

Ultrasonographic Assessment of Normal Achilles Tendon Thickness and Width in the Asymptomatic Sudanese Population

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Abstract

Background: The goal of this study was to measure normal Achilles tendon (AT) thickness and width in adult asymptomatic Sudanese people using high-resolution ultrasound.

Methods and Results: The study was conducted on members of a healthy Sudanese population (120 volunteers: 73/60.8% women and 47/39.2% men), who were chosen using simple random sampling. The study cases were all healthy people with no history of AT injuries or abnormalities. All patients were examined using a Toshiba Xairo200 linear transducer with a frequency range of 7-10MHz. All measurements were taken from a transverse scan at the calcaneus bone level of the AT insertion and 2 to 3cm above the calcaneus. The age group 20-27 had the most participants (44.2%), followed by 36-43 years (19.2%), 28-35 years (15.8%), 52-60 years (14.2%), and 44-51 years (6.7%). The study revealed that the mean age of participants was 34.19±12.29 years, height - 164±0.081 cm, weight - 67.22±15.97 kg, and BMI - 24.38±5.84 kg/m². The mean thickness and width of the AT were 4.36±0.81 mm and 21.85±3.23 mm, respectively, at its insertion into the calcaneus, and 4.63±0.77 mm and 12.20±1.37 mm, respectively, at the level 2-3 cm above the insertion. We found significant differences according to gender between the AT thickness and width at insertion into the calcaneus and above insertion and no statistically significant differences between the AT measurement's right and left side data.

Conclusion: The study found gender differences in the AT thickness and width at insertion into the calcaneus and 2-3 cm above the insertion. No statistically significant differences were detected between the AT measurement's right and left side data. Age, weight, height, and BMI correlated with the thickness and width of the AT at its insertion into the calcaneus and 2-3 cm above. Furthermore, additional research should be conducted using an extended field-of-view technology to measure the length of the AT tendon in the Sudanese population. (**International Journal of Biomedicine. 2023;13(1):95-100.**)

Keywords: Achilles tendon • high-resolution ultrasound • thickness

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Introduction

Traditionally, conventional radiography was thought to be the primary tool for investigating bone and joint disorders. But now ultrasound (US) is taking on a larger role. Because of their superficial nature, the muscles, joints, connective tissues, and vascular structures of the upper and lower extremities are particularly well-suited for an ultrasound examination. As a result, over the last decade, ultrasound has played an important role, frequently serving as the primary tool for investigating many joint injuries and pathologies. In addition, when compared to other imaging technologies, such as MRI or CT scanning, ultrasound is very cost effective. For these reasons, the applications of musculoskeletal ultrasound have grown significantly in recent years.⁽¹⁾

Recent advancements in ultrasound system instrumentation and transducer technology promise a bright future for musculoskeletal disease research. Extended field-of-view imaging, harmonic tissue imaging, spatial compound imaging, and 1.5D transducer arrays are just a few of the advancements.⁽¹⁾ Transverse scans should be used for measurements.

Ultrasound (US) is thought to be the gold standard imaging technique for assessing tendons.⁽²⁾ To date, there is a noticeable lack of a standardized method for measuring AT thickness using US. In some studies, the insertion site of the tendon was used for measuring the thickness, while in others, the measurement was taken 2 or 3 cm proximal to the insertion site.⁽³⁻⁷⁾

The Achilles tendon (AT) has a thickness of 5 to 7 mm and a width of 12 to 15 mm at level 2 to 3 cm superior to its insertion into the calcaneus.⁽⁸⁾ Because the AT is the most commonly injured ankle tendon, it is critical to examine it from origin to insertion in both transverse and sagittal planes. The AT is most commonly injured 2-6 cm proximal to its insertion into the calcaneus, where a zone of relative vascularity exists.⁽⁹⁾

The goal of this study was to measure normal AT thickness and width in adult asymptomatic Sudanese people using high-resolution ultrasound.

