ISSN 2515-8260 Volume 09, Issue 02, 2022

A study of correlation of ultrasound, MRI and arthroscopic findings in diagnosing rotator cuff pathology

[1]Dr. Yunus Salim CM, [2]Dr. Muni Sankar Reddy M

[1]Assistant Professor, Department of Orthopedics, Kanachur Institute of Medical Sciences, Mangalore, Karnataka, India
[2]Assistant Professor, Department of Orthopedics, Balaji Institute of Surgery, Research and Rehabilitation for the disabled (BIRRD Hospital), Tirupathi, Andhra Pradesh, India

Corresponding Author:
Muni Sankar Reddy M

Abstract

Background: The shoulder arthroscopy is the gold standard of reference in most of the shoulder pathologies including Rotator cuff tears. However, it is an invasive surgical procedure with associated risks of surgery and anaesthesia. The objective of the present study is to find out how accurately the rotator cuff pathologies can be diagnosed by these imaging tests.
Aims and Objectives: To compare the Ultrasonography, MRI findings with the Arthroscopic findings of Rotator cuff pathology of the shoulder.
Materials and Methods: All patients in whom the history and clinical examination is suggestive of Rotator cuff pathology were included in the study. Patients were evaluated using high resolution Ultrasound (HRUS) Philips HD-11, Germany and 1.5-Tesla MRI [1.5 Tesla, GE, Excite HD and USA]. Ultrasonographic and MRI examination is performed by a single radiologist experienced in musculoskeletal ultrasonography and MR Imaging. A Real time high resolution USG imaging and MRI of the shoulder was performed in a standardized fashion and subsequently with therapeutic or diagnostic arthroscopy on the symptomatic shoulder. Results were analyzed.
Results: Considering arthroscopy as the final gold standard of investigation, out of the 24 patients studied, five (20.8%) had rotator cuff tendinosis/tendinopathy, four (16.6%) had PT RCT, twelve (50%) had FT RCT while the remaining three (12.6%) had normal rotator cuff. The average delay between the MRI examination and arthroscopic surgery was 6 days (range 0-27 days) but in one case, it was as long as 117 days. A total of five (20.8%) patients were in the age group < 40 years while another five (20.8%) were between 40-50 years age group. A majority of eleven (45.8%) patients were between 50-60 years old while three (12.6%) were above 60 years.
Conclusion: It should be noted that following USG of the shoulder performed by a dedicated radiologist, MRI offers little additional value, with regard to the detection of rotator cuff tears.

Keywords: Ultrasound, MRI, arthroscopy, diagnosis, rotator cuff

ISSN 2515-8260 Volume 09, Issue 02, 2022

Introduction

Shoulder pain is one of the most common complaints in the medical practice, the initial evaluation of shoulder disorders usually consists of performing a physical examination, which includes various manipulative tests. But majority of the patients come with pain & restrictive movements of the joint, so in these patients a thorough physical examination is difficult and inconclusive. In these situations, Ultrasound and MRI are the most commonly used modality to evaluate the shoulder disorders. They are non-invasive, nonionizing and safe to the patients imaged.

The shoulder arthroscopy is the gold standard of reference in most of the shoulder pathologies including Rotator cuff tears. However, it is an invasive surgical procedure with associated risks of surgery and anaesthesia. The objective of the present study is to find out how accurately the rotator cuff pathologies can be diagnosed by these imaging tests and a final decision can be made using the results of these imaging tests to go ahead with arthroscopic surgery to treat and repair various shoulder pathologies including Rotator cuff tears.

Aims and Objectives

1. To compare the Ultrasonography, MRI findings with the Arthroscopic findings of Rotator cuff pathology of the shoulder.
2. To evaluate the Sensitivity, Specificity & accuracy of HRUS, MRI and Arthroscopy in the diagnosis of Rotator cuff pathology of the shoulder.
3. To determine the positive and negative predictive value of Ultrasonography and MRI with Arthroscopic findings in various Rotator cuff pathology.

Materials and Methods

This study was done in the Department of Orthopedics, from Jan 2018 to Dec 2020.

Study population

- All patients with suspected rotator cuff pathology were studied.
- Both male and females.
- All patients above 20 years old age group are included.

Inclusion criteria

Patients above the age of 20 years who are suspected of traumatic or degenerative rotator cuff pathology.

Exclusion criteria

a. Contraindication to MRI.
b. Previous history of shoulder surgery or arthroscopy.
c. Patients with other associated pathology.
d. Patients who are not fit for Surgery.
e. Patients who did not consent for study.

Sample size and sample technique

- Twenty four (n=24) patients.

ISSN 2515-8260 Volume 09, Issue 02, 2022

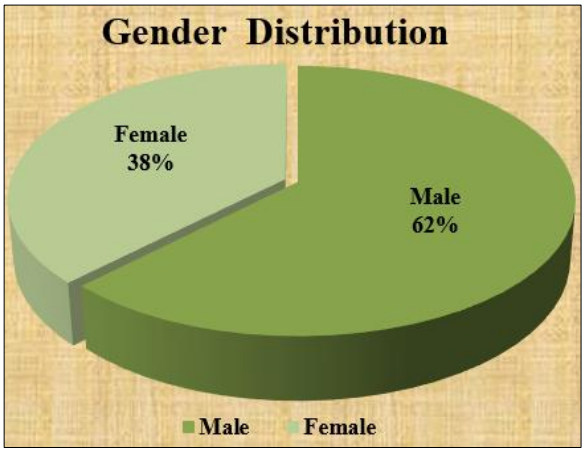
- Prospective, non-randomized, Observational study.

