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Original Research Paper

Radiology

COMPARISON OF ULTRASOUND AND MRI FINDINGS IN ROTATOR CUFF INJURIES

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ABSTRACT

Aims And Objectives: Comparison of ultrasound and MRI findings in rotator cuff injuries. **Material And Method:** We studied 30 suspected patientsof rotator cuff injuryat our hospital, the findings of ultrasound of the rotator cuff was compared with those of MRI. Then we subjected this data for statistical analysis using Kappa statistics to find the agreement between the two modalities i.e., ultrasonography and MRI.

Results:

- 30 patients were evaluated which included 16 male (53.3%) and 14 female patients (46.7%). There was good degree of agreement between ultrasound and MRI findings in cases of rotator cuff tears. The observed degree of agreement between ultrasound and MRI was 93.3%, with a Kappa coefficient of 0.91.
- In cases of partial thickness tears, USG showed a sensitivity of 100%, specificity of 92.8%, positive predictive value of 94.1%, negative predictive value of 100%, and accuracy of 96.7%.
- In cases of full thickness tears, USG showed a sensitivity of 88.9%, specificity of 100%, positive predictive value of 100%, negative predictive value of 95.4%, and accuracy of 96.7%.

Conclusion: Ultrasound has high sensitivity and specificity in detecting rotator cuff tears and hence, it should be used in the initial evaluation of all patients with suspicion of rotator cuff injuries. MRI can be used for confirming the findings and further characterization in terms of pre-operative evaluation. USG findings should be interpreted cautiously to avoid false positive results due to anisotropy. USG can be used as an alternative imaging modality in patients in whom MRI is contraindicated (claustrophobia, metallic implants,cardiac pacemakers, etc.)

KEYWORDS : Rotator cuff,shoulder MRI, Ultrasonography Shoulder

INTRODUCTION

One of the most common musculoskeletal complaints that general physicians encounter in primary care is shoulder pain. An accurate diagnosis is critical in order to minimize the economic and social impact of shoulder injuries. A delayed or incorrect diagnosis exposes patients and the healthcare system to the burden of unnecessary imaging studies, expensive treatment, and extended recovery.

Persistent shoulder pain can result from bursitis, tendinitis, rotator cuff tear, adhesive capsulitis, impingement syndrome, avascular necrosis, gleno-humeral osteoarthritis, and other causes of degenerative joint disease or from traumatic injury, either in combination or as a separate entity.

Rotator cuff disease is the most prevalent cause of shoulder pain, occurring in approximately 65% - 70% of patients. The prevalence of rotator cuff disease increase with age, and it is estimated, that by the age of 70 years, more than 50% of the population will have a full or partial thickness rotator cuff tear[1].

Early diagnosis of rotator cuff tear is important because untreated tears may enlarge, causing increased pain, and lead to irreversible fatty atrophy of the shoulder musculature[2, 3]. In addition, larger and retracted tears can pose difficultyin repair because of intrinsic changes in tendon properties[4].

Several imaging techniques have been used to detect rotator cuff disease. These include radiography, ultrasonography, MRI and MR arthrography[5, 6]. Each has its own advantages and limitations.

High resolution ultrasound is a noninvasive, less expensive and non-ionizing modality with good sensitivity in detecting both rotator cuff and non-rotator cuff disorder[7].It serves as a complementary role to MRI of the shoulder. The reported accuracy, sensitivity and specificity of ultrasound in detecting tearsare all greater than 90%. Ultrasound can also reveal the presence of other abnormalities that mimic rotator cuff tear at clinical examination. Over the last two decades musculoskeletal USG has established itself as a versatile imaging modality in the fields of radio-diagnosis, sports medicine and rheumatology. Cost effectiveness, dynamic imaging, ready availability and accuracy are biggest advantages of USG and makes it attractive procedure for screening and pre-surgical staging procedure[8].

MRI has now become the "gold standard" for detecting both subtle and obvious internal derangement and assessing overall joint structure[7]. MRI can provide information about rotator cuff tears such as tear dimensions, tear depth, thickness and shape, involvement of adjacent structures and muscle atrophy, all of which have implications for rotator cuff treatment and prognosis[9].

In this study, the USG and MRI findings of thirty patients with a clinical suspicion of rotator cuff injury was compared. The aim was to show the effectiveness of ultrasound examination as compared to MRI, in the evaluation of shoulder pain, especially in cases of rotator cuff injuries.

