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ORIGINAL ARTICLE

Measuring Average Supraspinatus Tendon Thickness on Musculoskeletal Ultrasound: Variation in Young Adults

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ABSTRACT

Background: The human shoulder is one of the most mobile joints of the body but it has less stability as compared to the hip joint which is also a ball and socket joint.
Aim: To measure average supraspinatus tendon thickness in young adults, and compare the tendon thickness between genders by using musculoskeletal ultrasound.
Study design: Cross sectional study.
Methodology: A total of 128 healthy young adults were screened for shoulder pathology using Apley scratch test, Empty Can and Full Can test. The measurements were taken in Modified Crass Short Axis View of Supraspinatus Tendon at 5mm, 10mm and 15mm from Bicep Long Head Tendon and Modified Crass Long Axis View of Supraspinatus Tendon at 5mm, 7mm and 10mm from the highest point of humerus. Data was evaluated by using SPSS version 23. All qualitative data was presented in frequency form and quantitative data was in the form of mean ± SD.
Results: There was a significant difference in tendon thickness between males and females. In the long axis view males had thicker tendon as compared to females at 5mm and 7mm in the right side whereas in the left side there was difference at 5mm, 7mm and 10mm from the highest point on the humerus. Within gender comparison showed significant difference in tendon thickness measured in short axis as significant tendon thickness difference measured at 5mm, 7mm and 10mm from highest point of humerus.
Conclusion: It was concluded that supraspinatus tendon thickness differed significantly in young males and females.
Keywords: Musculoskeletal Ultrasound, Supraspinatus Tendon Thickness, Young Adults, Body Mass Index and Rotator Cuff.

INTRODUCTION

The human shoulder is one of the most mobile joints of the body but it has less stability as compared to the hip joint which is also a ball and socket joint[1]. The stability that it has is solely due to the four muscles surrounding the two bones forming the gleno-humeral joint[2]. These four muscles insert on the neck of the humerus, blending together to form the rotator cuff[3]. The function of rotator cuff is to enhance stability of the gleno-humeral joint and serve as prime movers of the said joint[4].

The supraspinatus muscle lies on top of the other rotator cuff muscles and is quite prone to impingement between the acromion process of scapula and humeral head. According to a study on cumulative trauma of the shoulder, the clinical frequency of shoulder pain is second to low back pain in US. There may be several factors resulting in shoulder pain such as repetitive arm movements, awkward postures and heavy work[5]. Shoulder pain is the third most common condition that is presented to the physical therapists[6]. According to literature, there is generally a difference in the range of motion of dominant and non-dominant side of the body and this difference is consistent in the upper and lower extremity[7]. It is believed that body structure which is used more would develop more, whether it's a bone or muscle, even in older adults[8].

Apley scratch test is used to access any restriction in range of motion of shoulder joint[9]. Empty can test is used to assess supraspinatus impingement with 41% to 89% sensitivity and 50% to 90% specificity. Full can test is also used for supraspinatus impingement with 44% to 100% sensitivity with pain and 50% to 99% specificity[10]. Musculoskeletal ultrasound has been used in clinical practice for the past 33 years. The first published work on musculoskeletal ultrasound by a physical therapist was in 1986 by Maria Stokes and Archie Young[11]. Physical therapists have been using musculoskeletal ultrasound for several purposes including diagnosis, prognosis, interventional and research[12]. Ultrasound is considered to be a reliable tool for tendon thickness measurement, only when it is used with defined protocols[13]. For musculoskeletal ultrasound, linear probe is used. The probes are classified into two classes i.e. low and high frequency probes. The low and high frequency probes have <7.5 MHz and >7.5 MHz frequency respectively with the frequency reaching as high as 20 MHz[14]. The frequency used in musculoskeletal ultrasound can vary depending upon the tissue depth. As a general rule, high frequency has low penetration and low frequency has high penetration into the tissues[15].