Materials and Methods

The study was a descriptive cross-sectional study that took place at Prof. Abd Elsamad Mohammed Saleh X-ray and Ultrasound Training Center from April to September 2021. The study was conducted on members of a healthy Sudanese population (120 volunteers), who were chosen using simple random sampling. The study cases were all healthy people with no history of AT injuries or abnormalities. All subjects with a history of metabolic or inflammatory diseases, as well as those who have been treated with corticosteroids, were excluded from this study. All patients were examined using a Toshiba Xairo200 linear transducer with a frequency range of 7-10MHz.

The researcher filled out a data collection sheet that was designed to include all variables to satisfy the study and ultrasound examinations. The patient was lying prone on the examination table, with one foot hanging freely over the end of the table, slightly flexed.⁽⁹⁾ A coupling agent was required

to ensure good acoustic contact between the transducer and the skin, and complete sound beam transmission. Following informed consent, the patients' ankles were scanned with a linear transducer using the posterior approach technique.⁽¹⁰⁾

The AT was first imaged transversely from its insertion at the calcaneus to a level 2 to 3 cm above the insertion at the malleoli. The findings were then documented. All measurements were taken from a transverse scan at the calcaneus bone level of the AT insertion and 2 to 3cm above the calcaneus.

Statistical analysis was performed using statistical software package SPSS version 16.0 (SPSS Inc, Chicago, IL). Continuous variables with normal distribution were presented as mean (standard deviation [SD] and standard error of the mean [SEM]). Means of 2 continuous normally distributed variables were compared by independent samples Student's t-test. A 95% Confidence Interval (CI) of the difference was calculated. The frequencies of categorical variables were compared using Pearson's chi-squared test. A value of $P < 0.05$ was considered significant.

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Alzaiem Alazhari University (Khartoum, Sudan). The data was only used for study purposes without individual details identifying the participant. All patients gave verbal consent.

Results

A total of 240 ATs were scanned from 120 participants (73/60.8% women and 47/39.2% men), with 120 being right ATs and 120 being left ATs. The age group 20-27 had the most participants (44.2%), followed by 36-43 years (19.2%), 28-35 years (15.8%), 52-60 years (14.2%), and 44-51 years (6.7%) (Tables 1-9, Images 1-5).

Table 1.
Gender distribution of the study group.

Gender	Frequency	Percent	Valid Percent	Cumulative percent
Males	146	39.2	39.2	39.2
Females	94	60.8	60.8	100.0
Total	240	100.0	100.0	

Table 2.
Age distribution of the study group.

Age group	Frequency	Percent	Valid Percent	Cumulative percent
20- 27 years	106	44.2	44.2	44.2
28-35 years	38	15.8	15.8	60.0
36- 43 years	46	19.2	19.2	79.2
44- 51 years	16	6.7	6.7	85.8
52-60 years	34	14.2	14.2	100.0
Total	240	100.0	100.0	

Table 3.

Side distribution of AT measurements.

Side	Frequency	Percent	Valid Percent	Cumulative percent
Right	120	50.0	50.0	50.0
Left	120	50.0	50.0	100.0
Total	240	100.0	100.0	

Table 4.

Descriptive statistics for AT measurements, age, height, weight, and BMI.

Characteristics	n	Min	Max	Mean	SD
Age, year	240	20	60	34.19	12.29
Height, m	240	1.48	1.85	1.64	.0812
Weight, kg	240	37.00	120.0	67.22	15.97
BMI, kg/m ²	240	16	46	24.38	5.84
Thickness at insertion, mm	240	2.50	6.90	4.36	0.817
Width at insertion, mm	240	13.30	29.30	21.85	3.23
Thickness above insertion, mm	240	3.00	7.20	4.63	0.77
Width above insertion, mm	240	9.20	14.90	12.20	1.37
Valid N (list wise)	240				

Min - Minimum; Max - Maximum

Table 5.

Descriptive statistics for AT measurements according to gender.

A=Compare mean

Characteristics	Gender	n	Mean	SD	SEM
Thickness at insertion, mm	Males	94	4.61	0.62	0.064
	Females	146	4.20	0.88	.073
Width at insertion, mm	Males	94	22.99	2.83	0.29
	Females	146	21.12	3.27	0.27
Thickness above insertion, mm	Males	94	4.88	0.61	0.063
	Females	146	4.47	0.82	0.068
Width above insertion, mm	Males	94	12.76	1.18	0.12
	Females	146	11.83	1.36	0.11

Table 6.

