Original Article

ISSN (O): 2347-338X; ISSN (P): 2347-3371

Spectrum of Various Morphological Changes Detected on High Resolution Ultrasound & MRI in Patients with Painful Shoulder

Abhay Kumar[1], **Nikita Bansal**[2], **Madhu Sharma**[3]

[1]Junior Resident, Department of Radiodiagnosis, SNMC, Agra, Uttar Pradesh, India, [2]B.S., Cellular Neuroscience, USA, [3]Professor, Department of Radiodiagnosis, SNMC, Agra, Uttar Pradesh, India.

Abstract

Background: Shoulder joint pain is one of the most common complaints that are encountered in the Orthopedics and Rheumatology Department. X-Ray, Ultrasound (US) and MRI are widely used in evaluating various shoulder pathologies. US is a simple, cheap, fast and non-invasive imaging technology for detection of rotator cuff and non-rotator cuff pathologies. Currently, MRI is gold standard and more precise for imaging for shoulder joint pathologies. In this study, we are presenting a spectrum of various positive findings in 30 patients, presenting with painful shoulder, studied with HR USG and MRI. Both imaging modalities successfully detected 44 cases of partial tear of SUPRASPINATUS. US imaging yields a sensitivity of 95% and an accuracy of 91%. The corresponding values of MRI were greater than 95%. According to cited studies, USG imaging can be considered almost equally effective in detecting partial tears of the rotator cuff compared to MRI with a sensitivity of more than 90% and accuracy of 90%, particularly located in the SUPRASPINATUS (Small letters Supraspinatus). MRI may be reserved for doubtful or complex cases, in which delineation of adjacent structures is mandatory prior to surgical intervention. Tears of the INFRASPINATUS and subscapularis tendon have always been considered uncommon as compared to the SUPRASPINATUS. We found only 4 cases (14.3%) of IST and 2 cases (6.6%) subscapularis tendon tear. **Subjects and Methods:** The study was carried out in Radiology department of SNMC on patients with painful shoulder. HRUSG Performed using 7 -18 MHZ linear probe and MRI by 1.5 Tesla Philips machine using Shoulder coil .Various sequences like T1 ,T2 ,PDW ,FSE,FAT suppressed or without Fat suppressed, gradient echo planes in multiple planes. **Result:** In the present study maximum no of patients with painful shoulder were of Rotator cuff injury that is 20 patients out of total 30 patients .17 patients were of partial thickness tendon tear. 15 of them were diagnosed on HRUSG and all 17 patients were diagnosed on MRI .Full thickness tear was seen 4pts on MRI and 3 patients on USG. Tears/Tendinosis/tendinitis in the tendons were of prevalence Supraspinatous >infrspintous>Subscapularis. Joint effusion was equally diagnosed on HRUSG and MRI. For Hill sachs lesions and Bankarts lesions MRI Is the modality of choice. **Conclusion:** From present study we could conclude that in patients of painful shoulder HRUSG is a modality of choice for primary work up and diagnosis specially where MRI is not available. However for accuracy and extent of rotator cuff tears /tendinosis MRI is Gold standard so as to guide Orthopedician and Physiotherapist. For follow ups both HRUSG and MRI are helpful.

Keywords: Supraspinatus Tear, Tendinopathy, Impingement Syndrome, Bursal Surface Tear, Articular Surface Tear.

Corresponding Author: Madhu Sharma, Professor, Department of Radiodiagnosis, SNMC, Agra, Uttar Pradesh, India.
E-mail: drmadhusharmaagra01@gmail.com

Received: 09 September 2021 **Revised: 22 November 2021** **Accepted: 05 December 2021** **Published: 24 December 2021**

Introduction

Shoulder pain is the third most common musculoskeletal disorder after low back pain and neck pain. 60% of shoulder abnormalities have been attributed to rotator cuff disease, which is the most common cause of shoulder pain and dysfunction in patients above 40 years of age.[1]

Shoulder pain and weakness on elevation of the arm are regular clinical problems. Pain can be due to extrinsic or intrinsic conditions to the shoulder. The extrinsic conditions include disorders of the cervical spine and thoracic outlet, as well as postural conditions. Intrinsic conditions can be classified as rotator cuff and non-rotator cuff pathologies. Codding JL et al. Rotator Cuff fiber failure is a degenerative process,[2] starting as a tendinopathy and progressing through a partial-thickness tear to a full-thickness tear. This generally involves the supraspinatus tendon first and then, gradually, the other tendons.

