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The Cross-sectional Area of Tendo Achilles as Measured by Diagnostic Ultrasound

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Abstract:

Context: *Morphology of tendo achilles can be measured in vivo and in vitro. In vitro by dissection methods, specimen are usually used. In vivo radiological measurement is most commonly practiced. In radiological aspect X-ray, Magnetic Imaging Resonance (MRI), Computed Tomography (CT) scan, ultrasonography are the recommended methods of tendo achilles measurement. All the measurements of tendo achilles vary with age, body height of the subjects and the dominance of the ankle. Aging is associated with a marked change in tendon measurements. With advancing age, there is a decrease in the size but increase in the fibril concentration of tendon thus the cross-sectional area of tendo achilles in older subjects is relatively larger. Older people and dominant ankles tend to have tendo achilles with a larger cross- sectional area. So the cross- sectional area is more accurate than the tendon thickness in assessing variations of tendon size. The aim of the study was to establish the standard reference values for the cross-sectional area (CSA) of tendo achilles as measured by diagnostic ultrasound in several age groups of sedentary people.*

Materials and Methods: *This is a cross sectional analytical type of study conducted in the Department of Anatomy Dhaka Medical College Hospital from July 2013 to June 2014.The present study was performed on 200 tendo achilles of 100 people (among them 50 were male and 50 were female). They were randomly selected from the patients who came to the Radiology Department of Dhaka Medical College Hospital for ultrasonography of any regions of their body other than leg.*

Result: *Highly significant difference was observed between the cross-sectional area of tendo achilles of right and left leg in male and female ($p<0.001$). Cross sectional area was more in male than that of female and cross-sectional area was larger in left tendon than that of right. In the present study highly significant correlation was observed between the cross-sectional area of tendo achilles with age ($p<0.001$). Cross-sectional area of left tendo achilles of the age group of 50 to 65 years was significantly higher than that of other age groups ($P < 0.05$). But statistically no significant difference was found between the cross-sectional area of right dominant and left dominant leg ($p>0.05$).*

Conclusion: *The data of cross-sectional area of tendo achilles obtained from the present study may provide valuable information in different aspects of medical science as a guide line for physiotherapists, radiologists, sports professionals, ortho-surgeons in early detection and monitoring the rehabilitation of professional athletes.*

Key wards: Cross-sectional area of tendo achilles, diagnostic ultrasound.

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Introduction:

Up to a few years ago, the radiological assessments of tendons were essentially based on low kilovolt radiography that provided very few information[1]. In the great majority of times it could only indicate the site where there was an increase in soft tissues, irregularities in tendons contour or the presence of calcifications. So radiography is no longer considered to be the modality of choice for detecting tendon disorders though it has added valuable information about diseased achilles

tendon in the past. Presently, magnetic resonance imaging (MRI) and ultrasound are the modalities of choice for tendons diseases diagnosis. Ultrasound presents a better spatial resolution than MRI, when studies obtained with more modern devices are compared[1]. This is due to the fact that tissues with few mobile protons emit little or no signal therefore; tendons internal architecture is not well demonstrated by MRI[2]. MRI can illustrate the tendon pathology in detail. But, the therapeutic guidelines based on MRI are missing, and its importance in clinical decision making has not yet been established[2]. High-resolution sonography is a useful imaging tool for the assessment of achilles tendons because of its high image quality for accurate assessment and measurement of the tendons[3]. It has been reported that sonography has high reliability in measurements of achilles tendons[4]. Ultrasound also has the advantage of allowing the study of tendons in a real-time dynamic mode .Other ultrasound advantages are: low cost, easy availability and the fact that, usually, during the examination, the comparison with the opposite side will be available. Ultrasonography is a quick, safe (no radiation danger), non-invasive and widely accessible imaging technique for tendon assessment[5]. The high acoustic contrast of tendons with the adjoining tissues makes them particularly suitable for ultrasonographic evaluation[6]. The use of clinically reliable tools is necessary to ensure accurate diagnosis of a condition; to formulate effective treatment plan based on the obtained information and also for effective evaluation of the clinical outcomes acquired from the chosen intervention. It has been reported that ultrasonography has good to high reliability in measuring achilles tendon[7].

