tendoachilles

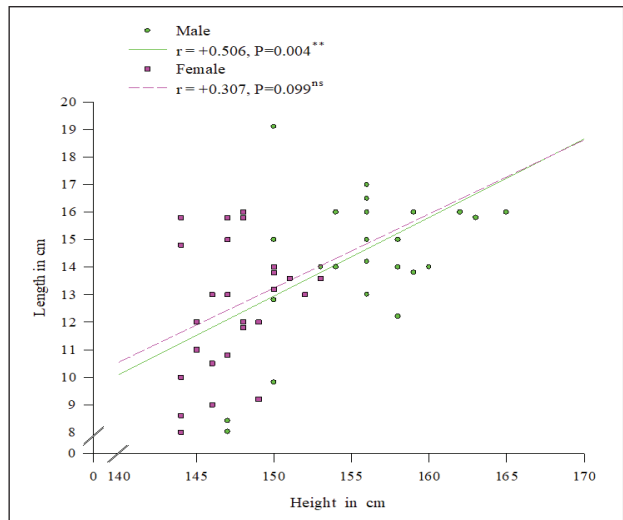


Fig. 4 Correlation of the body height of cadaver with the length of left tendoachilles

Table 3 Correlation of the height of cadaver with the length of the tendoachilles by Pearson's correlation coefficient (r) test.

Parameter	Right leg		Left leg	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Male	+0.483	0.007**	+0.506	0.004**
Female	+0.345	0.062 ^{ns}	+0.307	0.099 ^{ns}

ns = not significant, ** = significant at $P < 0.01$.

Table 4 Breadth of tendoachilles at its musculotendinous junction with gastrocnemius.

Sex	Breadth in cm Mean±SD (Range)		<i>P</i> value
	Right leg	Left leg	
Male (n=30)	5.87±0.84 (3.40-7.00)	5.80±0.86 (3.40-7.00)	0.046*
Female (n=30)	4.49±0.55 (3.80-5.80)	4.33±0.57 (3.80-5.80)	0.0001***
<i>P</i> value	0.0001***	0.0001***	

* = significant at $P < 0.05$, *** = significant at $P < 0.001$.

Table 5 Breadth of tendoachilles at the level of 4 cm above its junction with calcaneus.

Sex	Breadth in cm Mean±SD (Range)		<i>P</i> value
	Right leg	Left leg	
Male (n=30)	1.65±0.44 (0.80-2.30)	1.51±0.44 (0.80-2.30)	0.0001***
Female (n=30)	1.48±0.36 (0.80-2.00)	1.41±0.37 (0.80-2.00)	0.203 ^{ns}
<i>P</i> value	0.114 ^{ns}	0.326 ^{ns}	

ns = not significant, *** = significant at $P < 0.001$.

Table 6 Breadth of tendoachilles at the level of its junction with calcaneus.

Sex	Breadth in cm Mean±SD (Range)		<i>P value</i>
	Right leg	Left leg	
Male (n=30)	2.84±0.52 (1.00-3.36)	2.71±0.44 (1.00-3.10)	0.0001***
Female (n=30)	2.44±0.45 (1.60-3.30)	2.37±0.45 (1.40-3.00)	0.0001***
<i>P value</i>	0.003**	0.005**	

** = significant at $P < 0.01$, *** = significant at $P < 0.001$.

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