Although considered as benign condition, but majority of patients remain symptomatic despite of complete conservative management. Even though a large amount of clinical tests used for the diagnosis of painful shoulder can localize the periarticular lesions, these entities may still be difficult to

differentiate by clinical examination.[3] The development of and advancements in magnetic resonance imaging (MRI) and the introduction of high-resolution surface coils provided a technique that was attractive because image acquisition was not operator-dependent, as in ultrasound and interpretation was intuitively easier. MRI is considered the reference standard for imaging of shoulder disorders. The strength of MRI lies in its potential for assessing sonographically inaccessible areas such as the bone, labral cartilage, deep parts of various ligaments, capsule, and areas obscured by bone. High resolution Ultrasonography of shoulder is quick and painless. There is no risk and in contrast to arthrography there is no discomfort following the procedure. The simplicity, rapidity, low cost and accuracy of the examination make it especially attractive as a screening and presurgical staging study.[3] Arthrography can be performed in those cases in which ultrasound and MRI are not definitive.

Rotator Cuff Tear is the most common rotator cuff abnormality is found to be supraspinatus full thickness tear. Middleton et al.[4] postulated three sonographic criteria that are indicative of rotator cuff tear: (1) Discontinuity in the normal homogenous echogenicity of the rotator cuff; (2) replacement of the normal homogenous echogenicity by a central echogenic band; and (3) Nonvisualization of the rotator cuff.[5] The tears are categorized into two, full thickness tear and partial thickness tear. The full thickness tears may extend to involve the infraspinatus (IST), subscapularis, and long head of the biceps. Secondary or indirect signs are presence of fluid in the subacromial/subdeltoid bursa and in glenohumeral joint. Other indirect signs of partial or full thickness rotator cuff tears are the sagging of bursa and a bright aspect of the humeral cartilage (cartilage interface sign) or uncovered cartilage sign.[6]

Partial thickness tears may be difficult to detect when they are located in an area of tendinosis. With longstanding impingement (i.e. chronic tendinosis), calcium may be deposited in the rotator cuff tendons and/or the subacromial subdeltoid (SASD) bursa.

MR imaging can provide information about rotator cuff tears such as tear dimensions (depth or thickness), tendon retraction, and tear shape that can influence treatment selection and help determine the prognosis. In addition, tear extension to adjacent structures, muscle atrophy, size of muscle cross-sectional area, and fatty degeneration have implications for the physiologic and mechanical status of the rotator cuff. Rotator cuff tears can be classified according to size. DeOrio and Cofield classified rotator cuff tears on the basis of greatest dimension as either small (<1 cm), medium (1–3 cm), large (3–5 cm), or massive (<5 cm). The dimensions of tear have implications for selection of treatment and surgical approach, postoperative prognosis, and tear recurrence. Articular-surface partial-thickness rotator cuff tears are common and occur more frequently than bursal-surface partial-thickness tears. Partial-thickness tears that are not repaired can lead to persistent pain and disability. Articular-surface partial-thickness tears may propagate to a full-thickness tear. Both articular-surface and bursal-surface partial-thickness tears are graded according to their depth as either grade 1 (<3 mm), grade 2 (3–6 mm), or grade 3 (>6 mm). The normal rotator cuff is 10–12 mm thick; thus, grade 3 tears are considered significant tears involving more than 50% of the cuff thickness. The shape of a rotator cuff tear is important in the selection of a surgical technique. Tears can be classified arthroscopically into three basic shapes according to the tear geometry as viewed from the tendon surface: crescentic, U-shaped, and L-shaped.[7] The ability to identify the tear geometry at arthroscopy diminishes as tear size increases. Massive contracted rotator cuff tears have been classified at MR imaging into two categories: massive crescentic tears (wide anteroposterior dimension) and massive longitudinal tears (spared anterior cuff tissue at the rotator interval). The degree of tendon retraction is important information obtained with MR imaging. Optimally, in primary repair, the tendon stump should be adjacent to the attachment site so that reattachment is free of tension. It has been suggested that a tear is suspected to be irreparable if MR imaging depicts retraction of the tendon edge medial to the glenoid fossa. Supraspinatus tendon tears may extend to adjacent structures, significantly affecting the mechanics of the glenohumeral joint and having important prognostic implications. A supraspinatus tendon tear may extend anteriorly to involve the medial aspect of the coracohumeral ligament and superior subscapularis tendon fibers, a situation that is associated with more severe supraspinatus atrophy [Figure 1] and poor prognosis.