Levene's test for equality of variances (Independent sample t-test) for gender groups

Characteristics	T	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% CI of the difference	
						Lower	Upper
Thickness at insertion, mm	3.932	238	0.000	0.41	0.10499	.20600	.61967
	4.226	235.764	0.000	0.41	0.09768	.22040	.60528
Width at insertion, mm	4.542	238	0.000	1.86	0.41142	1.05809	2.67907
	4.685	218.045	0.000	1.86	0.39888	1.08244	2.65472
Thickness above insertion, mm	4.115	238	0.000	0.40	0.09935	.21306	.60449
	4.376	232.676	0.000	0.40	0.09341	.22474	.59280
Width above insertion, mm	5.419	238	0.000	0.93	0.17188	.59288	1.27008
	5.594	218.481	0.000	0.93	0.16651	.60330	1.25965

Table 7.

Descriptive statistics for AT measurements according to right and left sides.

A=Compare mean

Characteristics	Side	n	Mean	SD	SEM
Thickness at insertion, mm	Right	120	4.36	0.80004	.07303
	Left	120	4.36	0.83819	.07652
Width at insertion, mm	Right	120	21.84	3.22898	.29476
	Left	120	21.87	3.25724	.29734
Thickness above insertion, mm	Right	120	4.60	0.77536	.07078
	Left	120	4.66	0.77865	.07108
Width above insertion, mm	Right	120	12.16	1.38963	.12685
	Left	120	12.24	1.36440	.12455

The study revealed that the mean age of participants was 34.19±12.29 years, height - 164±0.081 cm, weight - 67.22±15.97 kg, and BMI - 24.38±5.84 kg/m². The mean thickness and width of the AT were 4.36±0.81 mm and 21.85±3.23 mm, respectively, at its insertion into the calcaneus, and 4.63±0.77 mm and 12.20±1.37 mm, respectively, at the level 2-3 cm above the insertion.

Discussion

This result is consistent with the findings of a study by Beatrice et al.⁽¹¹⁾ The mean thickness of the AT above insertion was 5.1±0.63 mm, which agrees with the findings of Aydın et al.,⁽¹²⁾ who discovered that the mean thickness of the AT above insertion was 4.0±0.8mm in the healthy control group, but differs from the findings of van Schie et al.,⁽¹³⁾ who discovered that the mean AT thickness was 6.8 mm in the asymptomatic group.

Schmidt et al.⁽⁵⁾ have previously reported a difference of half a millimetre in the mean AT thickness of male and female healthy subjects. The sagittal diameter of the AT was 4.9 mm for women and 5.3 mm for men in a Spanish study,⁽¹⁴⁾ compared with 4.1 mm and 4.6 mm, respectively, in a study by Schmidt et al.⁽⁵⁾ Our study also discovered that in men, the mean thickness and width of the AT were 4.61±0.62 mm and 22.99±2.83 mm, respectively, at its insertion into the calcaneus, and 4.88±0.61 mm and 12.76±1.18 mm, respectively, at the level 2-3 cm above the insertion. In women, the mean thickness and width of the AT were 4.20±0.88 mm and 21.12±3.27 mm, respectively, at its insertion into the calcaneus, and 4.47±0.82 mm and 11.83±1.36 mm, respectively, at the level 2-3 cm above the insertion (Table 5). de Mello et al.⁽¹⁵⁾ found that the mean transverse diameter and anteroposterior diameter of the AT were 14.4±1.4 mm and 5.6±0.6 mm for males and 13.3±1.0 mm and 5.4±0.5 mm for females. We found significant differences according to gender between the AT thickness and width at insertion into the calcaneus and above insertion ($P<0.05$) (Table 6). This finding is consistent with the findings of de Mello et al.,⁽¹⁴⁾ whose measurements were significantly lower in females, and also agrees with a study done by Aydın et al.,⁽¹²⁾ who found a significant difference in the AT thickness in different genders (higher in males).

Table 8.