Materials and Methods:

Subjects: In the present study 100 sedentary people of Bangladeshi were recruited. They were randomly selected from the Radiology Department of Dhaka Medical College Hospital. The study populations were those who did not take part in any physical exercise regularly or attended the gymnasium or sports club routinely or involved in any profession where legs were used most. We excluded those who were sportsmen, athletes, day labors, any history of foot surgery or systemic diseases as factors influencing the cross section area. They all gave their signed consent to participate in the study. Dominance of ankle was determined by asking the subjects electively use either the left or right foot to kick a ball. Therefore, the elected leg for ball kicking was considered as the non-dominant leg and the rest one was the dominant leg. They were assigned in four groups. Among them three male and three female were right dominant and rest were left dominant. Table 1 shows the study population that was classified into four groups to describe the various changes in relation to age[4]

Methods:

All ultrasonographic examinations were performed by using the high resolution B-mode ultrasound machine HITACHI EUB -7000HV and with a 7.5 MHz linear array transducer (probe).

Operational definitions:

a) Linear array transducer- the linear array transducer produces sound waves parallel to each other and produces a rectangular image. The width of the image and number of scan lines are the same at all tissue levels. This has the advantage of good near field resolution. High frequencies ie. 7.5 MHz's can be used for viewing superficial structure like tendon. Its disadvantage is artifacts when applied to a curved part of the body creating air gaps between skin and transducer.

b) Longitudinal and transverse evaluation: The tendo achilles can be easily seen when the transducer (probe) is placed in the transverse plane, longitudinal to the tendon fibers. The probe is moved proximally from the insertion site at the calcaneal tuberosity to the myotendinous junction. For evaluation in the longitudinal plane the transducer is turned 90 degrees.

The subjects were examined in a prone position with the ankles extended beyond the examination bed. Each ankle was just positioned at 90° such that the foot was dorsi-flexed. This position was

chosen to facilitate contact between the probe and the tendon and to avoid anisotropy effect which can occur if the tendon was not taut[8]. A small layer of ultrasound gel used as a medium for propagation of sound[9]. The probe was placed in the transverse plane, longitudinal to the tendon fibers at the insertion site at calcaneal tuberosity. Then it was turned 90 degrees for evaluation in the longitudinal plane. The normal tendo achilles had an echogenic pattern of parallel fibrillar lines in the longitudinal plane and an echogenic round to ovoid shape in the transverse plane [7]. Cross-sectional area was taken at rest from transverse plane, 4 centimeters proximal from the proximal margin of calcaneal tubercle (tendo achilles insertion site) which was approximately narrowest site of tendo achilles. Cross-sectional area was outlined using a polygon selection tool. Cross-sectional area was measured in millimeters² (mm²). Both the right and left tendo achilles were examined by using ultrasonography.

Ethical Clearance:

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

Result:

Cross-sectional area of right and left tendo achilles of different groups were 47.14±4.32 mm², 49.10±4.56 mm², 51.74±12.13 mm² & 52.91±11.42 mm² & 60.83±9.25 mm², 62.39±8.89 mm², 71.46±10.70 mm², 72.68±9.68 mm² respectively (Table II, Fig. 1).

Table-I

Grouping of study subjects of the present study (n=100).

Group	Age Range	Number of Study Subjects	
		Male	Female
A	20-29	10	11
B	30-39	18	16
C	40-49	10	09
D	50-65	12	14

Table II

Cross-sectional area of tendo achilles in different subjects of different age groups.

Age Group	Side	Cross-sectional area
A	Right leg	47.14±4.32
	Left leg	49.10±4.56
B	Right leg	51.74±12.13
	Left leg	52.91±11.42
C	Right leg	60.83±9.25
	Left leg	62.39±8.89
D	Right leg	71.46±10.70
	Left leg	72.68±9.68

Group A: Age 20-29 years
Group B: Age 30-39 years
Group C: Age 40-49 years
Group D: Age 50-65 years

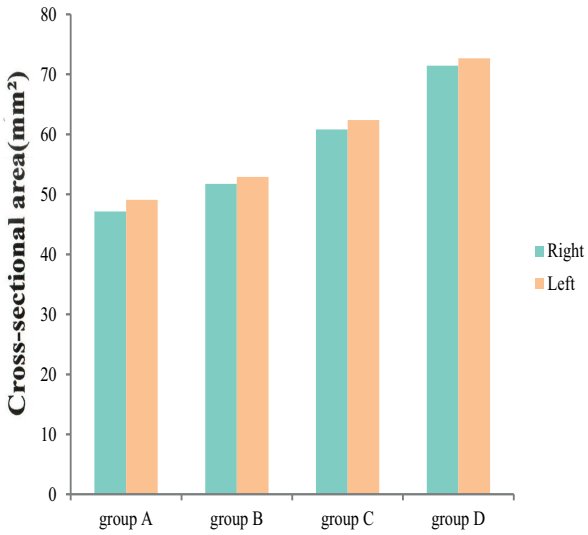

Fig.-1: *Cross-sectional area of tendo achilles in subject of different age groups.*

