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Diagnostic Accuracy of High Resolution Ultra Sound in Evaluation of Rotator Cuff Tears In Reference To Magnetic Resonance Imaging

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Abstract

Background: Persistent shoulder pain is a very common condition that often has an underlying multifactorial pathology.Rotator cuff disease is the most prevalent cause of shoulder pain, occurring in approximately 65% - 70% of patients. In this study, the USG and MRI of fifty patients with a clinical suspicion of rotator cuff injury was done. The aim was to show diagnostic accuracy of high resolution ultrasound in evaluation of rotator cuff tears in reference to magnetic resonance imaging.

Materials and Methods: The prospective study included 50 patients who were referred to the radiology department with history of shoulder pain were clinically examined by the orthopaedician and those with high clinical suspicion of rotator cuff tear were radiologically evaluated and referred for high resolution ultrasound of both the shoulder joints and magnetic resonance imaging of the affected shoulder.

Results: Our study demonstrated high sensitivity and specificity of high resolution USG when compared to MRI for diagnosis of both full thickness and partial thickness rotator cuff tears with accuracy of 98.% for full thickness and 92.% for partial thickness tears. We conclude from the present study that USG can be comparable to MRI inthe diagnosis of Rotator cuff tears as it has high Sensitivity, Specificity and Diagnostic Accuracy in detecting both Partial and Full thickness Tears.The ready availability of USG allows it to remain as the first line of investigation of choice.

Conclusion: Ultrasound has a high sensitivity, specificity and accuracy in detecting partial thickness and full thickness tears of rotator cuff tears. So,USG can be considered almost equally effective as MRI, in the evaluation of Rotator cuff tears however MRI is presently the imaging modality of choice in the evaluation of rotator cuff tears and is consistently superior to USG in not only detecting the lesion, but also to characterize them.

Introduction

Persistent shoulder painis a very common condition that often has an underlying multifactorial pathology. It is the third most common cause of musculoskeletal pain ranking after back pain and knee pain.1The four most common

causes of shoulder pain and disability in primary care are rotator cuff disorders, glenohumeral disorders, acromioclavicular joint disease and referred neck pain.[1]

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.[3]

Our understanding of the rotator cuff and its pathologies has been broadened by extensive basic and clinical research. With the introduction of new diagnostic methods, including sonography and MRI, therapeutic decisions can now be based on visualization of the soft parts of the shoulder. Several imaging techniques have been used to detect rotator cuff disease. These include radiography, Ultrasonography, Magnetic resonance (MR) imaging and MR arthrography.

MRI is becoming a widely used imaging modality for rotator cuff tear evaluation and now considered the gold standard for rotator cuff imaging.[5] The place of the different diagnostic techniques in a diagnostic algorithm of rotator cuff pathology is still being discussed. These days, USG serves as a complementary role to MRI, and there are potential benefits from the combined use of these two modalities.[2]

Sonography is often considered the first-line imaging modality in the assessment of cuff as well as in non-rotator cuff disorders. It is suitable for examination of localized and predominantly superficial disorders. MRI is of value in cases of extensive abnormality that is often incompletely characterized by the initial sonographic examination, as in case of sonographically inaccessible areas.[4]

Aims and Objectives

Aims and objective of this study is to evaluate the role of high resolution ultrasound and magnetic resonance imaging in rotator cuff tears., to find out the diagnostic accuracy of high resolution ultrasound in evaluation of rotator cuff tears in reference to magnetic resonance imaging ans to find out sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) of high resolution ultrasound and magneticresonance imaging in rotator cuff tears.

Material and Methods

After clearance from the institutional ethics committee, a total of 50 patients fulfilling the inclusion criteria were included in this prospective study spanning a period of 12 months. The inclusion criterion was patients with clinically suspected rotator cuff injury who presented in the outpatient clinic of Orthopedics Department of our institution. These patients subsequently underwent both USG and MRI in the Department of Radiology after giving informed consent.Exclusion criteria were as follows: patients with a previous history of surgery or prosthesis in the shoulder, patients with pacemakers, metal implants in their bodies, claustrophobic patients and patients not willing to participate in the study.

