Original Research Article

Comparison of the role of ultrasonography in shoulder pathology with MRI and arthroscopy What is best for the blip on your shoulder?

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Abstract

Background and Objectives: The aim and objective of the study was to assess the role of ultrasonography (USG) in shoulder pathology with arthroscopic and MRI association. **Materials and Methods**: The study was a prospective analytical study of patients presenting with clinical symptoms of rotator cuff pathology, who underwent arthroscopy evaluation and possible repair over a 2 year period. Predesigned performa was used to collect all the relevant information which included patient data, clinical findings, MRI findings and ultrasound findings. Findings of USG and MRI along with arthroscopy were compared. **Results:** USG had 94.4% sensitivity for partial thickness tears, 100% sensitivity for full thickness and100% sensitivity for no tear of the supraspinatus while MRI 94.4%, 60% and 55.5% for the same. For the detection of biceps tendon tear USG had sensitivity of 50 % and specificity of 100%, while MRI was not sensitive . USG was 100% sensitive and 96.7% specific in the detection of tendon calcification. In the detection of joint effusion both modalities had 100% sensitivity. **Conclusion:** The overall sensitivity of both the both USG and MRI were similar, but USG proves to have higher specificity in classifying supraspinatus tear, detecting tears of the biceps tendon and tendon calcification.

Key Words: Ultrasonogram shoulder, Rotator cuff tear, Supraspinatus tear, Shoulder arthroscopy

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INTRODUCTION

The shoulder is one of the most mobile joints of the human body. This increased mobility of the shoulder joint makes it vulnerable to instability and injury. Shoulder pathologies are the third most prevalent musculoskeletal disorder and accounts for a large number of referrals from the physician to the orthopaedic surgeon[1]. It can present as pain, restriction in movement, redness, loss of contour, swelling or a combination of these.[2] Rotator cuff disease is the most common cause of shoulder pain and is increasingly common after 40 years of age[3]. Shoulder arthroscopy is regarded as the gold standard for the diagnosis of shoulder pain.[4,5] However, it is invasive and has low sensitivity to detect partial thickness tears. MRI is nowadays the current pre-operative diagnostic tool in the evaluation of shoulder pathology, as it provides multi-planar images with exceptional soft tissue contrast allowing evaluation of rotator cuff degeneration, tears[6], and structural abnormalities and disorders which may mimic pathology of the rotator cuff [7]. The short comings of MRI that it is expensive and is not readily available at all centers. Secondly, MRI fails to evaluate the rotator cuff tendons in their true dynamic states. These drawbacks of MRI are mitigated by high resolution ultrasonography (USG) imaging which is fast, cost effective, noninvasive and a sensitive tool that is easily

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available[8,9]. Ultrasound offers excellent spatial resolution and is a dynamic examination tool, which can be performed during shoulder movements. It can accurately diagnose and quantify full and partial-thickness tears preoperatively[10,11] and recurrent tears in the postoperative shoulder. Further, USG can also determine the tear location, and evaluate the cuff muscles for fatty degeneration[12,13]. Literature review has shown that sonography and MRI are comparable in accuracy for diagnosing full and partial-thickness cuff tears[14,15,16] assessing muscle atrophy and fatty degeneration[17,18]. Accuracy, sensitivity and specificity of ultrasound in detecting any tear is greater than 90%[19]. Yamaguchi *et al*[20], found the sensitivity of USG in detecting a full thickness tear when compared with arthroscopy, was 100%, while the specificity was 85% and the accuracy was 96%. Zeigler *et al*[21], found that the sensitivity, specificity, positive predictive value and negative predictive value of USG in diagnosing partial and full thickness tears were as follows: (94%,96%),(96%,94%),(97%,93%) and (93%,97%). High resolution USG is also sensitive in recognizing biceps tendon rupture and dislocation[22,23,24,25]. Musculoskeletal USG is a highly clinical way to image the shoulder. However, it is not widely used in the diagnosis and post-operative imaging of shoulder pathology. This study has been conducted to demonstrate the efficiency of USG in detecting shoulder injuries and comparing the USG findings with arthroscopic and MRI. Also, this study aims to remove the notion that the learning curve for musculoskeletal USG is sharp as it was conducted at a post graduate resident level.