Group A: Age 20-29 years
Group B: Age 30-39 years
Group C: Age 40-49 years
Group D: Age 50-65years

The cross-sectional area of right and left tendo achilles were compared with age and the r value was r=+0.705 and +0.712 respectively and the correlation between the cross-sectional area of tendo achilles of right and left leg with age was found highly significant (P=<0.0001) (figure 2). Irrespective of sex statistically no significant difference was found between cross-sectional area of tendo achilles of right and left dominant leg (table III and Fig.-3).

Table III

Comparison between cross-sectional area of tendo achilles of dominant leg in male and female.

		Cross-sectional area in mm^2		
Dominant leg	Sex	Right leg	Left leg	*P value*
		Mean±SD	Mean±SD	
Right dominant	Male	76.33±21.96	74.53±21.32	0.393^{ns}
	(n=3)	(51.00 90.00)	(50.00 88.60)	
	Female	58.33±3.79	58.00±5.29	0.808^{ns}
	(n=3)	(54.00 61.00)	(52.00 62.00)	
	P value	0.234^{ns}	0.262^{ns}	
	Total	67.33±17.20	66.27±16.59	0.324^{ns}
	(n=6)	(51.00 90.00)	(50.00 88.60)	
Left dominant	Male	60.83±12.68	62.28±12.44	0.0001^{***}
	(n=47)	(41.00 90.00)	(42.00 90.00)	
	Female	53.00±12.72	54.70±12.13	0.031^{*}
	(n=47)	(31.00 85.00)	(38.00 77.000)	
	P value	0.004^{**}	0.004^{**}	
	Total	56.91±13.23	58.49±12.80	0.0001^{***}
	(n=94)	(41.00 90.00)	(38.00 90.00)	
Right dominant vs Left dominant				
		P value	*P value*	
	Male	0.054^{ns}	0.118^{ns}	
	Female	0.476^{ns}	0.645^{ns}	
	Total	0.069^{ns}	0.159^{ns}	

Figures in parentheses indicate range. Comparison between right and left leg was done by paired Student's 't' test and comparison between sex was done by unpaired Student's 't' test, ns = not significant, * = significant at P<0.05, ** = significant at P<0.01, *** = significant at P<0.001.

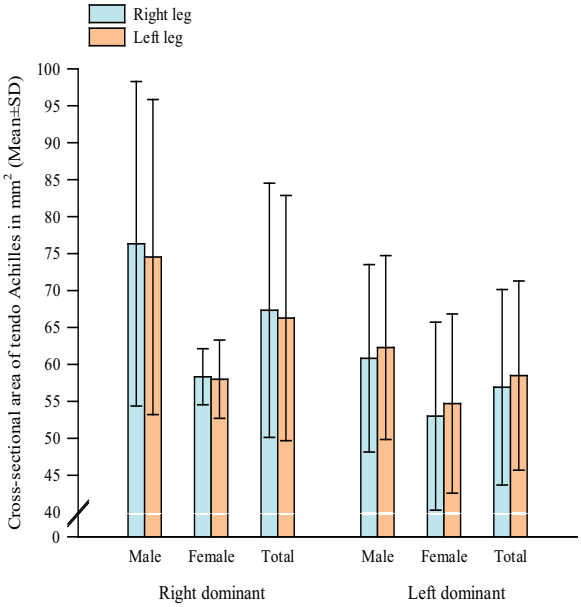

Fig.-2: *Correlation of age with cross-sectional area of tendo achilles of right and left leg of male and female.*

Discussion

It is observed by reviewing the available literatures that few works have been conducted on the measurements of tendo achilles in children, adult and sportsman in other countries. But so far it is known, there is no published work on ultrasonogram based measurements of tendo achilles and its variations with age and dominance of ankle of adult people of Bangladesh. So the findings of the present study could not be compared with any previous similar study on adult population of Bangladesh. A comparative discussion of the results of different variables with that of different authors and researchers of other countries are mentioned in this discussion.