The mode most commonly used for musculoskeletal ultrasound is Brightness mode also known as B-mode. The picture produced by B-mode is black and white. All tissues have a characteristic appearance on ultrasound. The terminology of ultrasound is based on echo. The bone being more reflective appears hyper echoic which refers to being more bright. The muscle having more water content as compared to bone appears more darker or hypo echoic while the tendon appears as hyper echoic as compared to muscle because of having more connective tissue and less water.[16] A few studies suggest that supraspinatus tendon thickness increases with impingement, while one study stated otherwise.[17] It was to find out the average thickness of supraspinatus tendon in healthy male and female adults, to see whether there lies any difference of thickness between both genders of homogenous characteristics like age, body mass index and height, as well as to find out any difference between the dominant and non-dominant shoulder.

The objective of the study was to measure average supraspinatus tendon thickness in young adults, and compare the tendon thickness between genders by using musculoskeletal ultrasound.

METHODOLOGY

It was an explorative comparative cross-sectional study. It was conducted at Aqua Shoulder Rehab Centre, Islamabad, Pakistan. There were 128 participants (64 males and 64 females) who volunteered for this study. Written consent was taken from all participants for their supraspinatus tendon thickness measurement and procedures followed were in accordance with ethical

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standards as per Declaration of Helsinki.[18] All the participants were screened on the basis of Apley scratch test[19], Empty can (Jobe's) and Full can (Neer's) test[20] and were included in the study only if all the aforementioned test findings were negative. The musculoskeletal ultrasound machine used was Hitachi EUB-5500, with default settings on B-Mode, with 6-13 MHz linear probe (L-54M). The measurements were taken in Modified Crass Short Axis View of Supraspinatus Tendon at 5mm, 10mm and 15mm from Bicep Long Head Tendon (Fig. 1) and Modified Crass Long Axis View of Supraspinatus Tendon at 5mm, 7mm and 10mm from the highest point of greater tuberosity of humerus (Fig. 2). Three measurements were taken at each site and averaged for a single measurement. Data was collected by a self-structured questionnaire that included demographics and supraspinatus tendon thickness measurements in Modified Crass positions at the above mentioned locations. All the measurements were done by the machine's default calipers; no image processing was done after that. All the images were stored in a USB by the patient's unique identity number.

Statistical analysis: All data collected were analyzed through SPSS version 23. All qualitative data was presented in frequency form and quantitative data was in the form of mean±SD. To confirm the difference between the mean values of the two groups of males and females, independent sample t-test was used. For within group analysis, paired t test was used.

RESULTS

Mean Body Mass Index was 23.8±5.38 for male and 24.2±4.45 for female participants. Table-1 reflected values of independent sample t-test that was applied to measure the mean difference in score of males and females participants. It was evident from the values shown that a difference existed in the mean score as mean value 5.21±0.81 in the males' group was significantly greater than mean value 4.76±0.84 in females' group (p = 0.003) in Short axis view at 5mm and 10mm from Bicep long head tendon.

Table-1: Comparison of supraspinatus tendon thickness between genders

		Males		Females		P-value
		Mean	SD	Mean	SD	
Short Axis View From Bicep Long Head Tendon						
Right Side	5mm	5.21	0.81	4.76	0.84	0.003*
	10mm	5.34	.85	4.84	.70	0.000*
	15mm	5.47	.87	5.33	1.14	0.439
Left Side	5mm	5.01	.94	4.64	.85	0.020*
	10mm	4.89	.78	4.53	.46	0.002*
	15mm	4.80	.69	4.68	.55	0.285
Long Axis View From Highest Point on Humerus						
Right Side	5mm	4.02	.53	3.37	.57	0.000*
	7mm	4.68	.66	4.18	.58	0.000*
	10mm	5.36	.77	5.11	.70	0.063
Left Side	5mm	3.67	.47	2.93	.38	0.000*
	7mm	4.21	.48	3.61	.42	0.000*
	10mm	5.07	.64	4.42	.74	0.000*

*Statistically Significant

The result showed significant difference in Supraspinatus tendon thickness between males and females in Short axis View at 5mm and 10mm from Bicep Long Tendon. However, there was no difference in tendon thickness at 15mm between males and females. Males and females have difference in tendon thickness in Modified Crass long axis View of Right Supraspinatus Tendon at 5mm and 7mm and Left Supraspinatus Tendon at 5mm, 7mm, and 10mm from the highest point on tuberosity of humerus (Fig.1).