METHODS AND MATERIALS

Setting: The study was done in a 2 year period from September 2013 to August 2015 in the departments of Radio diagnosis in liaison with the specialized arthroscopic department at a tertiary care center and teaching institute in Kerala, India.

Study and Sample Size: This was a prospective analytical study. The sample size of 30 was kept according to the prevalence of the condition and the frequency of patient undergoing arthroscopy in our institution. However, during the study period, 32 patients were included into the study and compared.

Selection of Patients: The patients were selected on a consecutive basis from the inpatient and outpatient departments of orthopedics, who were clinically suspected to have rotator cuff tears and were planned for arthroscopy, had a preoperative MRI and were willing to undergo USG. The following patient were excluded from the study – Patients who were willing to undergo USG but not arthroscopy. Patients who underwent any surgery in the past on the same shoulder. Those with chronic rotator cuff tears of more than one year duration. Patients with conditions in which USG and arthroscopy are technically difficult to perform.

Ethics:

The study protocol was presented to the institutional ethics committee and was approved before commencement of the study. The patients with a suspected shoulder pathology who came to the orthopedic department was briefed about the study, assured confidentiality and an written informed consent was obtained ,before the study was commenced. Confidentiality was maintained using unique identifiers.

Tools:

1. Information sheet: An information sheet was used to collect demographic data of the study subject.
2. Informed consent form: An informed consent was taken from the study subject after explaining the purpose of the study in the language he/he understood.
3. USG shoulder scanning protocol

In this study, the shoulder sonography was performed using a high-frequency linear array transducer. The patient was seated on a stool. The radiologist sat and faced the patient, however to scan the infraspinatus muscle, the radiologist stood behind the patient. All the rotator cuff tendons and the bicipital tendon were dynamically evaluated sonologically.

The biceps tendon was examined first. The patients arm was slightly externally rotated with the forearm in a supinated position resting on a hard pillow placed on the thigh. This positioning ensured optimal visualization of the bicipital groove. The tendon was first examined in the transverse plane from the level where it emerges beneath the acromion to the musculo-tendinious junction. The transducer was gently rocked to maintain the normal echogenicity of the biceps tendon. Later, to examine the tendon in the longitudinal plane, the transducer was rotated 90°. To visualize the normal echogenic, fibrillar pattern the ultrasound beam is oriented perpendicular to the long axis of the tendon by gently pushing of the inferior aspect of the transducer against the patient's arm. The criterion for normal tendon was that of a hyper echoic and fibrillar structure of uniform thickness. Partial-thickness and full-thickness tears were diagnosed if an anechoic cleft or complete tendon discontinuity was present. To study joint effusion, fluid around the bicipital tendon and the posterior gleno-humeral joint recess were studied. All joint effusions >0.6mm in the transverse and longitudinal plane around the bicipital tendon with shoulder in neutral position and internal rotation and effusion in the posterior glenohumeral joint with shoulder in external rotation >0.7mm in the anterior-posterior direction was measured as standard protocol in this study.

Next, the subscapularis tendon was imaged. The patient's arm still resting on the hard pillow, was externally rotated to optimally visualize the tendon. The transducer initially was placed transversely at the level of the lesser tubercle of the humerus and moved medially along the long axis of the tendon. The transducer was later turned 90° to view the tendon fibers perpendicular to their long axis. This view was useful to diagnose superior partial or full thickness tears. To visualize the supraspinatus and infraspinatus tendons, the patient was asked to extend his or her arm posteriorly and place the palm on the superior aspect of the iliac crest with the elbow flexed and directed toward the midline of the back. However, in majority of the patients included in the study, this position was not feasible due to pain and restriction of movement .Hence, adaptation of this technique to view the muscle in the most efficient manner was done. Next, the infraspinatus tendon was evaluated from a posterior approach. The patient was asked to place the hand of the side to be examined on the opposite shoulder. To identify the posterior aspect of the infraspinatus tendon, the transducer was placed immediately below the scapular spine and angled slightly inferiorly. Internal and external rotation of the arm wsas done to visualize the infraspinatus attachment better. Finally, each of the posterior cuff muscles was evaluated for fatty degeneration in both long and short axis. It is important to note that the cuff was evaluated from the most lateral aspect of the greater tubercle of the humerus to as far medially as possible to ensure that more medial mid substance tears were not missed.