Ultrasound examination of the shoulder: The examination on the affected shoulder was carried out on VOLUSON 730 PRO machine or LOGIC P6 with high frequency 6-12 MHz linear transducer. The rotator cuff tendons and muscles were examined in various positions, the acromio claviculer joint and the posterior aspect of the joint were also examined. Dynamic examinations of the shoulder were also taken into consideration. Findings were also compared with the opposite shoulder.

Magnetic resonance imaging of the affected shoulder: The magnetic resonance imaging examination was performed on PHILIPS 1.5 Tesla machine with shoulder coil centered over the affected shoulder with the patient in

supine position. Multiplanar images were also obtained in the axial, oblique coronal and oblique sagital planes.

Data were collected and entered in MS Word 2007 and Excel 2007 and a descriptive statistical analysis was carried out in the present study. Results on continuous measurements were presented as Mean ±SD (Min-Max), while the results on categorical measurements were presented in numbers (%). Significance was assessed at 5% level of significance. Chi-square/Fisher Exact test was used to find the significance of study parameters on categorical scale between two or more groups. Diagnostic statistics viz. sensitivity, specificity, positive predictive value, negative predictive value and accuracy were computed to find the correlation of USG with MRI findings as standard reference.

Observations And Results

The present study was carried out in the Department of Radiodiagnosis, Santokhba Durlabhji Memorial Hospital, Jaipur, Rajasthan. The study group comprised of fifty patients with symptoms and signs related to the shoulder joint, suspected to have rotator cuff tear. The following observations were made during the study.

Out of 50 patients, there were 28 males and 22 females in this study. The age of the patients ranged from 16 to 70 years. Most patients were in age group of 41 –50 years (15 patients) followed by <30 years (12 patients). 70% of the patients were above 40 years and only 30% patients were below 40 years of age.

In this study, Right shoulder was more commonly involved with 38 patients showing right shoulder involvement and 12 patients showing left shoulder involvement. In this study population, right hand was dominant in 48 patients and only 2 patients had left hand dominance.

In this study, Supraspinatus tendon was the most common tendon involved. On MRI- 16 (32%) patients had partial thickness tear, 11(22%) had full thickness tear, 10 patients (20%) had tendinosis, and muscle atrophy was noted in 9(18%) patients. On USG- 13(26%) patients had partial thickness tear, 12(24%) had full thickness tear, 7 patients (14%) had tendinosis and muscle atrophy was noted in 7 (14%) patients.

Second most common tendon involved in this study was subscapularis tendon. On MRI- 3 (6%) patients had partial thickness tear, 1(2%) patient had full thickness tear, 5 patients (10%) had tendinosis and muscle atrophy was noted in 5 patients (10%).

On USG- 5 (10%) patients had partial thickness tear, 1 (2%) had full thickness tear, 5 (10%) had tendinosis and muscle atrophy was noted in 3 patients (6%). Infraspinatus and teres minor involvement was less common in the study.

In this study, Out of total 50 patients (200 tendons), Partial thickness tears of rotator cuff were seen in 20 tendons (10%) on USG and in 22 tendons(11%) on MRI. Overall Full thickness tears were present in 14 tendons (7%) on USG and in 14 tendons (7%) on MRI.

In this study, USG showed 88.89 % sensitivity, 93.75% specificity, 92.0% accuracy in detecting partial thickness tears and, 100 % sensitivity, 97.44% specificity, 98.0% accuracy in detecting full thickness tears.

Table 1: Frequency distribution of Rotator cuff pathologies on USG and MRI. [PTT: Partial Thickness Tear, FTT: Full thickness Tear]

Tendon	USG/MRI	Rotator cuff tears				
		PTT	FTT	Tendinosis	No Tear	MA
Subscapularis	USG	5	1	4	44	2
	MRI	3	1	5	44	5
Supraspinatus	USG	13	12	7	25	7
	MRI	16	11	10	23	9
Infraspinatus	USG	1	1	1	48	3

	MRI	1	1	1	48	4
Teres Minor	**USG**	1	0	0	49	0
	MRI	2	1	0	47	1

Table 2: Statistical parameters for Diagnostic role of USG in reference to MRI for detection of Partial thickness and Full thickness Rotator cuff tears.

	Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
FTT	100.00	97.44	91.67	100.00	98.00
PTT	88.89	93.75	88.89	93.75	92.00

Discussion

The etiology of rotator cuff injury is multifactorial, contributed both by extrinsic and intrinsic factors. The extrinsic factors can be anatomical factors, like the acromion shape, coracoacromial ligament impingement, os acromiale and acromial spurs, or environmental factors like shoul-der overuse, smoking, obesity, and diabetes mellitus. The intrinsic factors include repetitive microtraumas, areas of hypoperfusion in the tendons, inflammation, and cellular changes in the collagen. The advancing age also causes ten-dons to degenerate, occurring most commonly in patients after the third decade and increases linearly thereafter[9]. Initially there is partial thickness tear which typically progresses from partial thickness tear to full thickness tear in a zipper-like fashion known as “zipper phenomenon”.

This study aimed at evaluation of rotator cuff by High resolution ultrasound in reference to Magnetic Resonance Imaging in 50 patients who were clinically suspected to have rotator cuff injury.

The study group comprised of 50 patients with mean age of 45.9 (S.D±13.8) years. Maximum patients (30%) were in the age group of 41-50 years. 70% of the patients were above 40 years and only 30% patients were below 40 years of age. This finding is in concordance with Milgrom et al and Görmeli et al (2014)[6] who stated that the prevalence of rotator cuff disease increases with age.

The gender distribution in the study showed a male preponderance, with 28 males (56.0%) and 22 females (44.0%). Right shoulder was the affected side in 38 (76.0%) of cases, while the left side was affected in only 12 patients (24.0%). 48 patients (96.0%) in this study had right hand dominance and only 2 patients (4.0%) had left hand dominance. These two patients with left hand dominance showed involvement of left shoulder. So, in the study middle aged and elderly male patients were more commonly involved with dominant hand more affected, these finding were in concordance with Atsushi Yamamoto et al (2010)[7].

47 patients (94.0%) had pain in affected shoulder, 34 patients (68.0%) had restriction of movements and 6 patients(12.0%) gave history of dislocation of shoulder. These findings correlate with findings of study by Hawkins and Hertel[8], who observed that main complaints by patients with a symptomatic rotator cuff tear were shoulder pain and weakness.

18 patients (36.0%) had a history of trauma to the affected shoulder and there was no history of trauma in 32 (64%) patients. History of trauma was more common in young and middle age group (upto 50 yrs) and less common above 50 yrs of age, indicating degenerative etiology. This finding is in concordance with Mitchell et al[1] (2005) who stated that rotator cuff tear is strongly indicated by the history: traumatic in young and atraumatic in elderly.

Maximum patients (64%) had duration of symptoms in the range of 1 months to 1 year.6 patients (12%) had duration of symptoms for more than 1 year. Most patients (15/18) with history of trauma presented with complaints of rotator cuff injury within 1 year. This is in concordance with Kuhn (2007)[9] who classified rotator cuff tears into acute or chronic according to duration and observed that

people with acute rotator cuff tears usually present with a history of acute trauma.

Rotator cuff pathologies included partial and full thickness tears, tendinosis and muscle atrophy. Supraspinatus tendon was the commonest tendon to be involved in our study. Where in USG detected 50% patients with rotator cuff tear and 14% with tendinosis (total involved tendons 64%) and MRI detected 54% patients with rotator cuff tear and 20% with tendinosis (total tendons involved 74%). This is comparable to the study by Zlatkin et al[10] wherein they found that supraspinatus tendon involvement was present in around 70% of their cases. Supraspinatus involvement was followed by subscapularis tendon and infraspinatus tendon and least involved tendon was teres minor.