Table-2 showed the comparison of two values; right and left of males and females groups, for the Short and Long Axis View Supraspinatus Tendon Thickness. The mean value of male participants' right side is 5.21±0.80 and the mean value of left side is 5.01±0.94 while mean value of female participants' right side is 4.76±0.84 and the mean value of left side is 4.64±0.85. The right and left side short axis supraspinatus thickness at 5mm from Bicep long head tendon of males and females participants had p >0.05.

Figure-1: Supraspinatus Tendon thickness in Short Axis View in Modified Crass Position

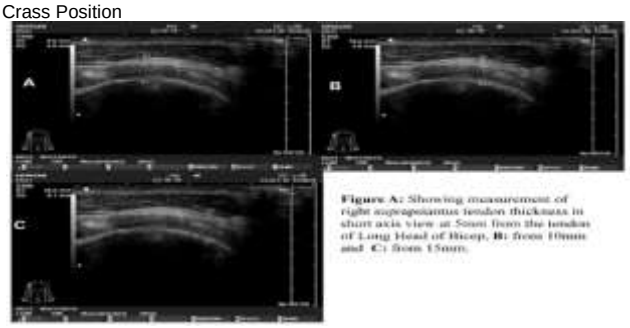


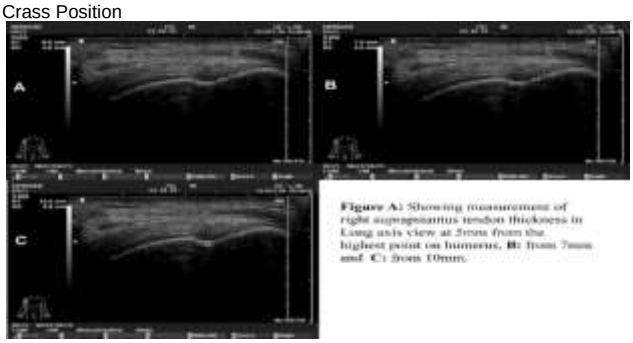
Table-2: Comparison of supraspinatus tendon thickness of right and left side within genders

		Gender	Mean	SD	*p-value*
Short Axis View from Bicep Long Head Tendon					
Right	5mm	Males	5.21	.80	0.010*
Left	5mm		5.01	.94	
Right	5mm	Females	4.76	.84	0.066
Left	5mm		4.64	.85	
Right	10mm	Males	5.33	.85	0.000*
Left	10mm		4.88	.77	
Right	10mm	Females	4.83	.70	0.000*
Left	10mm		4.53	.45	
Right	15mm	Males	5.46	.87	0.000*
Left	15mm		4.80	.69	
Right	15mm	Females	5.33	1.11	0.000*
Left	15mm		4.68	.55	
Long Axis View from Highest Point on tuberosity of Humerus					
Right	5mm	Males	4.02	.52	0.000*
Left	5mm		3.68	.47	
Right	5mm	Females	3.37	.57	0.000*
Left	5mm		2.94	.38	
Right	7mm	Males	4.68	.66	0.000*
Left	7mm		4.21	.48	
Right	7mm	Females	4.18	.59	0.000*
Left	7mm		3.61	.41	
Right	10mm	Males	5.36	.77	0.002*
Left	10mm		5.06	.63	
Right	10mm	Females	5.11	.70	0.000*
Left	10mm		4.42	.74	

*Statistically significant

This value was indicating that difference between supraspinatus thickness of right side and left side of males and females participants is not significant. Short axis at 10 mm and 15mm from Bicep Long Head Tendon and Long Axis at 5mm, 7mm and 10mm from highest point on tuberosity of humerus of males and females participants had p<0.05. This value was indicating that there was significant difference in males and females tendon thickness in Short and Long Axis View of Supraspinatus Tendon Thickness as shown by figure-2.