4. Orthopedic surgery intra operative notes
5. MRI report.

Relevant information was gathered from item 4 and 5 after the USG scan was done to aid in comparison and study association.

RESULTS

A total of 32 subjects were included in the present study, out of which 17 males were male. Majority of the subjects were between 40-59 years and belonged to middle socioeconomic status. *(Ref chart 1a).* Occupation wise distribution of the sample was wide, ranging from manual labor to white collar job. Most of the sample had both pain and restriction in movement as their presenting complain, and the symptoms were acute in nature (<3 months). Right sided lesion were more common and Type 2 Diabetes Mellitus was a common comorbidity. *(Ref chart 1b)* The parameters assessed by USG were joint effusion *(Image 5,6),* biceps tendon tear, subscapular tear *(Image 4*), supraspinatus tear (*Image 1,2),* infraspinatus tear (*Image 3*), tendon calcification *(Image 7),* bursitis *(Image 8)* and soft tissue edema . Statsitical analysis of the association between USG findings with Arthroscopy examination and USG findings with MRI findings were done with Pearson's chi square test. P value less than 0.01 was considered significant. . *(Ref chart 2 ,3,4)*

Table 1a

VARIABLE	FREQUENCY	PERCENTAGE
AGE		
20-39 years	6	18.8
40-59 years	21	65.6
>60 years	5	15.6
GENDER		
Male	17	53.1
Female	15	46.9
SOCIOECONOMIC STATUS		
Low	5	15.6
Middle	17	53.1
High	10	31.3
OCCUPATION		
Manual labor	2	6.3
Semi skilled labor	4	12.5
Unemployed	11	34.4
White collar job	15	46.9

Table 1b

VARIABLE	FREQUENCY	PERCENTAGE
CHIEF COMPLAINT		
Pain	14	43.8
Restriction in movement	1	3.1
Both	17	53.1
DURATION OF COMPLAINT		

0-3 months	22	68.9
4-12 months	10	31.1
COMOBIDITY		
Trauma	24	75
Diabetes mellitus	18	56.3
Connective tissue disorder	11	34.4
SIDE OF THE LESION		
Right	20	62.5
Left	12	37.5

Table 2: Statistical analysis of USG association with arthroscopy

Parameter	USG	Arthroscopy	USG-Arthroscopy Association	Sensitivity	Specificity
Joint effusion	90.6%(n=29)	90.6%(n=29)	p-value<0.001	Sensitivity 100%	Specificity 100%
Subscapularis tear	15.6% (n=5)	15.6% (n=5)	p-value 0.003	sensitivity 60%	specificity 92.6%
Supraspinatus tear	75% (n=24)	75% (n=23)	-value <0.001	sensitivity 100%	specificity 88.9%
Infraspinatus tear	12.5% (n=4)	15.6% (n=5)	p-value 0.043	sensitivity 40%	specificity 92.5%
Tendon calcification	9.4%(n=3)	6.3%(n=2)	p-value <0.001	sensitivity 100%	specificity 96.7%
Bursitis	28.1% (n=9)	31.3% (n=10)	p-value <0.001	sensitivity 90%	specificity100%

Table 3: Statistical analysis of MRI association with arthroscopy

PARAMETER	MRI	ARTHROSCOPY	MRI-ARTHROSCOPY ASSOCIATION	sensitivity	specificity
Joint effusion	90.6% (n=29)	90.6%(n=29)	p-value <0.001	sensitivity 100%	specificity 100%
Subscapularis tear	21.9% (n=7)	15.6 (n=5)	p-value <0.001	sensitivity 100%	specificity 92.5%
Supraspinatus tear	81.5% (n=26)	71.9% (n=23)	p-value <0.001	sensitivity 100%	specificity 92.5%
Infraspinatus tear	6.3% (n=2)	15.6% (n=5)	p-value 0.001	sensitivity 100%	specificity 92.5%
Tendoncalcification	3.1%(n=1)	6.3%(n=2)	p-value <0.001	sensitivity 50%	specificity 92.5%
Bursitis	31.3% (n=10)	31.3% (n=10)	p-value <0.001	sensitivity 90%	specificity 95.4%

