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Orignal Article

Accuracy Of The Sonographic Acromion to Greater Tuberosity Distance During Abduction in The Diagnosis of Shoulder Impingement Syndrome

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ABSTRACT

Shoulder impingement is the painful entrapment of the soft tissues in the shoulder outlet. Currently, dynamic sonography of the shoulder is the modality of choice for the evaluation of shoulder impingement syndrome. However, the current sonographic criteria for the evaluation of shoulder impingement is more subjective (operator dependent). And it is rather difficult for a novice observer to diagnose it. The measurable acromian to greater tuberosity distance during shoulder abduction is considered as a diagnostic criteria for shoulder impingement syndrome **Objective:** To estimate the accuracy of the acromion to greater tuberosity distance in shoulder abduction as a sonographic diagnostic parameter for the shoulder impingement syndrome **Methods:** Seven hundred and seventy-two shoulders were observed in this study. All the shoulders were evaluated with Toshiba Xario Prime ultrasound Unit with linear transducer 7-14MHz. Acromion to greater tuberosity distance was measured during the abducted arm. All the shoulders with measurable distance during abduction were declared as positive for impingement while unmeasurable distance due to disappearance of the greater tuberosity underneath the acromion was normal **Results:** An excellent inter-observer (novice and expert) agreement was observed in the diagnosis of shoulder impingement through the acromon to greater tuberosity distance during abduction criteria with a Kappa value of 0.96. For the diagnosis of shoulder impingement syndrome, its sensitivity, was 0.9731% and specificity 99.9% **Conclusion:** Sonographically measurable acromion to greater tuberosity distance during active arm abduction is a more accurate, reliable, and objective technique for the diagnosis of shoulder impingement syndrome.

INTRODUCTION

Amongst musculoskeletal disorders, shoulder impingement syndrome (SIS) is the third most common cause of pain. Most of the patients are visiting the orthopedic department with this complaint [1]. Shoulder impingement or shoulder pain syndrome is the painful entrapment of the soft tissues in the shoulder outlet [2]. The shoulder outlet is the space between the acromion and humeral head. It is caused either by narrowing of the shoulder outlet or thickening of its contents (supraspinatus tendon (SST), subacromial subdeltoid (SASD) bursa, joint capsule, etc.) [3,4]. The one-month prevalence of shoulder pain is between 16% and 30% [5]. SIS could be caused by a myriad of different conditions ranging from occupation to degenerative bone disease and tendon tear [6]. Historically multiple imaging and clinical examination techniques were used for the evaluation of SIS. However, plain x-ray, CT, MIR and sonography are being used for its diagnosis as imaging modalities [7]. In adjunct to physical examination, Sonography has progressively being used for the evaluation of SIS for more than three decades [8]. It is the peculiar property of dynamic sonography to observe, the movement of the SST and SASD bursa could be observed in real-time while moving beneath the acromion during abduction [9,10]. Currently, study dynamic sonography is being used to evaluate shoulder pain [11,12]. The sensitivity and specificity of dynamic sonography are high enough to be reliably used in the assessment of SIS [8,13]. Grayscale sonography combined with the dynamic study was proved as a helpful tool in the detection of various causes of the painful shoulder

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especially impingement syndrome [14]. The sensitivity and specificity of sonography are very high in SST full-thickness tear 100% and 97% respectively. Whereas slightly low in the SST partial-thickness tears(15,16). Conversely, sonography is a non-invasive, readily available, relatively quick procedure, and safe modality in the diagnosis of various diseases [17,18]. Currently, dynamic sonography of the shoulder is the procedure of choice for the diagnosis of SIS. In dynamic sonography, the arm of the patient is abducted and the movement of the subacromial contents is observed to see whether they are passing smoothly underneath the acromion or not. Sometimes it is overlooked or over-diagnosed and thus results in a great deal of variation. However, the diagnosis of SIS with the help of dynamic sonography requires experience and is rather a subjective criterion and operator-dependent [19,20]. For more uniform and prudent (reliable and accurate) use of sonography in the evaluation of SIS some objective (based on numerical value) criteria are needed to be adopted. In the current study, the accuracy of the acromion to greater tuberosity distance (AGTD) measured during arm abduction in the diagnosis of SIS was focused.