MATERIALS AND METHODS

1. Ethics:

Approval from Institutional Ethics Committee (IEC) was sought. Informed written consent in Subject's vernacular language was taken before enrolment for study.

2. Inclusion And Exclusion Criteria:

The study comprised of thirty patients who were referred to the department of radiology with clinical suspicion of rotator cuff injury.

Inclusion Criteria

- History of pain in either shoulder joint.

- History of trauma (trivial).
- Clinically suspected to have rotator cuff injury (full thickness or partial thickness tears), biceps tendon injury, or calcific tendinitis.

Exclusion Criteria

- Clinically suspected cases of instability.
- Known cases of Rheumatoid arthritis
- Previous surgery or prosthesis of shoulder.
- Patients with pace makers, metal implants in their bodies, foreign bodies in their eyes and those having claustrophobia.

4. Method Of Collection Of Data:

These patients were initially clinically examined by the orthopedician and then radiologically evaluated. The radiological examinations that were undertaken are USG examination with comparison of the opposite shoulder and MRI of the affected shoulder.

Ultrasound examination of the shoulder: The examination on the affected shoulder was carried out on PHILLIPS iU22 machine, with high frequency linear transducer having 12-5MHz frequency range. The rotator cuff tendons and muscles were examined in various positions, the ACJ and the posterior aspect of the joint was also examined. Dynamic examinations of the shoulder were also carried out. Comparison of the opposite shoulder was also done.

MRI of the affected shoulder: The MRI examination was performed on Siemens Ingenia 3.0 Tesla machine with shoulder coil centred over the affected shoulder with the patient in supine position. Multiplanar images were obtained in the axial, oblique coronal and oblique sagittal planes.The slice thickness was 3 to 5mm.

Following are the sequences with FOV 160mm-

1. Coronal oblique T1W fast spin echo (FSE) sequence.
2. Coronal oblique PDW FSE sequence (with / without fat suppression).
3. Coronal oblique T2 W FSE sequence (with / without fat suppression).
4. Axial PDW FSE (with / without fat suppression)
5. Coronal oblique STIR sequence

Statistical Analysis-

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups. Diagnostic statistics viz. Sensitivity, Specificity, PPV, NPV and Accuracy have been computed to find the correlation of USG with MRI findings.

Statistical software: The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1,MedCalc 9.0.1,Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc.

The Kappa coefficient was interpreted as follows:-0- 0.2poor agreement;0.2-0.4fair agreement;0.4-0.6moderate agreement;0.6-0.8 good agreement;0.8-1excellent agreement.

RESULTS

- Out of the total 30 patients included in our study, 16 (53.3%) patients were males and 14 (46.7%) patients were females. Right shoulder complaints were present in 21 patients (70%) as compared to 9 (30%) patients with left sided shoulder complaints. Range of motion was restricted in 21 patients (70 %).
- 25 patients (85.3%) had a history of trauma to the affected shoulder. A complaint of tenderness was present in 11 (36.6%) of the patients. On clinical examination, 9 patients (30.0%) had normal range of motion, whereas restricted range of motion was seen in 21 patients (70.0%).
- The most common tendon to be involved in rotator cuff injuries is supraspinatus tendon, followed by subscapularis tendon, infraspinatus tendon and biceps tendon. Supraspinatus tendon was the commonest tendon to be involved in our study. Where in USG detected 22 patients and MRI detected 23 patients with supraspinatus tendon involvement.
- Supraspinatus tendon tears (partial or full thickness) was observed in 23/30 (76.7%) patients, subscapularis tendon tears in 4/30 (13.3%) patients, infraspinatus tendon tears in 3/30 (10%) patients and biceps tendon tears in 1/30 (3.3%) patients.
- Of the 23 supraspinatus tendon tears, there were 14 partial thickness tears and 9 full thickness tears, detected on MRI. Ultrasound correctly identified all (i.e.14) cases of partial thickness tears and 8 out of 9 cases of full thickness tears.
- In case of subscapularis tendon involvement, ultrasound detected 5 partial thickness tears and 3 cases of tendinosis, out of which 2 were falsely positive and 1 case was falsely negative.
- Similarly, USG correctly detected 1 case each of partial thickness tear and tendinosis of infraspinatus tendon.There were 2 additional cases of partial thickness infraspinatus tears detected MRI which were falsely negative on USG.
- There was 1 case of partial thickness tear of biceps tendon. Ultrasound showed tendinosis of biceps tendon in 2 cases, out of which one was falsely positive.
- The pickup rate of Supraspinatus tears the USG pick up rate was 73.3% and MRI pick up rate was 76.7%. Subscapularis tears by USG was 16.7%, whereas the MRI pick up rate for subscapularis injuries was 13.3%. The supraspinatus tendon tears showed 95.6% sensitivity, 100.0% specificity, a PPV of 100%, a 87.5% NPV, with an accuracy of 96.7% and a significance of P = 0.0001. Subscapularis tendon tears showed 75.0% sensitivity, 92.3% specificity, a PPV of 60%, a 96.0% NPV, with an accuracy of 90.0% and significance of P = 0.009.
- For partial thickness tears, USG had a sensitivity of 100%, specificity of 92.8%. In cases with full thickness tears, 88.9% sensitivity and 100% specificity was achieved. Sub acromial, sub deltoid bursitis had a USG pickup rate of 56.7% and a MRI pickup rate of 70.0%, showing that MRI being a better modality than USG in picking up SA-SD bursitis.
- 6 patients had rotator cuff tendon calcification on USG, whereas 2 on MRI.
- In this study, USG findings of all patients were correlated with MRI findings. However, MRI additionally picked up IGHL thickening and muscle atrophy. MRI, in particularly the PD & STIR sequences are informative in detecting cuff tears. MRI is better in picking up labral and ligamentous pathologies, bony abnormalities, glenohumeral joint arthritis and muscle atrophy.
- USG advantages: It is non-invasive, real-time, multiplanar and non-ionizing. It can be done rapidly without any patient preparation. It is widely available and at a low cost. It has a high spatial resolution.