Of the 50 supraspinatus tendon tears, there were 16 partial thickness tears and 11 full thickness tears, detected on MRI. Ultrasound correctly identified 13 cases of partial thickness tears and all cases of full thickness tears. 3 cases of partial thickness tear were missed on USG and 1 case was falsely diagnosed as full thickness tear. Supraspinatus tendinosis was noted in 10 patients (20%) on MRI and in 7 patients (14%) on USG.

Supraspinatus muscle atrophy was seen in 7 patients (14%) on USG and in 9 patients (18%) on MRI. USG showed high accuracy in detecting supraspinatus atrophy and atrophy was associated with full thickness tear of supraspinatus tendon in most of the cases. This finding corresponded with study by Viviane et al.[11]

Conclusion

Our study demonstrated high sensitivity and specificity of high resolution USG when compared to MRI for diagnosis of both full thickness and partial thickness rotator cuff tears with accuracy of 92.0% for full thickness and 98% for partial thickness tears. Thus, considering the comparable diagnostic accuracy of both these modalities, high resolution USG can be used as the first-line investigation For diagnosis of RCT whereas MRI can be used secondarily as a problem-solving tool, either following an equivocal shoulder USG or for delineation of anatomy in cases where surgical correction is needed.

Limitations

Limitations of the present study:

- There was relatively small sample size in this study.
- Inter-observer variability was not assessed in the present study.
- Artefacts like Anisotropy which is inevitable can give rise to false positive cases. The rotator cuff appears echogenic when the ultrasound beam insonates at 90° to the long axis of the tendon fibers because the beam is then reflected maximally. Tendons may appear hyperechoic, could erroneously take this for tendinosis or a partial-thickness rotator cuff tear.

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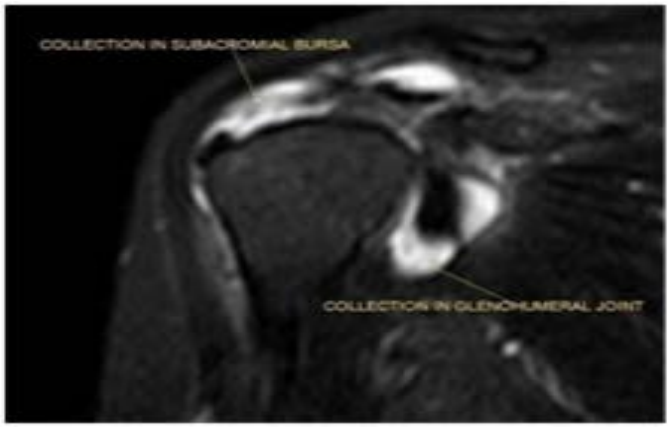
Abbreviation

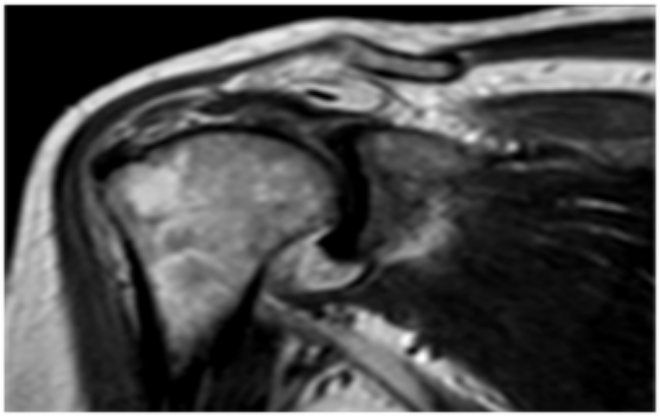
MR/MRI :	Magnetic Resonance Imaging
US/USG :	Ultrasonography
T :	Tesla
MHz :	Mega Hertz
RCT :	Rotator cuff tear
RCI :	Rotator cuff interval
GHL :	Glenohumeral ligament
ACJ :	Acromioclavicular joint
FOV :	Field of view
FSE :	Fast spin Echo
T1W :	T1 weighted sequence
T2*W GRE :	T2 weighted gradient echo sequence
STIR :	Short tau inversion recovery
PDW :	Proton density weighted
PD-FAT SAT :	Proton Density – Fat Saturated
TR :	Time to repeat
TE :	Time to echo
NA :	Not Available
PTT :	Partial Thickness Tear
FTT :	Full thickness Tear
MA :	Muscle atrophy
EMG :	Electro myography
NPV :	Negative predictive value
PPV :	Positive

