ROLE OF ULTRASOUND IN ROTATOR CUFF TEARS

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ABSTRACT

Objective: The objective of the study was to determine the role of ultrasound in rotator cuff tears and to calculate the sensitivity, specificity, positive & negative predictive values of ultrasonographic findings in Supraspinatus tears with magnetic resonance imaging (MRI).

Study Design: Validation study.

Place and Duration of Study: The study was conducted in the Radiology Department CMH Lahore, from April 2004 to October 2004.

Patients and Methods: This study included 40 patients above 35 years of age who presented with shoulder pain and were referred for Ultrasound shoulder in Radiology Department. They were followed for their Magnetic Resonance Imaging (MRI) performed in Children Hospital, Defence National Hospital Lahore & Military Hospital Rawalpindi.

Results: Out of 40 patients 17 patients were diagnosed as having rotator cuff tears on ultrasound while 23 patients were normal. When MRI was conducted in these patients, it showed 19 rotator cuff tears while 21 patients were normal. Out of 17 patients with cuff tears on Ultrasound, 10 showed full thickness tears while 7 had partial thickness tears. Out of 19 patients with cuff tears on MRI, 11 had full thickness tears and 8 had partial thickness tears.

Conclusion: Ultrasound should be the primary diagnostic method for shoulder pain and detection of rotator cuff tears because it is economical, noninvasive, quick and easy to perform. The MRI technique should be used secondarily because it provides more information about extent of tendons and has lower risk of artifacts.

Keywords: Magnetic Resonance Imaging, Ultrasound, Rotator cuff, Supraspinatus tear, Full thickness tear, Partial thickness tear.

INTRODUCTION

The shoulder is a complex joint having a great range of motion. The rotator cuff tendons are key to the healthy functioning of the shoulder. Shoulder pain is a significant cause of morbidity; the prevalence of self reported pain is estimated to be between 16 and 26%, and it is the third most common cause of musculoskeletal consultation in primary care [1]. Shoulder pain and weakness of the arm on elevation are common clinical problems with a wide variety of causes that produce similar symptoms [2]. Tendinitis, cuff strain, and partial or full thickness tear may cause pain and weakness on elevation of the arm [3]. Rotator cuff fiber failure is one of the most common causes of shoulder pain and dysfunction in the patient over 40 years of age [4]. Fiber failure demonstrates a sequential progression from partial-thickness tears, almost always starting in the supraspinatus, to massive tears involving multiple cuff tendons.

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The dynamic ultrasound of the shoulder technique has provided a powerful tool for correlating the status of the cuff tendons with the clinical status of the patient [5]. Knowledge of the relevant anatomy and pathologic appearances and experience in performing the technique are required of operators [6]. Specific ultrasound criteria for diagnosing rotator cuff tears include non-visualization of the rotator cuff or focal tendon defect to indicate a full thickness tear, and flattening of surface or hypo or hyperechoic defect to indicate a partial thickness tear [7, 8].

MRI provides a global view of the shoulder and is relatively easy to learn to interpret and has lower risk of artifacts [9]. However, it is expensive and time-consuming. MRI with T2-weighted images in both the oblique coronal and oblique sagittal planes is the preferred technique for imaging the rotator cuff [10]. Signal changes of the rotator cuff tendon were the most reliable criteria in diagnosis of the tear. Changes of subacromial and subdeltoid fat planes and bursa were complimentary when primary signs were indeterminant [11]. The purpose of the study was to determine the role of ultrasound in Rotator cuff tears and to calculate the sensitivity, specificity, positive & negative predictive values of ultrasonographic findings in Supraspinatus tears with MRI.

PATIENTS AND METHODS

Study was conducted in Radiology Department Combined Military Hospital Lahore from April 2004 to October 2004. Forty patients of either sex of more than 35 years of age who presented with shoulder pain in Hands & Upper Limb Surgery (HULS) Department & Orthopaedic surgery Department of CMH Lahore and were referred to Radiology department for Ultrasound shoulder were included in the study using non-probability convenient sampling. They were followed for their MRI conducted in Defence National Hospital and Children Hospital Lahore and entitle patients were referred to Military Hospital Rawalpindi.

Ultrasound shoulder was performed with Aloka SSD-5500 ultrasound machine which has 7.5 MHz frequency probe. MRI used was Siemens 1.5T Shoulder coil having phased array design with 20cm FOV. Ultrasound is operator dependent and has a long learning curve so in order to develop expertise in Ultrasound and understand the normal anatomy and variants, number of ultrasounds were performed before start of the study. The examination was conducted by single Radiologist.