DISCUSSION:

Various techniques are used for evaluating patients with shoulder pain including clinical examination, X-ray, arthrography, USG, CT scan and MRI. The most accurate is MR arthrography. Conventional MRI is sensitive and specific, but cannot be used as a first line of investigation. However, USG is a non-invasive, relatively inexpensive modality that can be used.

USG criteria for detection of partial thickness tears were focal

discontinuity of the tendon either at the bursal or articular margin. USG criteria for full thickness tears were recognized by complete absence of the tendon. The space over the humeral head is filled by the deltoid muscle and a thickened sub acromial- sub deltoid bursa. Tendinosis was diagnosed by USG, in the form of thinning of the tendon and heterogeneous echotexture.

MRI criteria for detection of partial thickness tears are characterized by a focal region of fibre discontinuity that is filled with fluid signal. Beside a focal tendon defect, additional findings included surface fraying or changes in tendon calibre, such as attenuation or thickening. MRI criteria for full thickness tears were characterized by tendon discontinuity. Tendon retraction was another sign to detect full thickness tears. The presence of fluid in the sub acromial- sub deltoid bursa, although not specific for a full-thickness tear, to be another indirect sign.

CONCLUSION:

- The most common tendon involved in rotator cuff injuries is supraspinatus tendon, followed by subscapularis tendon.
- Ultrasound has a high sensitivity of 100% and a specificity of 92.8% for partial thickness tears, and for full thickness tears, sensitivity of 88.9% and a specificity of 100%. USG imaging can be considered almost equally effective as compared to MRI, in the evaluation of rotator cuff injuries.
- MRI is presently the imaging modality of choice in the evaluation of rotation cuff injuries. Also, MRI is consistently superior to USG scan in not only detecting the lesion, but also to characterize them.
- From our findings, US can be considered comparable to MRI in the diagnosis of rotator cuff injuries. Beside diagnostic value, several factors must be considered to appreciate the clinical implications of such results. Safety, cost, availability and impact of the results of clinical management are key elements.
- Regarding safety, both USG and MRI are equally safe, being non-invasive tests and not involving the use of non-ionising radiations.
- When considering cost and availability, ultrasonography definitely scores over MRI which makes it first line investigation of choice and best option in most settings for the diagnosis of rotator cuff tears.
- Though operator dependent, a well performed USG can effectively serve as a primary diagnostic method and screening of all suspected cases of rotator cuff injuries because it is economic and fast and MRI should be used secondarily.