The role of biceps tendon, as a source of shoulder pain and pathology which has been associates with subscapularis lesions, superior labral anterior to posterior (SLAP) lesions, rotator cuff pathology, impingement, and pulley or “hidden” lesions of the rotator interval have been demonstrated.[8]

Calcific tendinitis, the critical zone in the supraspinatus is the most common site for calcification, probably due to its hypervascularity’s is more reliable than x rays Slurry calcifications found on USG nearly liquid cases found in ~93% can be successfully aspirated.[9] Acromioclavicular joint inflammation often presents clinically in a similar fashion to rotator cuff disorders. The small amount of fluid that is usually present can be detected easily on USG. Impingement syndrome, Repetitive friction results in bursal thickening and is often accompanied by minimal fluid accumulation. During dynamic testing,[10] the thickened bursal tissue may be seen to bunch up against the outer edge of the acromion, failing to pass beneath it, which easily demonstrated on USG during the impingement test.

Aims and Objectives

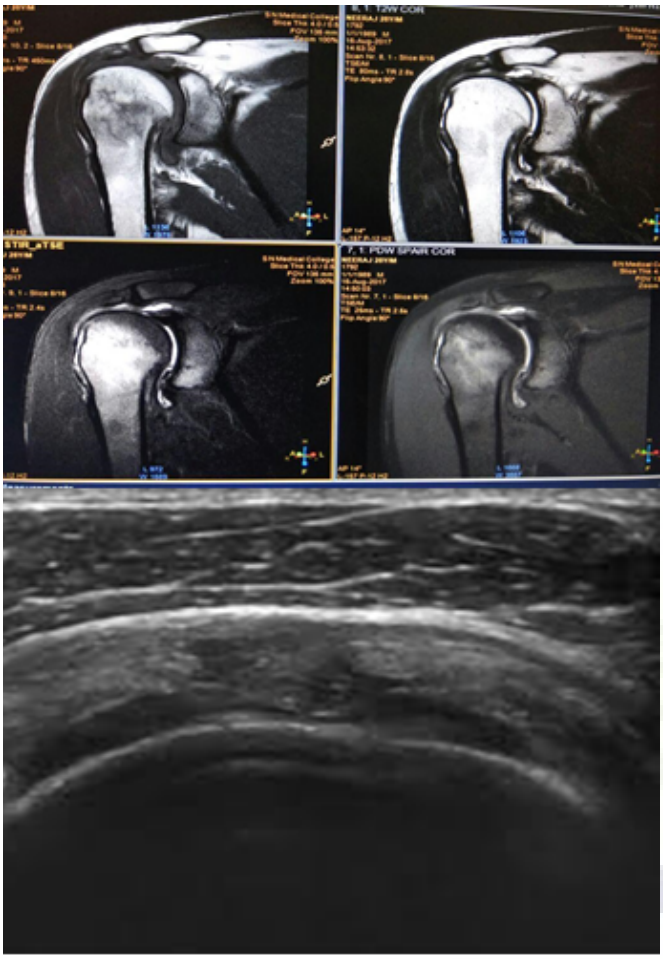


Figure 1: MRI Coronal(A)TI(B)T2(C)Stir (D)PDW images showing complete chronic SUPRASPINATUS with proximal tear retraction and atrophy of muscle (E)On USG complete tear of supraspinatus

1. To study the spectrum of various morphological changes detected on high resolution ultrasound in patients with painful shoulder.
2. To correlate the sensitivity of positive morphological changes on high resolution ultrasound and MRI

Materials and Methods

The main source of data for the study are patients from the orthopedics and rheumatology department of S.N. Medical College, Agra. Appropriate MRI sequences and multiplanar imaging and ultrasonogram were performed for every patient.

Technique

Imaging were done with 1.5 Tesla Philips achieva machine using shoulder coil the following sequences were selected as required:

- Coronal oblique T1W/ proton density weighted (PDW) fast spin echo (FSE) sequence and fat suppressed (FS) PDW FSE / T2W FSE sequence.
- Sagittal oblique T2W FSE sequence (with/without fat suppression).
- Axial T2W gradient echo (GE) sequence.
- Axial PDW FSE (with/without fat suppression)
- Field of view 14-16 cm, slice thickness 2-3 mm and matrix 512 x 512.

All patients referred to the department of Radiodiagnosis with clinically suspected rotator cuff injuries in a period of 2 years from Sep 2017 to Aug 2019 were subjected for the study.

Data Analysis: Prospective study.

Inclusion Criteria

All patient attending in our hospital mainly orthopaedics and rheumatology with complain of painful shoulder with or without motion restriction.

Exclusion criteria

1. Refusal of consent
2. Patients with congenital abnormality/neural or vascular pathology.

Result

Table 1: Tendinosis/Tendinitis

Age group	No.	%
<20	2	6.6 %
21-40	13	43.3 %
41-60	13	43.3 %
>60	2	6.6 %
Total	30	

[Table 1] In our study patients ranging from age group 0 to 80 years. Most of the cases (13 cases) were seen in both 21-40 and 41-60 years of age groups.