Figure-2: Supraspinatus Tendon thickness in Long Axis View in Modified Crass Position



DISCUSSION

Ultrasonography has been extensively considered a primarily qualitative and quantitative diagnostic tool. In this study, sonographic measurement of supraspinatus tendon was performed by a trained physiotherapist. Most tendons vary in thickness along their length, and a standardized examination procedure should be used to ensure that measurements are taken at same point. The results of our study showed that males and females have difference in tendon thickness in Modified Crass long axis View of Right Supraspinatus Tendon at 5mm and 7mm and Left Supraspinatus Tendon at 5mm, 7mm and 10mm from the highest point on tuberosity of humerus. There is difference in Supraspinatus tendon thickness between males and females in Short axis View at 5mm and 7mm from Bicep Long Tendon but there is no difference in tendon thickness at 15mm between males and females. Bjordal JM et al reported that men have slightly larger tendon thickness than women and depth to the supraspinatus tendon is doubled in overweight white-collar workers[21].

When right and left side in males and vice versa for females were compared, it was found that there is significant difference in tendon thickness measured in short axis view between males and females at 10mm and 15mm distance from long head of bicep tendon. There was significant tendon thickness difference in long axis view measured at 5mm, 7mm and 10mm from highest point of tuberosity of humerus between males and females. The p value for both long and short axis view mentioned above was <0.05. According to Neil P. Shah MD et al., Crass and modified Crass positions should remain the standard shoulder positions for sonographic evaluation of the supraspinatus tendon because of excellent visualization of the tendon[22]. A study was conducted on Supraspinatus tendon and subacromial space parameters measured on ultrasonographic imaging in subacromial impingement syndrome, suggesting that supraspinatus tendon mean thickness was 6.6mm in those with subacromial impingement syndrome and 6.0mm in the healthy controls.[17] Another study described the thickness of rotator cuff tendons (supraspinatus, infraspinatus, and subscapularis) and deltoid muscle to be significantly different for men and women. The thickness of subacromial subdeltoid bursa was significantly different between men and women for non-dominant side. In rotator cuff tendon measurements, the differences between dominant and non-dominant shoulders were not significant, which means the asymptomatic contralateral shoulder can be used to estimate the normal reference values[23]. There has been research demonstrating that the thickness of the supraspinatus tendon was significantly different for the dominant and non-dominant arms in men and women. The difference in thickness was 0.5mm in men and 0.3mm in women at the medial edge of the footprint and was 0.3 mm in men and 0.27mm in women at the middle of the footprint. A statistical difference was found between the dimensions of women and men. The thickness of the supraspinatus tendon was significantly different between the dominant and non-dominant arms in men and women but no significant difference between the dominant and non-dominant sides was found amongst the same sex[24].

Limitations: Unable to compare the right and left sided hand dominance and its effects on the tendon thickness. The physiotherapists or other healthcare professionals should measure the supraspinatus tendon thickness at various points and on both sides to determine any hypertrophy or pathology.

CONCLUSION

It is concluded that supraspinatus tendon thickness differed significantly in male and female adults. There was no difference in supraspinatus tendon thickness in right and left side of both genders at 5mm from the tendon of long head of bicep but there was significant difference between both sides at other measured points.

Conflict of interest: Nil

Author's contribution: SAH&AK: Conceptualized the study and formulated the initial draft, **SJ&ZH:** Contributed to the proof reading, **NK&RA:** Analyzed data

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