The finding of the present study showed some similarities with the finding of Beatrice S.F. and Ying M. study[4] (p>0.05). They conducted a study over 80 achilles tendons of 40 subjects belonging to Hong Kong. They reported that the cross-sectional area of tendo achilles of 50 years or older was significantly higher than that of the subjects in the other age groups (P <0.05). There was a low correlation between body height and the cross-sectional area of the tendons (dominant ankle, P > 0.05; non dominant ankle, P >0.05). The similarities might be due to selection of same age group. With advancing age, there was a decrease in the size but increase in the fibril concentration of tendon thus the cross-sectional area of tendo achilles in older subjects is relatively larger. Yeung E[11] carried a study over 40 adult people (20 frequently exercised people and 20 infrequently exercised). Their age ranged from 19 to 25 years. He reported the mean value of cross-sectional area of left tendo achilles was 56.91mm². This value was close to the value of the cross-sectional area of left tendo achilles of the present study. Similarities might be due to the selection of study subjects in the same subcontinent area. Stenroth L[12]. conducted a study over 100 people (33 young and 67 old) of Finland, age ranged between 18-30 years and reported a result on cross-sectional area of male and female. Cross-sectional area of tendo achilles was 16% larger in old compared to young subjects (p<0.001) and 21% larger in men compared to women (p<0.001). This study showed highly significant difference with the findings of the present study (p<0.001). Difference were observed in measurements which might be due to admixture of different race and geographical distribution. It is known that there is a racial variation between Finland and Bangladeshi (mixed) people. People of Finland are admixture of Sweden, Amerindians, Europeans and Norwegians (Wikipedia, 2013).

Conclusion:

The use of diagnostic ultrasound can give reliable information regarding the morphological state of tendo achilles and these findings might be useful in the objective evaluation of pathological condition of tendo achilles. For measuring achilles tendon conditions ultrasonography can be used clinically in musculoskeletal and sports physiotherapy. It can prove to be a beneficial tool which can be used routinely by physiotherapists. Physiotherapists can incorporate the use of ultrasonography into routine examination of sport professionals.

References:

1. Andrade R, Marchiori E, Augosto A. and Neto T. Morphometric evaluation of Achillis Tendon by ultrasound. Radiol Bras. 2006;39(3): 2-11.

2. Eriksen H.A., Pajaia A., Leppilathi J and Ristelli J. Increased content of type III collagen at the rupture site of human achilles tendon. Journal of Orthopaedic Research. 2002; 20:1352–57.

3. Maffulli N., Barrass V. and Ewen SW. Light microscopic histology of achilles tendon ruptures: a comparison with unruptured tendons. Am J Sports Med. 2000; 28: 857-63.

4. Beatrice S.F. and Ying M. Sonographic Measurements of AchillesTendon in Asymtomatic Subjects 2006; 25:1291-96.

5. Grassi W, Filippucci E, Farina A and Cervini C (2000) Sonographic imaging of tendons. Arthritis & Rheumatisim. 2000; 43(5):969-76.

6. O'Connor P, Grainger AJ, Morgan SR, Smith KL, Wateron JC and Nash AFP. Ultrasound assessment of tendons in asymptomatic volunteers: a study of reproducibility. European Journal of Radiology. 2004; 14:1968-73.

7. Koivunen-niemela T and Parkkola K. Anatomy of achilles tendon (tendo calcaneous) with respect to tendon thickness measurements. Surgical and Radiologic Anatomy. 1995; 17:263-68.

8. Doral MN., Alam M., Bozcourt M., Turhan E and Maffulli N. Functional Anatomy of Achilles Tendon 2010;18:638-43.

9. Rumack C.M. Physics of ultrasound.3rd ed. Diagnostic Ultrasound. Elsevier Mosby .2005;1(1):3-8.

10. Brittany N. House. Bilateral mechanical properties of tendo achilles.2012;1-84.

11. Yeung E., Li B., Li W., Lui M and Tsoi CW. Sonographic evaluation of the size of achilles tendon: the effect of exercise and dominance of the ankle. Ultrasound Med Biol. 2003;29(5):637–42.

12. Stenroth L. Age related differences in achilles tendon properties and triceps surae muscle architecture in vivo.2012;(10):1152.