Supraspinatus tears were diagnosed on ultrasound by direct signs including absence or thinning of Supraspinatus tendon, by hyper or hypoechoic areas in Supraspinatus tendon. Secondary signs include double cortex /cartilage interface sign, flattening or concavity of the subdeltoid bursal fat, cortical irregularity, fluid in subacromial /subdeltoid bursa and fluid in the long head of biceps tendon sheath. A defect was only diagnosed if a criterion was reproducible either in different joint positions or in different transducer positions or the dynamic criterion of bulging was demonstrated in addition to a static criterion. Complete thickness tear on ultrasound were diagnosed by non visualization of the supraspinatus tendon, hypoechoic discontinuity and abnormal echogenicity of the tendon while partial thickness tears showed focal, well defined hypoechoic or anechoic defects in the tendon but involved only the bursal or articular surface (Fig. 1 & 2).

On MRI, primary sign of hyperintense focus in rotator cuff tendon on T2W image was the most reliable criterion in the diagnosis of the tear. Secondary signs include non visualization /retraction, bicep tendon sheath fluid collection and Subdeltoid or subacromial fluid collection.

Statistical Analysis

Data had been analyzed using SPSS version 10. Percentages were used to describe the data. Sensitivity, specificity, positive & negative predictive values and accuracy had been calculated.

RESULTS

A total of 40 patients were included in the study. Patients presented with shoulder pain and reported to Radiology Department CMH Lahore for Ultrasound were 26(65%) males and 14(35%) females. Frequency of patients with shoulder pain in three age groups detected 4(10%) patients in 35-40 years age group, 11(27%) were in 41-50 age group while 25(63%) patients were present in above 50 years age bracket.

Out of 40 patients, Ultrasound diagnosed 17 supraspinatus tears while 23 patients were normal. Out of 17 patients with supraspinatus tears, 10 patients showed full thickness tears & 1 patient was falsely diagnosed as having partial thickness tear (Table 1). Ultrasound also showed 6 partial thickness tears & 2 patients were falsely diagnosed as normal. On total, Ultrasound detected 16 truly positive supraspinatus tears (10 full & 6 partial thickness tears), 1 falsely positive partial tear,

Table 1: Statistical evaluation of ultrasound vs. MRI No. of patients (n = 40)

		MRI			
		Normal	**Full thickness tears**	**Partial thickness tears**	**Total**
ULTRASOUND	Normal	21 (TN)	-	2 (FN)	23
	Full thickness tears	-	10 (TP)	-	10
	Partial thickness tears	-	1 (FP)	6 (TP)	7
	Total	21	11	8	40

Table 2: Frequency and percentages of ultrasound signs in complete and partial thickness tears

Ultrasound signs	Complete Tears (n=10) Frequency (%)	Partial Tears (n=7) Frequency (%)
Hypoechoic defects.	9 (90)	6 (86)
Hyperechoic defects/Abnormal echogenicity	1 (10)	0 (00)
Tendon non visualization.	3 (30)	0 (00)
Double cortex/cartilage interface sign	5 (50)	0 (00)
Flattening or concavity of the subdeltoid bursal fat	4 (40)	1 (14)
Cortical irregularity.	7 (70)	4 (57)
Fluid in subacromial / subdeltoid bursa	6 (60)	2 (28)
Fluid in the long head of biceps tendon sheath.	4 (40)	1 (14)
Dynamic examination- bulging	8 (80)	2 (28)

- No of patients with complete tear on ultrasound. n = 10
- No of patients with partial tear on ultrasound. n = 7

Table 3: Frequencies of pathological findings seen on ultrasound and MRI

Pathological Findings in Rotator Cuff	Ultrasound (n = 17) Frequency (%)	MRI (n = 19) Frequency (%)
Hypo or hyperechoic area on Ultrasound & hyperintense signal on MRI	16 (94)	19 (100)
Tendon non visualization/retraction	3 (17)	6 (31)
Bicep tendon sheath fluid collection	5 (29)	7 (37)
Subdeltoid or subacromial fluid collection	8 (47)	11 (58)

- No of patients with Supraspinatus tears (Complete & partial) on MRI n =19
- No of patients with Supraspinatus tears (Complete & partial) on Ultrasound n =17

2 falsely negative as normal while 21 patients were diagnosed as normal (True negative). The important ultrasound signs in diagnosing partial and complete thickness tears and their relative frequencies are shown in Table 2.

Taking MRI as Gold standard, when MRI was conducted on these patients, 19 patients were having supraspinatus tears while 21 patients showed no Supraspinatus tears & diagnosed as normal, Out of 19 patients with supraspinatus tears, 11 patients showed full thickness tears & 8 were having partial thickness tears. Frequencies of pathological findings seen on ultrasound and MRI were described in Table 3.