Sex distribution: out of 30 patients, male patients were 20 (66.6%) and female patients were 10 (33.4%). So, male to female ratio was 2:1 with 20 male and 10 female patients. Our study matched with study Mail Gram et al.[11]

Distribution of Involement of Shoulder (Total= 30 Pt.)

Out of total 30 cases, right shoulder was relatively more involved i.e. in 22 patients (73.4%) as compared to left shoulder in 8 patients (26.6%).

Chief Complaints

Most common presenting complaint in case of shoulder pathology was shoulder pain (21) followed by post traumatic pain (6) and recurrent dislocation (3).

Findings in Acromio Clavicular Joint :

Such as effusion noted in 17 patients in both MRI and USG studies, AC joint widening noted in 1 patient in both MRI and USG, AC joints narrowing with degenerative changes noted in 1 patient both MRI and USG.

Table 2: Tendinosis/Tendinitis

	Supraspinatus tendon		Infraspinatus tendon		Subscapularis tendon	
	No.	%	No.	%	No.	%
MRI findings	6	20	2	6.66	1	3.33
USG findings	5	16.6	2	6.66	1	3.33

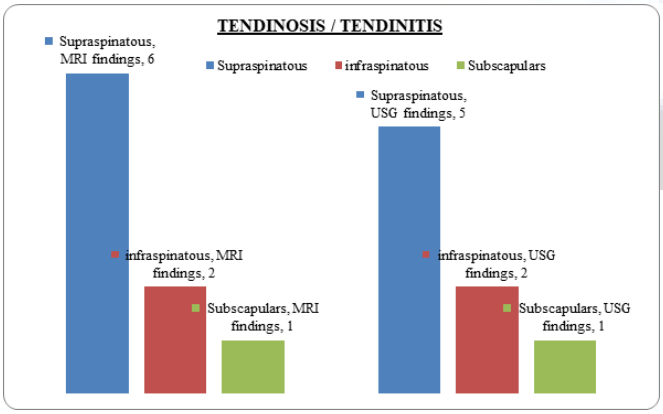


Figure 2: a-d showing tendinosis in supraspinatus tendon

Bursitis

Bursitis was found in 9 patients and was detected on USG as well as MRI both.

[Figure 6] showing Hill Sach's lesion

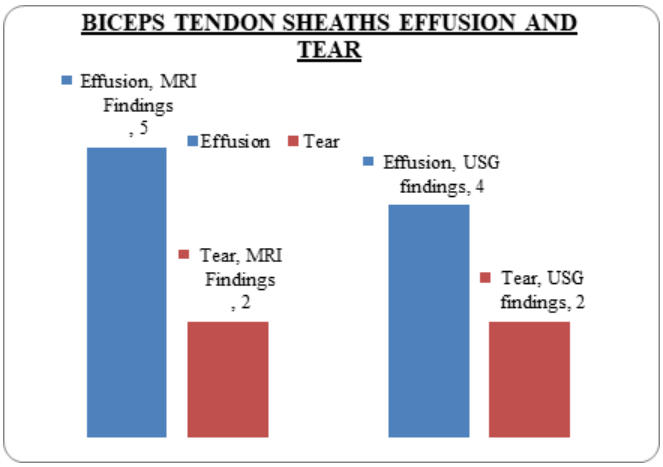


Figure 3: howing effusion in biceps tendon sheath

Table 3: Lesions of Greater Tuberosity of Humerous

	Bankert lesion		Hill ach's lesion		SLAP	
	No.	%	No.	%	No.	%
MRI findings	5	16.6 %	7	23.3 %	3	10 %
USG findings	0	0 %	0	0 %	0	0%