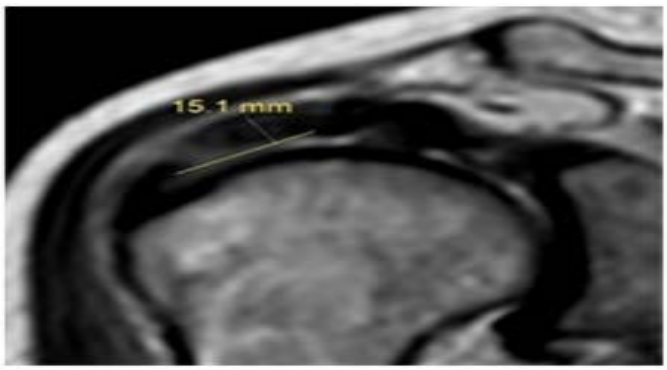
Illustrations

Case 1full Thickness Tear Of Supraspinatus Tendonusg Showing Full Thickness Tear Of Right Supraspinatus Tendon With Surrounding Collection. Left Supraspinatus Tendon Appear Normal In Echotexture.

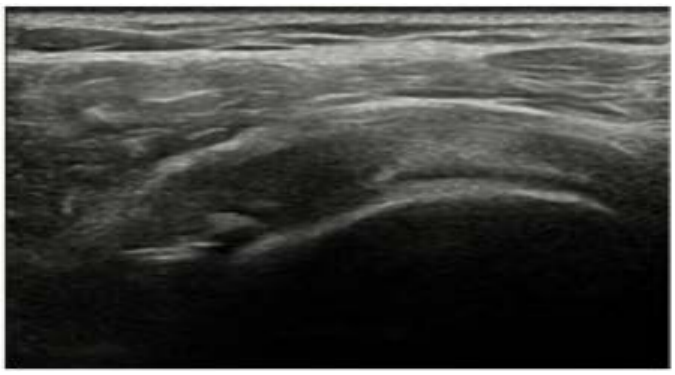
MRI Coronal PDW and STIR images showing full thickness tear of supraspinatus tendon with its medial retraction and collection in subacromial bursa and glenohumeral joint. Dimension of Tear is 1.5 cm (Medium grade).

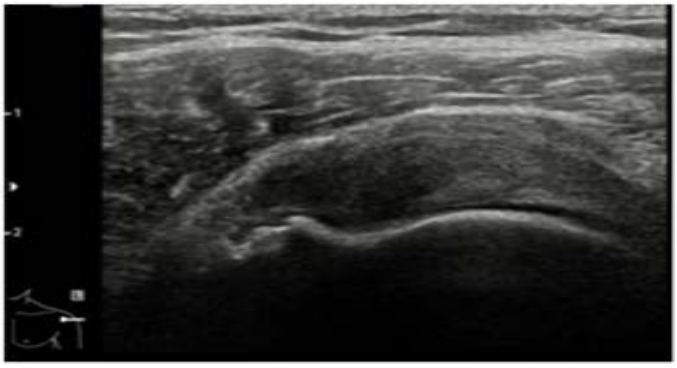






Case 2: Partial Thickness Tear Of Supraspinatus Tendon USG Left Shoulder Showing Intrasubstanse Hypoechoic Area In Supraspinatus Tendon Predominantly Involving Articular Surface S/O Partial Tear.





MRI coronal PDW images revealed altered signal intensity involving humeral insertion of supraspinatus tendon (depth 5mm), predominantly involving articular surface s/o Partial tear.