Levene's test for equality of variances (Independent sample t-test) for the right and left sides.

Characteristics	T	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% CI of the difference	
						Lower	Upper
Thickness at insertion, mm	.055	238	.956	.00583	.10578	-.20254	.21421
	.055	237.485	.956	.00583	.10578	-.20255	.21421
Width at insertion, mm	-.076	238	.940	-.03167	.41869	-.85647	.79314
	-.076	237.982	.940	-.03167	.41869	-.85647	.79314
Thickness above insertion, mm	-.565	238	.573	-.05667	.10031	-.25428	.14094
	-.565	237.996	.573	-.05667	.10031	-.25428	.14094
Width above insertion, mm	-.431	238	.667	-.07667	.17778	-.42689	.27356
	-.431	237.920	.667	-.07667	.17778	-.42689	.27356

Table 9.

Correlations between age, gender, height, weight, and BMI and all AT measurements.

Characteristics	Statistics	Age	Gender	Height	Weight	BMI	Side
Thickness at insertion	PC	.241**	-.247**	.351**	.577**	.451**	-.004
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.956
Width at insertion	PC	.169**	-.282**	.368**	.364**	.226**	.005
	Sig. (2-tailed)	.009	.000	.000	.000	.000	.940
Thickness above insertion	PC	.231**	-.258**	.369**	.660**	.530**	.037
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.573
Width above insertion	PC	.139*	-.331**	.416**	.490**	.331**	.028
	Sig. (2-tailed)	.031	.000	.000	.000	.000	.667
	N	240	240	240	240	240	240

PC -Pearson Correlation

** - Correlation is significant at the 0.01 level (2-tailed).

* - Correlation is significant at the 0.05 level (2-tailed).

The study also discovered that the mean thickness and width of the AT on the right side were 4.36±0.80 mm and 21.84±3.22 mm, respectively, at its insertion into the calcaneus, and 4.60±0.77 mm and 12.16±1.38 mm, respectively, at the level 2-3 cm above the insertion. The mean thickness and width of the AT on the left side were 4.36±0.83 mm and 21.87±3.26 mm, respectively, at its insertion into the calcaneus, and 4.66±0.78 mm and 12.24±1.36, respectively, at the level 2-3 cm above the insertion. We used the independent sample t-test to compare means and found no statistically significant differences between the AT measurement's right and left side data (Table 7, 8). Canbolat et al.⁽¹⁶⁾ also found that AT width and thickness showed no significant differences between the right and left side tendons.

Our study discovered statistically significant weak positive correlations between age and all AT measurements (Table 9). Statistically significant weak negative correlations were found between genders and all AT measurements. Moderate, significant positive correlations were found between the height and all AT measurements. Weight had a strong significant positive correlation with the AT thickness at insertion and a level above the insertion into the calcaneus, and a moderate, significant correlation with the AT width. Abate et al.⁽¹⁷⁾ noted that overweight, sedentary individuals showed Achilles tendon thickness values significantly higher than normal-weight sedentary individuals. BMI correlated strongly with the AT thickness above its insertion into the calcaneus and moderately with other AT measurements. According to the findings, there was no significant relationship between the side and the AT measurements (Table 7-9).

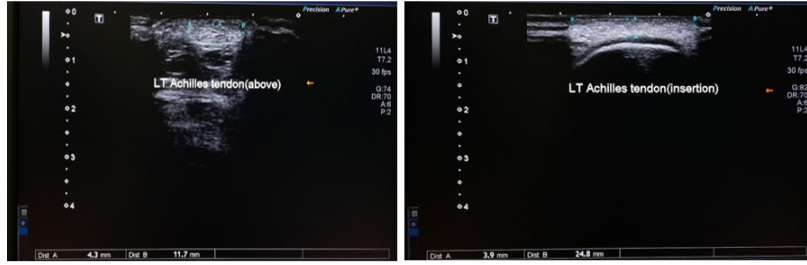


Image 1. Linear MSK ultrasound of the same patient. The left AT measurements (thickness at the AT insertion into the calcaneus and above insertion: 3.9 mm and 4.3 mm, respectively; the width at the AT insertion into the calcaneus and above insertion: 24.8 mm and 11.7mm, respectively).