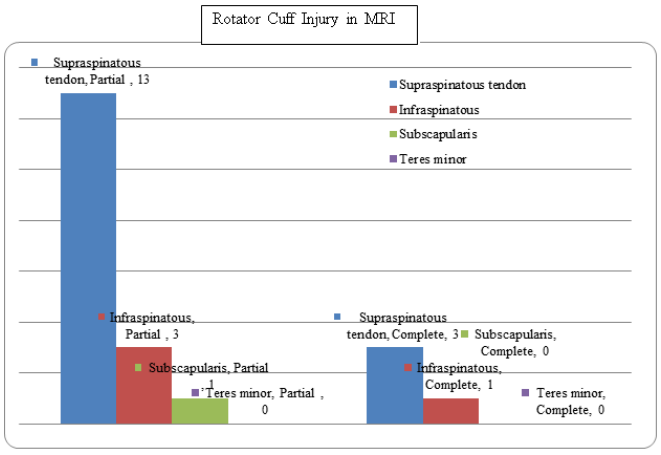
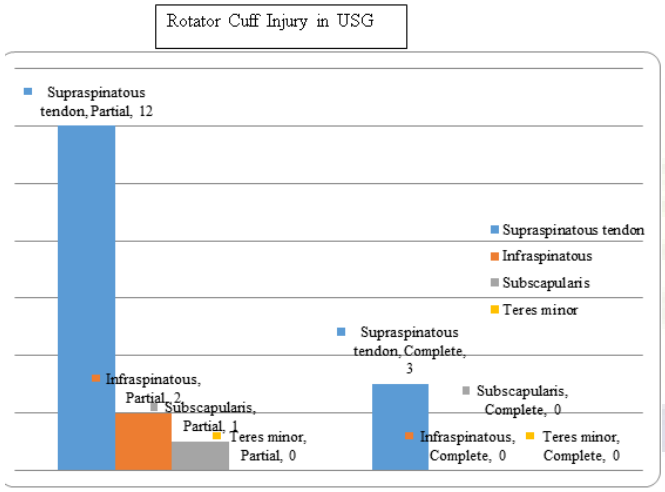


Table 4: Rotator Cuff Injury in MRI and USG Findings(N=30)

MRI Findings	Supraspinatus tendon		Infraspinatus		Subscapularis		Teresminor	
	No.	%	No.	%	No.	%	No.	%
Partial	13	43.3%	3	10%	1	3.3	0	
Complete	3	10 %	1	3.3 %	0		0	
USG Findings								
Partial	12	40 %	2	6.6 %	1	3.3%	0	0
Complete	3	10 %	0		0		0	0



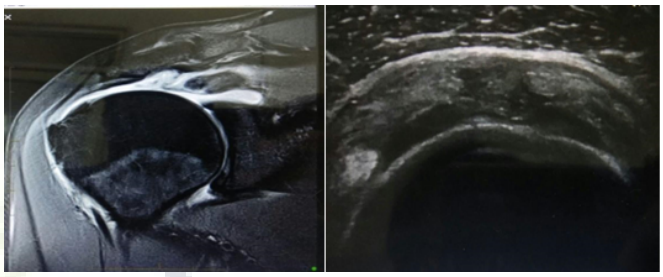
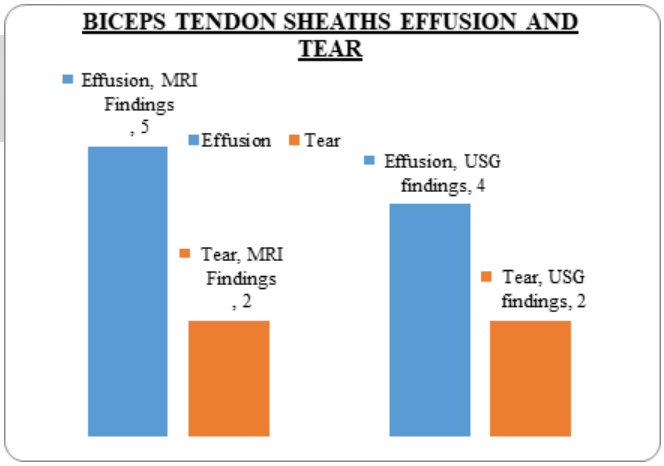


Figure 4: (a)MRI, t2w coronal imagecomplete tear of RT SUPRASPINATUS and RT coracoid bursitis with glenohumoral effusion. (b) USG images showing complete tear of RT SUPRASPINATUS



Out of total 30 Cases, 21 cases show rotator cuff injury with full thickness tear in 4 cases and partial thickness tear seen in 17 cases. On MRI, both the full thickness tear and partial thickness tear was detected in all 4 and 17 cases. However, on USG the full thickness tear was detected only in 3 cases and partial thickness tear was seen in 15 cases [Table 4]. Overall, most common tear including both partial and complete tear was seen involving supraspinatus muscle (16) followed by infraspinatus muscle tear.

Both partial and full thickness tear was more prevalent in supraspinatus muscle seen in 13 and 3 cases, respectively. The second most common involved muscle was infraspinatus (3) partial thickness tear and (1) full thickness tear. Partial tear of subscapularis muscle was detected only in 1 case.