Statistical evaluation of ultrasonographic diagnosis vs. MRI was done (Table 1). Sensitivity, Specificity and positive & negative predictive values were calculated according to formulae:

- Sensitivity TP / TP + FN x 100= 88.9 %
- Specificity TN / TN + FP x 100= 95.4 %
- Positive Predictive value TP/ TP + FP x 100= 94.1 %
- Negative Predictive value TN / FN + TN x 100 = 91.3%
- Accuracy (40-3) = 37 / 40 x 100 = 92.5% (TP = True Positive, FN = False Negative, TN = True Negative, FP = False Positive).

DISCUSSION

Patients presenting with shoulder pain and referred to Radiology Department for Ultrasound were 26 males and 14 females of more than 35 years of age. Out of 40 patients 17 patients were diagnosed as having rotator cuff tears on ultrasound while 23 patients were normal. When MRI was conducted in these patients, it showed 19 rotator cuff tears while 21 patients were diagnosed as normal.

Out of 17 patients with cuff tears on Ultrasound, 10 showed full thickness tears while 7 had partial thickness tears. Out of 19 patients with cuff tears on MRI, 11 had full thickness tears and 8 had partial thickness tears. Ultrasound had high sensitivity, specificity, positive and negative predictive values and accuracy.

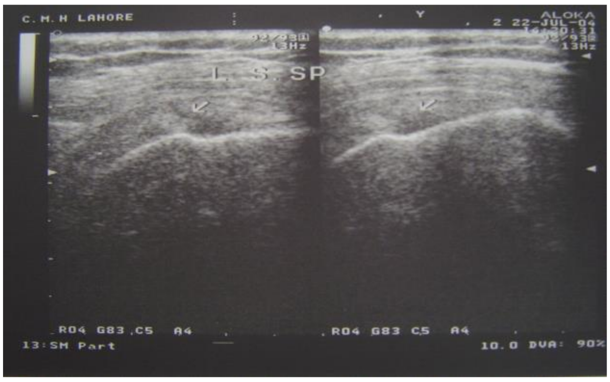

Fig.1: Full thickness Left Supraspinatus tear. L.S.SP= Lt Supraspinatus

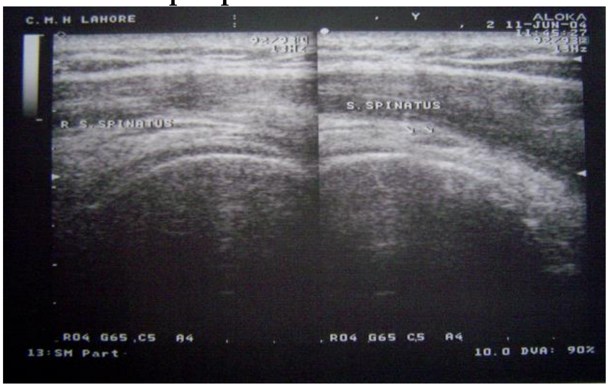

Fig.2: Partial thickness Right Supraspinatus tear. R.S.SPINATUS= Rt Supraspinatus

Our study indicated male prevalence, which is in contradiction to the study carried by Sharlene et al [12]. However our study was of small sample size and the proportion of the patients who presented to us were mostly entitled military personal (males).Another possible reason for this disparity could be the difference in the life pattern of females in our sample population and west that could have affected the prevalence of rotator cuff pathologies.

We performed the ultrasound on these patients by using 7.5 MHz frequency probe and ultrasound machine with tissue harmonic capabilities. Development of high resolution equipments as well as high frequency transducers has greatly increased the efficacy of ultrasonography [4, 5, 8, 13].

Wiener and Seitz [14] classified tears of the rotator cuff into following criteria of massive, large full thickness, small full thickness, partial thickness tears and normal rotator cuff. We simplified the criteria in our study and categorized the rotator cuff pathologies as complete thickness tears, partial thickness tears (which were further sub divided into the articular and bursal side partial thickness tears) and normal rotator cuff. Rotator cuff tears were diagnosed on ultrasound by absence or thinning of the rotator cuff, by hyper or hypoechoic areas in Supraspinatus tendon, double cortex /cartilage interface sign, flattening or concavity of the subdeltoid bursal fat, cortical irregularity, fluid in subacromial /subdeltoid bursa and fluid in the long head of biceps tendon sheath. Middleton [15] categorized the criteria into four groups: (a) nonvisualization of the cuff, (b) localized absence or focal nonvisualization, (c) discontinuity and (d) focal abnormal echogenicity.