Table 4: Association of USG vs Arthroscopy in Subscapular tear

	ARTHROSCOPY PARTIAL THICKNESS TEAR	ARTHROSCOPY FULL THICKNESS TEAR	ARTHROSCOPY NO TEAR	TOTAL	P VALUE	SENSITIVITY
USG PARTIAL THICKNESS TEAR	17	0	0	17	<0.001	94.4%
USG FULL THICKNESS TEAR	1	5	0	6	<0.001	100%
USG NO TEAR	0	0	9	9	<0.001	100%
TOTAL	18	5	9	32		

Table 5: Statistical analysis of USG Vs MRI association

PARAMETER		MRI YES	MRI NO	TOTAL	Fisher Exact Probability
JOINT EFFUSION	USG YES	29	0	29	<0.001
	USG NO	0	3	3	
	TOTAL	29	3	32	
BICEPS TENDON	USG YES	0	1	1	1
TEAR	USG NO	0	31	31	
	TOTAL	0	32	32	
SUBSCAPULARIS	USG YES	4	1	5	<0.001
TEAR	USG NO	3	24	27	
	TOTAL	7	25	32	
SUPRASPINATUS	USG YES	23	1	24	<0.001
TEAR	USG NO	3	5	8	
	TOTAL	26	6	32	
INFRAPSINATUS	USG YES	1	3	4	0.237

TEAR	USG NO	1	27	28	
	TOTAL	2	30	32	
TENDON	USG YES	1	2	3	0.093
CALCIFICATION	USG NO	0	29	29	
	TOTAL	1	31	32	
BURSITIS	USG YES	8	1	9	<0.001
	USG NO	2	21	23	
	TOTAL	10	22	32	