METHODS

This cross-sectional observational study was conducted in two years at Gilani Ultrasound Center, Lahore, Pakistan. To compare the findings and perform accuracy tests 772 shoulders of 386 individuals were included in two groups. Group-1: positive SIS according to Neer and Hawkins Kennedy's tests, 402 (52.1%). Group-2: normal volunteers 370 (47.9%). Toshiba Xario ultrasound machine with linear transducer frequency ranging from 7-14MHz was used for the patients examination in this study. Informed consent was obtained from all the participants. American Institute of Ultrasound in Medicine (AIUM) guidelines for shoulder sonography were followed in this study [21]. Linear transducer was placed in coronal view while one end of the transducer is directed towards the acromion and the other towards the greater tuberosity (Figure 1). The patient was asked to raise their arm under examination in the scapular plane while the elbow flexed at 90 degrees while the hand was directed forward. In the normal individuals, the greater tuberosity along with the rotator cuff tendons and SASD bursa smoothly moved underneath the acromion and consequently, no measurable distance was left behind (Figure 2). In the cases of SIS, the movement of the greater tuberosity is ceased and a measurable distance remains in arm abduction. The shoulders having measurable AGTD in the abducted arm were declared as SIS (Figure 3). The procedure was repeated by a novice observer as well while kept blind from the findings of the experienced observer, to look for the interobserver agreement. The findings were confirmed with dynamic sonography (reference standard) performed by a 10-year experienced sonologist.

Data analysis: SPSS 24, IBM, Armonk, NY, United States of America) software was used for the data analysis [22]. Sensitivity, specificity, positive predictive, and negative predictive values were calculated with the help of two-by-two contingency table. Other demographic data was presented in the form of frequency and percentage

RESULTS

The mean age of all the included 386 patients was a 43.42±18.00 years (Table 1). Data related to other descriptive parameters is given in the table. For the determination of the accuracy of the new sonographic criteria (AGTD in Abduction), the findings were compared with dynamic sonography. At 95% confidence interval, the sensitivity, and specificity with lower and upper limits, of the acromion to greater tuberosity distance during abduction for the diagnosis of SIS were 97.31% (95.25 to 98.49%) and 100% (98.49 to 100%) respectively (Table 1). While the positive-predictive and negative-predictive value were 99.9% (98.22% to 100%) and 97.12% (94.96% to 98.37%) respectively. However, the overall Accuracy at 95% confidence interval was 98.45% (97.30% to 99.20%). A strong interobserver (novice and expert) agreement was seen in the diagnosis of SIS through this criteria with a Kappa value of 0.96. However, the new criterion is relatively more accurate and reliable. Amongst all the participants; 331(43%) were females and 441(57%) were males. While 364 (47%) were hypertensive and 408(52.7%) were non-hypertensive. Both the shoulders of all the participants were examined in this study. Cortical bone irregularity was found in 413 (53.4%) while absent in 359 (46.6%) shoulders. Mean Acromion-to-greater tuberosity Distance in 3.07±3.70 (0.00-34.60) mm (Table 1). According to the real-time dynamic sonography 401 (51.9%), participants were Positive and 371 (48.1%) were Negative for SIS. But with the help of new criteria (AGTD in abduction) with the help of acromion to greater tuberosity distance in abduction declared 390 (50.52%) shoulders positive for SIS while 382 (49.49%) negatives.

Descriptive Statistics	Mean	SD	Minimum	Maximum
Age (Years)	44.42	17.00	6.00	91.00
AGTD in neutral (mm) of total 772 shoulders	16.51	3.11	12.10	48.90
AGTD in Abduction (mm) of total 772 shoulders	3.07	3.70	0.00	35.70
AGTD in neutral (mm) in the (401) cases of SIS	16.3	3.17	12.1	48.9
AGTD in Abduction (mm) in the cases of SIS	5.80	3.03	0.00	35.7
AGTD in neutral position (mm) in (371) normal shoulders	16.75	3.03	13.39	25.50
AGTD in Abduction (mm) in normal volunteers	0.06	0.65	0.00	8.81