Direct sign of abnormal tendon echogenicity were present in most of the patients. Weiner et al found that complete absence or nonvisualization of a tendon indicates full-thickness tear with retraction [16, 17]. The importance of movement during the ultrasound examination was emphasized by Allen et al [18]. In our study, 80% of patients with full thickness tear showed bulging or indentation of tendon on dynamic examination. The real time evaluation of shoulder with ultrasound has provided a powerful tool for correlating the status of the cuff tendons with the clinical status of the patient.

Because of the difficulty in diagnosing some rotator cuff tears with ultrasound certain secondary signs have been described. These secondary signs in our study were double cortex sign, flattening or concavity of the subdeltoid bursal fat (sagging peribursal fat sign), cortical irregularity, and presence of fluid in subacromial / subdeltoid bursa and in the long head of biceps tendon sheath [5, 13, 19]. We found cortical irregularity as an important secondary sign, seen in 7 out of 10(70%) and 4 out of 7(57%) in full thickness and partial thickness tears respectively. It is comparable to the study carried by Churchill et al [20]. Another important secondary sign was fluid in the subacromial subdeltoid bursa seen in 60 % (6 out of 10) of full thickness and 28%(2 out of 7) of partial thickness tears. The presence of intraarticular fluid in combination with subacromial/subdeltoid fluid on ultrasound was highly specific and had a high positive predictive value for rotator cuff tears [21]

Study by Schmidt et al [22] detected sensitivity of 93%, specificity of 83%, positive predictive value of 78% and accuracy of 87% and study by Teefey et al [23] shows sensitivity of 100%, specificity of 85%, positive predictive value of 95.5% and accuracy of 96.4% which are in favorable comparison to our study.

Sharlene et al [24] reported that on MRI signal changes of the rotator cuff tendon (primary signs) were the most reliable criteria in diagnosis of the tear. Changes of subacromial and subdeltoid fat planes and bursa (secondary signs) were complimentary when primary signs were indeterminant. Kawakawa et al [25] reported that high signal was observed in approximately 90% of full-thickness tears proven at surgery. Our study also shows similar change in signal intensity of tendons and changes of subacromial and subdeltoid fat planes and bursa.

Our study has several important clinical implications. Firstly, a common approach towards the patients suspected of rotator cuff tears is to advise MRI (if available). Instead ultrasound could be advised which will save time, cost and improve clinical outfit of management. Secondly, patients with prosthesis, implants and claustrophobic patients which are the limitations of MRI can be benefited by ultrasound. The accuracy of ultrasound in experienced hands was found to be as good as that of MRI [26]. The MRI has shorter learning curve, it should be used secondarily and in selective cases because it provides more information about extent of tendons and has lower risk of artifacts. Due to the cost difference between the two procedures, our study clearly shows that ultrasound is more cost-effective test to use for identification of rotator cuff tears. Radiology department should have experienced musculoskeletal sonologists, high frequency probes and equipments so that accurate and cost-effective diagnosis can be made. Our study showed that ultrasound is accurate in diagnosing rotator cuff pathologies which is in favourable comparison with Kenn et al [27] and Lach et al [28] who proved Ultrasound to be accurate and reliable in diagnosing a wide range of shoulder disorders compared with MRI.

There were few limitations to our study. Firstly, the sample size was small consisting of 40 patients. It could not be increased, as only one MRI machine is available in our set up for entitled patients, which has heavy workload of patients, plus MRI is an expensive investigation and the study would not have remained cost effective. Secondly arthroscopy of shoulder joint is not performed in our orthopedic department, therefore surgical confirmation could not be done. However number of international studies has been carried out in which ultrasound has been compared with arthrography, MRI, and arthroscopic findings, and has proved ultrasound to be as an effective, comparable diagnostic tool. Final limitation to our study relates to observers i.e. lack of experience in performing US of the shoulder. It requires a sound knowledge of ultrasound technique and musculoskeletal anatomy as well as common imaging pitfalls. Although number of ultrasound examinations was performed by the radiologist before the start of study, however we recommend that period of formal training and continuing audit is required to ensure operator accuracy. Study conducted by William et al [29] showed the operators had five years of experience in performing shoulder ultrasound.

CONCLUSION

Ultrasound is sensitive in detection of abnormalities of the rotator cuff. Ultrasound should be the primary diagnostic method for shoulder pain because it is noninvasive, quick, easy to perform and cost-effective method for patients with a suspected rotator cuff tears. It has provided a powerful tool for correlating the status of the cuff tendons with the clinical status of the patient and can help clinicians in making decisions about ongoing management of the condition. Ultrasound is cost-effective test to use in a specialist hospital setting for identification of rotator cuff tears.

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