TABLES AND FIGURES-

Table 1: Age distribution of patients-

Age in Years	Number of Patients	%
30-50	12	40.0
51-70	16	53.3
>70	2	6.6
Total	30	100.0

Table 2: Gender distribution of patients-

Gender	Number of patients	%
Male	16	53.3
Female	14	46.7
Total	30	100.0

Table 3: Affected shoulder

Affected shoulder	Number of patients	%
Left	9	30.0
Right	21	70.0
Total	30	100.0

Table 4: Ultrasound findings: Rotator cuff Tears

Tendons	Ultrasound findings			
	Partial thickness-tear	Full thickness tear	Tendinosis	Normal
Sub-scapularis	5(16.6%)	0	3(10.0%)	22(73.3%)
Supra-spinatus	14(46.7%)	8(26.7%)	4(13.3%)	4(13.3%)
Infra-spinatus	1(3.3%)	0	1(3.3%)	28(93.3%)
Teres minor	0	0	0	30(100.0%)
Biceps Tendon	1(3.3%)	0	2(6.7%)	27(90.0%)

Table 5: USG findings: Calcification

Ultrasound findings calcification	Criteria	Number of patients (n=30)	%
Subscapularis	Absent	26	86.7
	Present	4	13.3
Supraspinatus	Absent	24	80.0
	Present	6	20.0
Infraspinatus	Absent	28	93.3
	Present	2	6.7
Teres minor	Absent	30	100.0
	Present	0	0.0
Biceps tendon	Absent	27	90.0
	Present	3	10.0

Table 6: MRI findings of tendon tears

TENDON	MRI FINDINGS IN TEARS			
	Partial Thickness Tear	Full Thickness tear	Tendinosis	Normal
Sub-scapularis	4(13.3%)	0	1(3.3%)	25(83.3%)
Supra-spinatus	14(46.7%)	9(30.0%)	4(13.3%)	3(10.0%)
Infra-spinatus	3(10.0%)	0	1(3.3%)	26(86.7%)
Teres Minor	0	0	0	30(100.0%)
Biceps Tendon	1(3.3%)	0	1(3.3%)	28(93.3%)

Table 7-Correlation of USG findings with MRI findings: An observation

Findings	TP	FP	FN	TN	USG pick up rate	MRI pick up rate	Total
Subscapularis	3	2	1	24	16.7	13.3	30
Supraspinatus	22	0	1	7	73.3	76.7	30
Infraspinatus	2	0	2	26	6.6	13.3	30
Teres minor	0	0	0	30	0.0	0.0	30
Biceps tendon	2	1	0	27	10.0	6.6	30
Peribicipital Tendon Fluid	14	0	8	8	46.7	73.3	30
Subacromial-subdeltoid bursitis	15	2	6	7	56.7	70.0	30
Subcoracoid bursitis	0	0	21	9	0.0	70.0	30

Table 8: Correlation of USG findings with MRI findings: An Evaluation

Findings	Sensitivity	Specificity	PPV	NPV	Accuracy	P value
Partial thickness	100.0	92.8	94.1	100.0	96.7	<0.0001**
Full thickness	88.9	100.0	100	95.4	96.7	<0.0001**

Table 9: Correlation of USG findings with MRI findings: An Evaluation

Ultrasonography	Magnetic Resonance Imaging		
	FTT	PTT	NO TEAR

FTT	8	0	0
PTT	1	14	1
NO TEAR	0	0	6

** P value from Fisher's exact test

Table 10: Agreement between USG and MRI findings in diagnosis of rotator cuff tears

	Sensitivity	Specificity	PPV	NPV	Accuracy	P value	Kappa coefficient
Subscapularis	75.0	92.3	60.0	96.0	90.0	0.009	0.609
Supraspinatus	95.6	100	100	87.5	96.7	0.0001	0.911
Infraspinatus	50.0	100	100	92.8	93.3	0.0138	0.634
Teres Minor	0.0	100	0	100	100	1.00	
BicepsTendon	100	96.4	66.7	100	96.6	0.006	0.783
Peribicipital tendon fluid	63.6	100	100	50.0	73.3	0.0027	0.483
Subacromial- subdeltoid bursitis	71.4	77.8	88.2	53.8	73.3	0.0196	0.437
Subcoracoid bursitis	0	100.0	0	30	30	1.000	0

Observed degree of agreement= 28/30 (93.3% [77%-99%])
Weighted Cohen's Kappa coefficient= 0.91 (good to excellent agreement 0.78 - 1)
(FTT-full thickness tear, PTT- partial thickness tear)