Table 1: Mean, Standard Deviation and range of Age (Years) of participants, Acromion-to-greater-tuberosity Distance AGTD in Neutral position, AGTD in Abduction, and AGTD in Neutral and Abduction of normal volunteers and SIS cases

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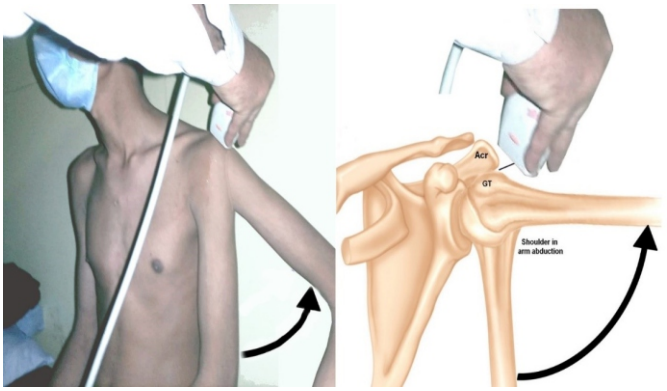

Figure 1: Patient position, and transducer approach for the acromion to greater tuberosity distance (AGTD) measurement for the evaluation of shoulder impingement syndrome (SIS)

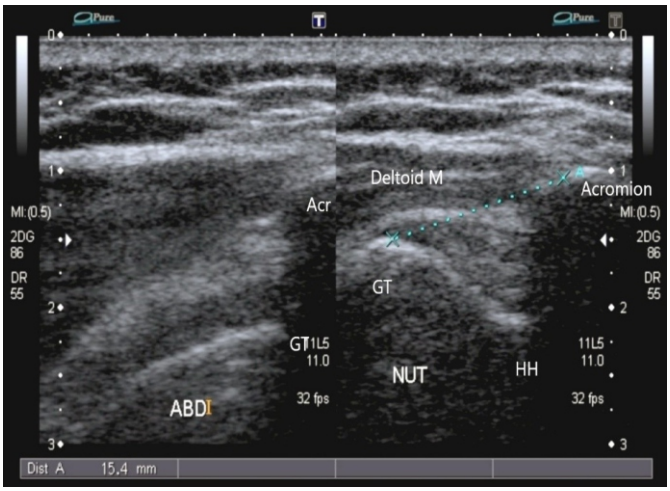

Figure 2: Ultrasound image of the normal right shoulder during abduction and neutral position. In the right-sided image, the distance from the acromion to grater tuberosity was measured the neutral position which is 15.4mm. In the left-side image, the greater tuberosity disappears beneath the acromion

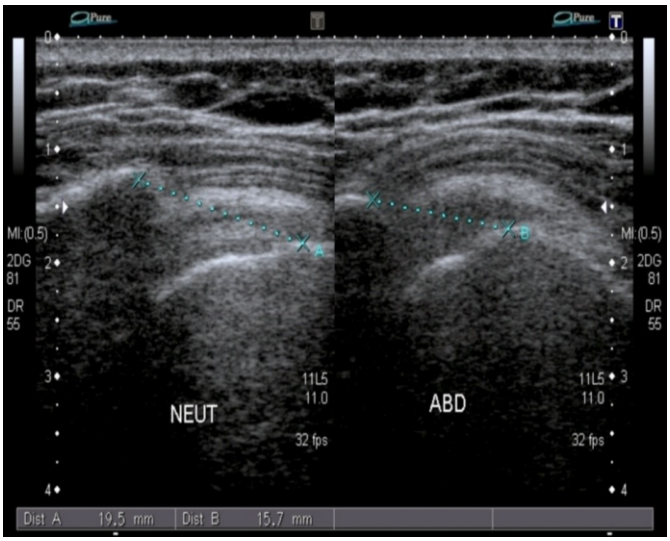

Figure 3: Ultrasound image of the left shoulder during abduction and neutral position. In the left-side image, the distance from the acromion to grater tuberosity was measured in the neutral position which is 19.5mm. After trying to abduct the arm the distance from acromion to greater tuberosity was reduced to 15.7mm. However, the movement of the arm was restricted, during abduction, the distance was 15.7mm. Key: (ABD) abduction, (NUT) neutral position