[Figure 3] showing effusion in biceps tendon sheath

Discussion

Shoulder pathologies are very common among the general population. The location of shoulder pain is very poor indicator of its pathology and the value of clinical assessment of the shoulder is very limited. Plain radiography is often used to

Table 5: Biceps Tendon Sheaths Effusionand Tear (N=30)

	MRI Findings		USG findings	
	No. of cases	%	No. of cases	%
Effusion	5	16.6%	4	16.6%
Tear	2	6.6 %	2	6.6 %

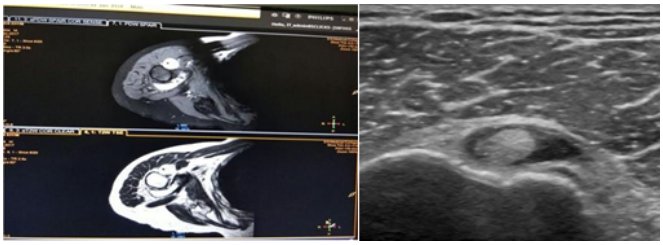


Figure 5: (a) MRI, PDW and T2 weighted images showing circumferential fluid collection around the long head of biceps tendon in bicipital groove. (b) USG images showing circumferential fluid collection around the long head of biceps tendon

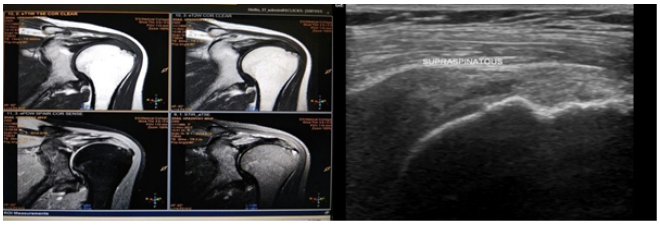


Figure 6: MRI Coronal (A) T1 W (B) T2 W (C) PDW and (D) STIR images showing Supraspinatus tendinosis evidenced by tendon thickening andintrasubstance altered signal intensity. Associated subarticular partial tear is noted as focal region of fluid collection (E) On USG, intrasubstance hypodensity noted consistent with partial tear.

supplement the clinical examination and is hardly diagnostic for rotator cuff tears.

Rotator cuff tears are a frequent finding in patient with shoulder pain. Noninvasive imaging modalities such as USG and MRI are used for evaluating rotator cuff pathologies. The purpose of the present study was to evaluate the ability of USG and MRI to detect shoulder pathologies. Total 30 patients with a clinically suspected rotator cuff shoulder pathologies are reviewed on both USG and MRI. Out of 30 patients 20 were male (66.6 %) and 10 (33.4%) were females. Thus, the M:F ratio was 2:1. Our study found no statically differences in the prevalence of rotator cuff tear between gender, which correlates with the results of study carried by Milgrom et al.[11]

In the present study with age ranging from 0 to 80 years, the majority of the patient belonged to age group between 20-40 yr (43.3 %) and 40-60 yr (43.3 %).

The tears of the rotator cuff as seen in this study, were commonly visualized as hypoechoic full thickness defects in the tendon extending from the bursal surface to its articular margin. Partial thickness tear on USG appear as focal discontinuities at the articular or bursal aspect or are located within the substance of the tendon. On MRI full thickness tear [Figure 2] seen as hypointense defects in tendon on T1W images. The presence of hyperintense fluid at site of tear on T2W images supports the diagnosis. Additional sign of complete tears includes muscle retraction, fluid in subacromial – subdeltoid bursa and peribursal fat plane displacement.

The present study out of 30 patients, 20 (66%) patients were found to have rotator cuff tears. 4 (13.2%) were having full thickness tear and 17 patients were having partial thickness tear [Figure 4]. Full thickness tear was detected in total 4 patients with 3 patients positive on USG and 4 patients positive on MRI. From total 17 patients detected with partial thickness tear, 15 patients were positive on USG and 17 patients were positive on MRI. Out of 20 patients, 16 patients were having Supraspinatus tear either isolated or in conjugation with Infraspinatus tear [Figure 5] and Subscapularis tear. Rest 4 patients are having only Subscapularis and Infraspinatus tear not involving Supraspinatus. So, prevalence of supraspinatus tear is very high.

Naqvi GA et al,[12] shows MRI has better accuracy for detecting full thickness tear and has high sensitivity and positive predictive value in diagnosis of partial thickness and full thickness tear. Present study also shows MRI has better accuracy for detection of full thickness and partial thickness tear. In the present study in 4 (12.0%) cases biceps tendon sheath effusion was seen on USG examination, while on MRI also 5 (16.6%) cases of bicep tendon sheath effusion was seen. Thus, both USG and MRI showed a high agreement for detection of bicep tendon sheath effusion similar result were reposted by Alasaarela et al. who reported effusion of biceps tendon sheath in 24 shoulder on MRI and in 20 patients on USG.