CASE

1. Full thickness tear of supraspinatus tendon:

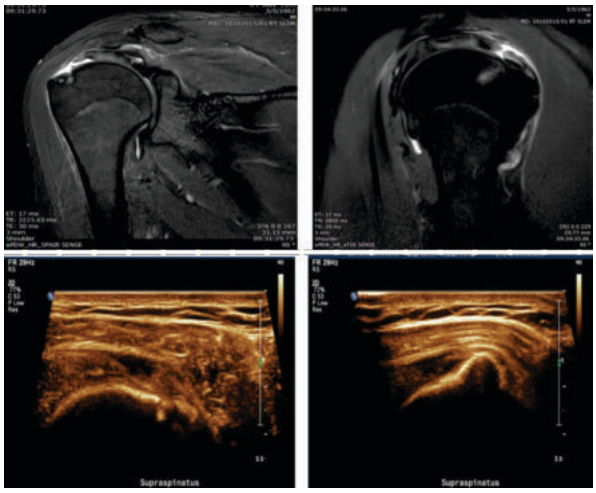

Figure 1- (a,b) MRI coronal and sagittal images showing full thickness tear of supraspinatus tendon at insertion site. (c,d) USG images in transverse and oblique showing the same.

2. Partial thickness tear of supraspinatus:

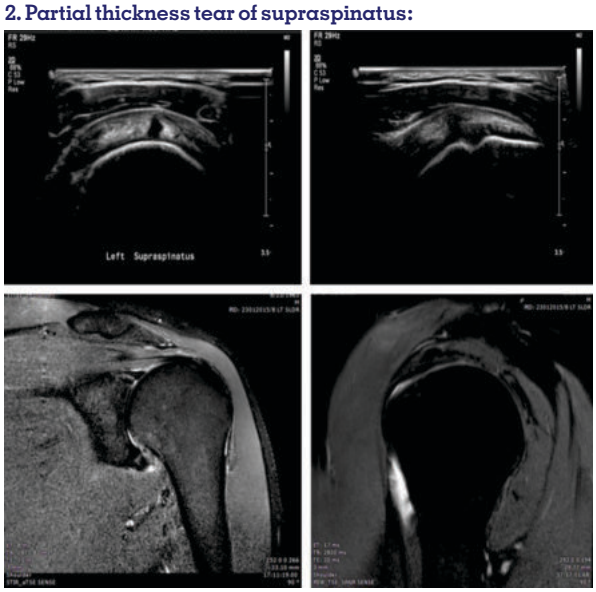

Figure 2- (a,b) USG images in transverse and oblique showing partial thickness tear of supraspinatus tendon. (c,d) MRI coronal and sagittal imagesshowing the same.

3. Full thickness tear of right supraspinatus tendon with fluid in subacromion-sub deltoid and sub-coracoid bursa-

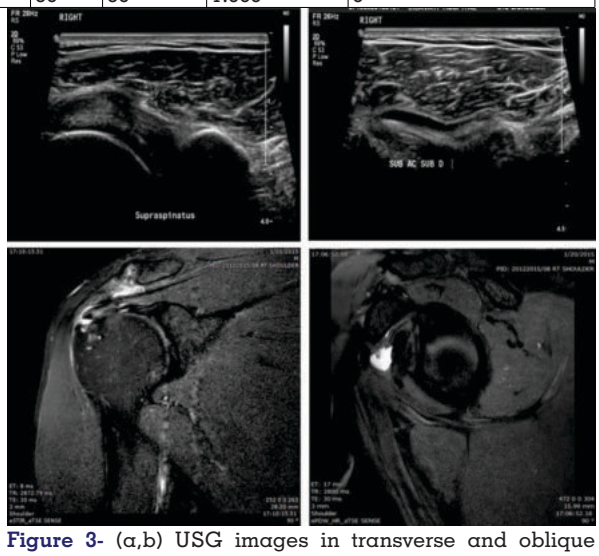

Figure 3- (a,b) USG images in transverse and oblique showing full thickness tear of supraspinatus tendonwith fluid in sub-acromion, sub-deltoid and sub-coracoid bursa, (c,d) MRI coronal and sagittal images showing the same.

Abbreviations: USG: Ultrasonography, MRI: Magnetic resonance imaging. FTT: full thickness tear, PTT: Partial thickness tear. TP: True positive, FP: False positive, TN: true negative, FN: False negative, PPV : Positive predictive value, NPV: Negative predictive value

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