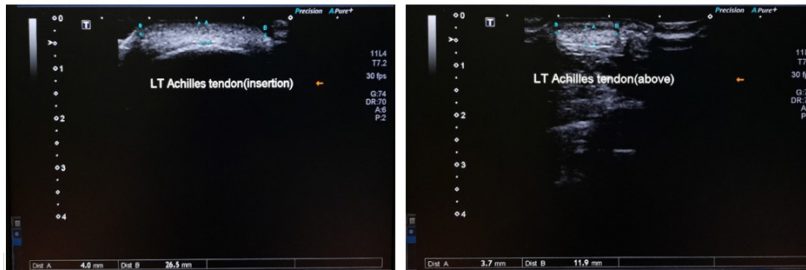


Image 2. Linear MSK ultrasound of a 26-year-old female patient. The left AT measurements (thickness at the AT insertion into the calcaneus and above insertion: 4.0 mm and 3.7 mm, respectively; the width at the AT insertion into the calcaneus and above insertion: 26.5 mm and 11.9 mm, respectively).



Image 3. Linear MSK ultrasound of the same patient. The right AT measurements (thickness at the AT insertion into the calcaneus and above insertion: 3.4 mm and 4.7 mm, respectively; the width at the AT insertion into the calcaneus and above insertion: 23.4 mm and 11.1 mm, respectively).

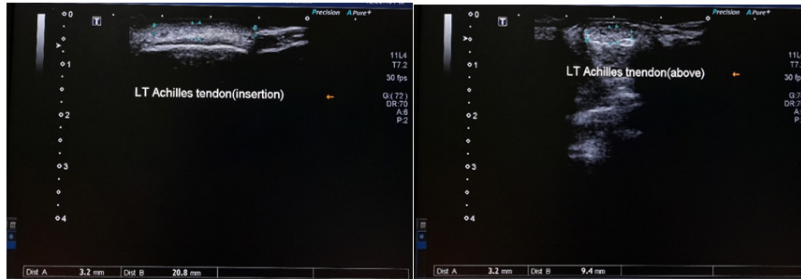


Image 4. Linear MSK ultrasound of a 26-year-old female patient. The left AT measurements (thickness at the AT insertion into the calcaneus and above insertion: 3.2 mm and 3.2 mm, respectively; the width at the AT insertion into the calcaneus and above insertion: 20.8 mm and 9.4 mm, respectively).

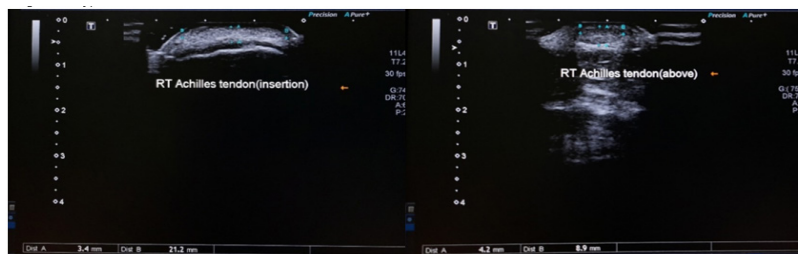


Image 5. Linear MSK ultrasound of the same patient. The right AT measurements (thickness at the AT insertion into the calcaneus and above insertion: 3.4 mm and 4.2 mm, respectively; the width at the AT insertion into the calcaneus and above insertion: 21.2 mm and 8.9 mm, respectively).

Conclusion

Our study found gender differences in the AT thickness and width at insertion into the calcaneus and at the level 2-3 cm above the insertion. Age, weight, height, and BMI correlated with the thickness and width of the AT at its insertion into the calcaneus and 2-3 cm above. All ultrasound departments should have a high-resolution musculoskeletal ultrasound. More research on athletes is needed to determine if sport affects AT size. Soldiers who have been standing on their feet for a long time should have more AT measurements taken. Children's reference value needs more research. Furthermore, additional research should be conducted using an extended field-of-view technology to measure the length of the AT tendon in the Sudanese population.

Competing Interests

The authors declare that they have no competing interests.

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