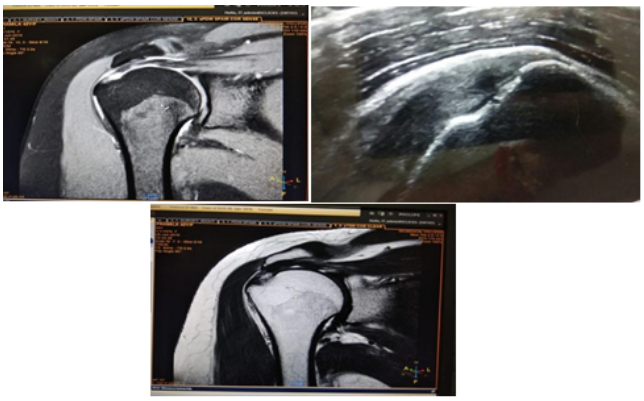


Figure 7: (a) USG images showing partial tear of SST. (b) MRI, T2W coronal images showing partial tear of Infraspinatus. (c) MRI, PDW coronal images showing partial tear of SST and fluid in sub deltoid bursa sub acromial bursa

Out of 30 patients, 9 (29.7%) patients were found to have tendinitis (SST= 6 pt, INFRASPINATUS= 2 pt. and Subscapularis tendon= 1pt) on MRI and 8(26.4%) patients were found to have tendinitis (SST = 5 pts, INFRASPINATUS = 2 pts and Subscapularis= 1 pt. on USG. Present study shows prevalence of Supraspinatus tendinitis is most common and MRI has better accuracy for detection of tendinitis than USG.

In this study, 17 (56%) patients of AC joint effusion was seen on USG examination, while on MRI also 17 (56.1 %) patient of AC joint effusion was seen. Thus, MRI and USG showed a high agreement for detection of AC joint effusion. Among total 9 patients of bursitis detected on MRI all patients were also positively detected on USG. Out of 30 patients, 5 (16.6 %) were found to have Bankart lesion, 7 (23.3 %), Hill Sach's lesion and 3 (10 %) FLAP lesion on MRI. None of the patients were found to have Bankart, Hill Sach's lesion and SLAP on USG [Table 3]. So present study shows MRI has better accuracy for detecting these lesions [Figure 6].

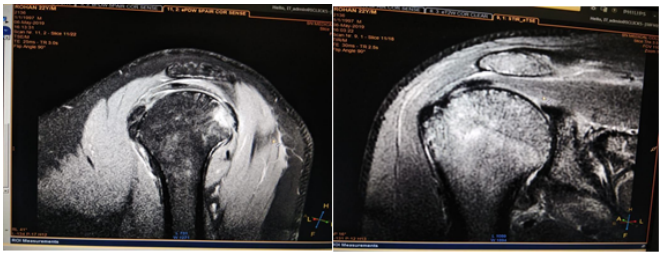


Figure 8: MRI coronal (A) PDW and (B) STIR images showing Hill Sach's lesion.

Conclusion

In our study, we concluded that USG can be used as an initial line of investigation for evaluation of all patients with painful shoulder. Rotator cuff pathologies proved to be the most common cause of shoulder pain and USG showed comparable result to MRI in detection of shoulder pain. Dynamic examination and ability to compare findings with other shoulder were added advantages. It is proved to have high sensitivity and specificity for full thickness tear with relatively less sensitivity and specificity in detection of partial thickness tear.

MRI proved to be superior in estimation of assessment of correct, extent of tear and grading of tear. It is also proved to be superior in detection of non-rotator cuff related pathologies like subacromial sub deleted effusion, subcoracoid effusion, ACJ arthropathies, labrum tear and ligamental Injury. Our study matched with following studies-

-Naqui G.A, jadaan, M. and Harrington P (2009) MRI has better accuracy for detecting FTT and has high sensitivity and positive predictive value is diagnosis both PTT and FTT combing more other variable in addition to RCT, MRI offers a great value is diagnosis RCT. Joseph O De Jesus, arthrography appear to be more accurate In diagnosis rotator cuff injuries then either MRI or USG but that must be set against the invasiveness and potential discomfort to Pt.