USG PATHOLOGICAL IMAGES

Image 1

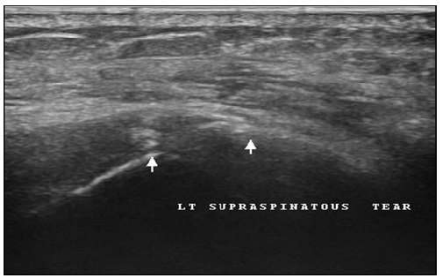

Image 2

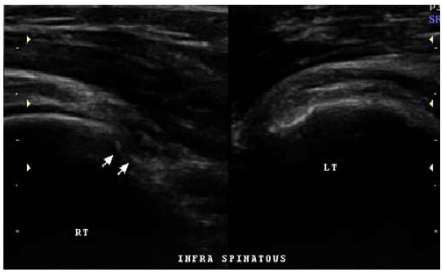

Image 3

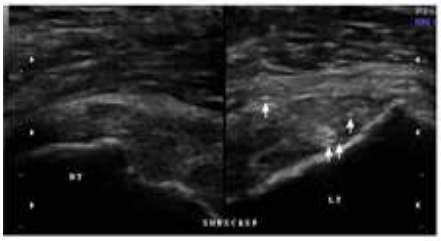

Image 4

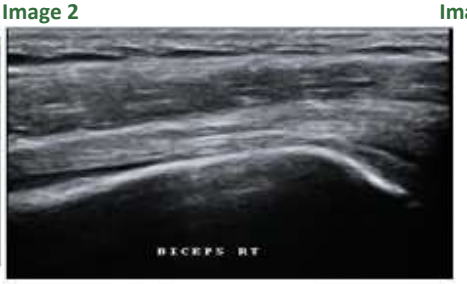

Image 5

Image 6

Image 7

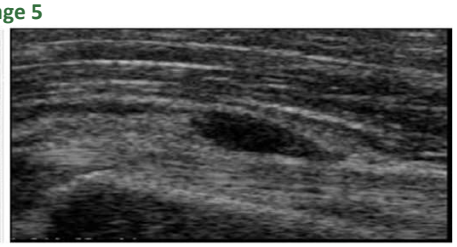

Image 8

Image 1: Long axis view with patient in modified Crass position, showing loss of fibrillar pattern with hypoechoic area within the supraspinatus tendon, suggestive of tear; **Image 2:** Long axis view with patient in modified Crass position showing the full thickness tear of the supraspinatus tendon with retraction of fibres; **Image 3:** Long axis view of the infraspinatus; on the left shows loss of normal fibrillary pattern at the foot print of the tendon consistent with tear, compare with image on the left side of the same patient; **Image 4:** Long axis view with shoulder in neutral position with forearm in abduction. On the left shows the normal subscapularis tendon, on the right shows the loss of normal fibrillary pattern consistent with the tear; **Image 5:** Long axis view at the bicipital groove; showing fluid effusion around the bicipital tendon; **Image 6:** Short axis view of the biceps tendon, fluid seen tracking down with normal intact biceps tendon; **Image 7**: Long axis view of supraspinatus, showing irregular hyperechoic area within the supraspinatus suggestive of calcification; **Image 8:** Long axis view showing a small bursa

DISCUSSION

In our study, it was seen that USG and MRI had 100% sensitivity in picking up joint effusion which was concurrent with the findings of Zubler and Mamisch-saupe *et al*[26], and Schmidt *et al*[27]. It was also seen that USG had 50% sensitivity and 100% specificity to detect bicipital tendon tear whereas MRI was not sensitive for the same. Jacobson, Carpenter, and Miller[28] studied 66 patients who underwent arthroscopic shoulder surgery with preoperative ultrasound examination and found that USG had 52% sensitivity in detecting bicipital tear, which was similar to the findings of the present study. These results show that ultrasound is a better diagnostic tool than MRI for detection of bicipital tendon tears. USG

detection of individual tears among the rotator cuff tendons was studied in the present study, in contrast to previous studies where the rotator cuff injuries are combined and reported as a whole. The results showed that USG was 100% sensitive and 88.9% specific in detecting supraspinatus tear. In categorizing tears by type, USG had 94.4% sensitivity for partial thickness tears, 100% for full thickness and100% sensitivity for no tear i.e. USG over estimated one partial thickness tear as a full thickness tear. These finding are similar to that of previous studies[29,30].

MRI on the other hand was 100% sensitive but only 66.6% specific for detection of supraspinatus tendon tear. In differentiating between tears, MRI had a sensitivity of 94.4% for partial thickness tear, 60% for full thickness and 55.5% to detect no tears. Like USG, MRI had similar sensitivity in detecting partial thickness, but fell short in detecting full thickness tears. Guido Garavaglia, Henri Ufenast, and Ettore Taverna[31] in their review of medical charts of 348 arthroscopic rotator cuff repairs found that MRI often fails to diagnose the presence of subscapularis tears and infraspinatus tears. This was the case in the present study too. In another study [16] ,it was shown that Ultrasonography was highly accurate for detecting full-thickness rotator cuff tears and characterizing their extent. It was less sensitive for detecting partial-thickness rotator cuff tears. Our study mirrors these findings. No previous literature is available to study USG or MRI association with arthroscopy in the detection of tendon calcification .In this study, data shows that USG can characterize consistency of the deposits and depict their location in the tendon.

LIMITATIONS

1. The sample size used in the study was small as it was difficult to get a large sample of patients who m*et al*l the inclusion and exclusion criteria in the study period.
2. Only MRI reports were available in the study (MRI films were not available). The MRI was not always done in the institution; they were done on different machines and reported by different radiologist. Hence the MRI reports included in the study lacked standardization.
3. Since the study hospital is a private urban hospital, the population group caters to was not truly representative of the general population.

CONCLUSION

USG shoulder is a widely available, low cost, real-time, cross-sectional imaging technique that is done painlessly without any special preparation. It is a non-invasive examination tool without hazards of ionizing radiation, contrast materials or contraindication to metallic implants. From the above discussion, it can be concluded that USG has proved to be accurate in diagnosing joint effusion, classifying tendon tears, and detecting tendon calcification of the shoulder joint. USG should be used as the first line investigation in suspected cases of rotator cuff tears and MRI should be used as a second line non-invasive test to confirm the diagnosis and to rule out associated problems in the labrum, articular cartilage, bone marrow or deep soft tissue. However, it should also be noted that USG may not be useful when there is destructive bone changes and tendon ruptures and changes in the normal anatomy or restricted shoulder motions, which limits the visibility of USG.

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