DISCUSSION

SIS is the aggravation of pain, weakness, and loss of movement at the shoulder. It is caused by the irritation of the subacromial structures (SST, and bursa) as they pass through the subacromial space during abduction. The irritation of the subacromial structures occurs due to the inflammation of tendons, bursa, and joint capsules or narrowing of the subacromial space [23,24]. SIS is initially diagnosed by patient history and physical examination, which is then followed by plain x-rays to rule out bone-related abnormalities [25]. The contrast resolution of MRI is better and can evaluate soft tissues but the dynamic evaluation is impossible in it. SIS is a condition that can be diagnosed during real-time dynamic evaluation which is only possible in Sonography. Due to a myriad of benefits of sonography over the other imaging modalities, it has been used for about two to three decades in the evaluations of musculoskeletal structures. SIS can only be diagnosed with real-time dynamic evaluation. Different sonographic techniques are being used for the diagnosis of SIS. But almost all of them are subjective and there are plenty of interobserver variabilities. Thus, the sonographic diagnosis sonography in the diagnosis of SIS is operator dependent and therefore, requires expertise and experience. It is difficult for a novice to diagnose SIS. However, a clear-cut, objective sonographic criterion is needed to be established for uniform diagnosis. It has been observed for long that during abduction of the arm under real-time sonography surveillance the distance between greater tuberosity and acromion has vanished in normal cases while passing underneath the acromion. However, in the cases of SIS, the greater tuberosity stuck away from the acromion during abduction and there remain some measurable distance from the acromion to the greater tuberosity. To evaluate the reliability of this technique in the current study 772 shoulders were included. While comparing the results with gold standard dynamic sonography the sensitivity and specificity of this technique were too high. Dynamic sonography has the highest sensitivity in the assessment of SIS. However, its sensitivity in the partial thickness tear is 85.7% f and cuff full-thickness tear is 90% [14]. With the help of sonography the underlying cause of the SIS can confidently be diagnosed to adopt appropriate management plan [26]. In a study, 50 patients were conveniently included for the determination of the value of sonography in SIS diagnosis

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while comparing with the MRI findings. It was observed that SIS could be caused by a myriad of pathological conditions including, osteoarthritis, rotator-cuff tendinosis, calcific tendinitis, and Partial-thickness tear, etc. The sensitivity and specificity of sonography 94.74% and 100% respectively in the diagnosis of SIS caused by osteoarthritis. But the sensitivity and specificity of sonography in the diagnosis of SIS caused by tendinosis were 83.33%, and 100% respectively. While the sensitivity and specificity of sonography in the diagnosis of SIS due to calcific tendinitis were 100% and 100% respectively. And the sensitivity and specificity of sonography in the diagnosis of SIS due to Partial-thickness tear were 98.22% and 100% respectively [14]. Similarly in the current study the specificity of sonography is too high as compared to sensitivity. The positive and negative predictive values of the techniques in the current study are 100% and 97.12% respectively, while its overall reliability is 98.45%. In the study mentioned above; while comparing the value of dynamic sonography in the assessment of SIS while comparing with the MRI findings. The positive and negative predictive values and accuracy of sonography in the diagnosis of SIS due to osteoarthritis were 100%, 94.74%, and 97.30% respectively. But the positive and negative predictive values and accuracy of sonography in the diagnosis of SIS due to rotator cuff tendinosis were 100%, 83.33, and 93.35% respectively. While the positive and negative predictive values and accuracy of sonography in the diagnosis of SIS due to calcific tendinitis were100%, 85.71, and 99.05% respectively. And the positive and negative predictive values and accuracy of sonography in the diagnosis of SIS due to Partial-thickness tear were 98.22% and 100% respectively. Similarly, the positive predictive value is too high, almost near to 100% as compared to the negative predictive value, in the current study[14].

CONCLUSIONS

Sonographically measurable acromion to greater tuberosity distance in abduction is a more accurate, reliable, and objective technique for the diagnosis of shoulder impingement syndrome.

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