Okoroha et al 2017 reviewed 114 cases who went arthroscopic epar of full thickness tear.[13] They did a randomized double-blind study on both USG and MRI. They evaluated tear size, retraction status muscle atrophy and fatty infiltration. USG measurements were found smaller in size as compared to MRI. MRI showed interobserver reliability in assessing tear size retraction and atrophy.[14,15]

References

1. Lee MH, Sheehan SE, Orwin JF, Lee KS. Comprehensive Shoulder US Examination: A Standardized Approach with Multimodality Correlation for Common Shoulder Disease. Radiographics. 2016;36(6):1606–1627. Available from: https://doi.org/10.1148/rg.2016160030.
2. Codding JL, Keener JD. Natural History of Degenerative Rotator Cuff Tears. Curr Rev Musculoskelet Med. 2018;11(1):77–85. Available from: https://dx.doi.org/10.1007/s12178-018-9461-8.
3. Naredo E, Aguado P, E DM. Painful shoulder: comparison of physical examination and ultrasonographic findings. Ann Rheum Dis. 2002;61(2):132–136. Available from: https://dx.doi.org/10.1136/ard.61.2.132.
4. Middleton WD, Teefey SA, Yamaguchi K. Sonography of the rotator cuff: analysis of interobserver variability. AJR Am J Roentgenol. 2004;183(5):1465–1473. Available from: https://doi.org/10.2214/ajr.183.5.1831465.

5. Seltzer SE, Finberg HJ, Weissman BN. Arthrosonography–technique, sonographic anatomy, and pathology. Invest Radiol. 1980;15(1):19–28. Available from: https://doi.org/10.1097/00004424-198001000-00004.
6. Kneeland JB, Middleton WD, Carrera GF, Zeuge RC, Jesmanowicz A, Froncisz W, et al. MR imaging of the shoulder: diagnosis of rotator cuff tears. AJR Am J Roentgenol. 1987;149(2):333–340. Available from: https://doi.org/10.2214/ajr.149.2.333.
7. Jacobson JA, Lancaster S, Prasad A, Van Holsbeeck MT, Craig JG, Kolowich P. Full-thickness and partial-thickness supraspinatus tendon tears: value of US signs in diagnosis. Radiology. 2004;230(1):234–276. Available from: https://doi.org/10.1148/radiol.2301020418.
8. Burkhart SS, Danaceau SM, Pearce CE. Arthroscopic rotator cuff repair: Analysis of results by tear size and by repair technique-margin convergence versus direct tendon-to-bone repair. Arthroscopy. 2001;17(9):905–917. Available from: https://doi.org/10.1053/jars.2001.26821.
9. Alasaarela E, Takalo R, Tervonen O, Hakala M, Suramo I. Sonography and MRI in the evaluation of painful arthritic shoulder. Br J Rheumatol. 1997;36(9):996–1000. Available from: https://doi.org/10.1093/rheumatology/36.9.996.
10. El-Shewi I, Azizy H, Gadalla A. Role of dynamic ultrasound versus MRI in diagnosis and assessment of shoulder impingement syndrome. Egypt J Radiol Nucl Med. 2019;50:1–7.
11. Milgrom C, Schaffler M, Gilbert S, Van Holsbeeck M. Rotator-cuff changes in asymptomatic adults. The effect of age, hand dominance and gender. J Bone Joint Surg Br. 1995;77(2):296–298.
12. Naqvi GA, Jadaan M, Harrington P. Accuracy of ultrasonography and magnetic resonance imaging for detection of full thickness rotator cuff tears. Int J Shoulder Surg. 2009;3(4):94–97. Available from: https://dx.doi.org/10.4103/0973-6042.63218.
13. Okoroha KR, Mehran N, Duncan J, Washington T, Spiering T, Bey MJ, et al. Characterization of Rotator Cuff Tears: Ultrasound Versus Magnetic Resonance Imaging. Orthopedics. 2016;40(1):124–130. Available from: https://doi.org/10.3928/01477447-20161013-04.
14. Hsu SH, Miller SL, Curtis AS. Long head of biceps tendon pathology: management alternatives. Clin Sports Med. 2008;27(4):747–62. Available from: https://doi.org/10.1016/j.csm.2008.07.005.
15. Chelli-Bouaziz M, Jabnoun F, Chaabane S, Ladeb MF. Diagnostic accuracy of high-resolution ultrasound in communicating rotator cuff tear. Iran J Radiol. 2010;7(3):153–60. Available from: https://dx.doi.org/10.14366/usg.18058.

How to cite this article: Kumar A, Bansal N, Sharma M. Spectrum of Various Morphological Changes Detected on High Resolution Ultrasound & MRI in Patients with Painful Shoulder. Asian J. Med. Radiol. Res. 2021;9(2):63-70.

DOI: dx.doi.org/10.47009/ajmrr.2021.9.2.14

Source of Support: Nil, **Conflict of Interest:** None declared.