Data collection techniques and tools

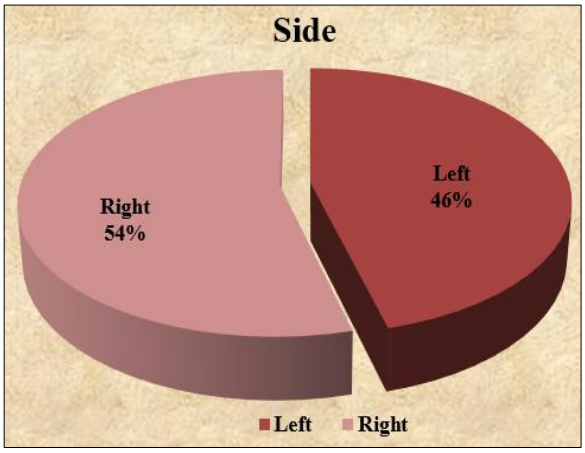
All patients in whom the history and clinical examination is suggestive of Rotator cuff pathology were included in the study.
Patients were evaluated using high resolution Ultrasound (HRUS) Philips HD-11, Germany and 1.5-Tesla MRI [1.5 Tesla, GE, Excite HD, and USA]. Ultrasonographic and MRI examination is performed by a single radiologist experienced in musculoskeletal ultrasonography and MR Imaging. A Real time high resolution USG imaging and MRI of the shoulder was performed in a standardized fashion and subsequently with therapeutic or diagnostic arthroscopy on the symptomatic shoulder. Results were analyzed.

Data analysis: The rotator cuff tears were analyzed twice; once complete and partial tears were put together and compared and other time complete and partial tears were separately compared against Arthroscopic findings. In the view of small number of individual tear of rotator cuff tendons, the complete tears, partial tears were considered as one group and compared against surgical findings. In the case of partial thickness tears, due to the small number of articular, interstitial and bursal tears, no statistical analysis was performed. Instead, general descriptive comparisons were made.
The sensitivity, specificity, positive and negative predictive values and accuracy were calculated. With the help of a biostatistician, statistical analysis was done. Initially the number of true positives, true negatives, false positives and negatives were calculated. Using these values the sensitivity, specificity, positive and negative predictive values and accuracy rates were determined. The level of agreement between the imaging techniques (USG/MRI) and the final arthroscopic results were calculated using Kappa scores.

Materials and Methods

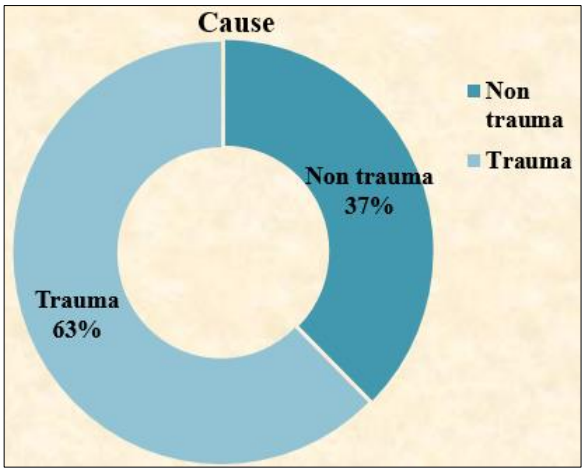


Graph 1: Sex distribution of patients

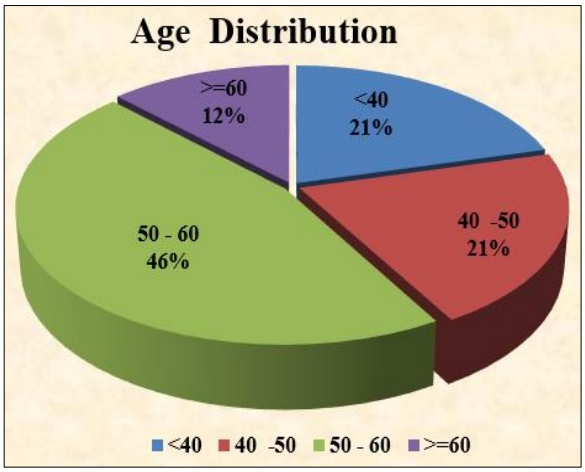


Graph 2: Side Distribution

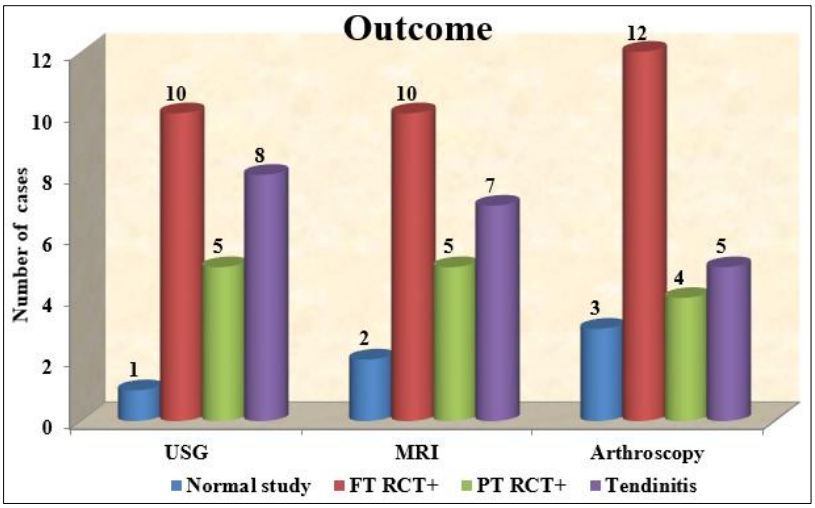
ISSN 2515-8260 Volume 09, Issue 02, 2022



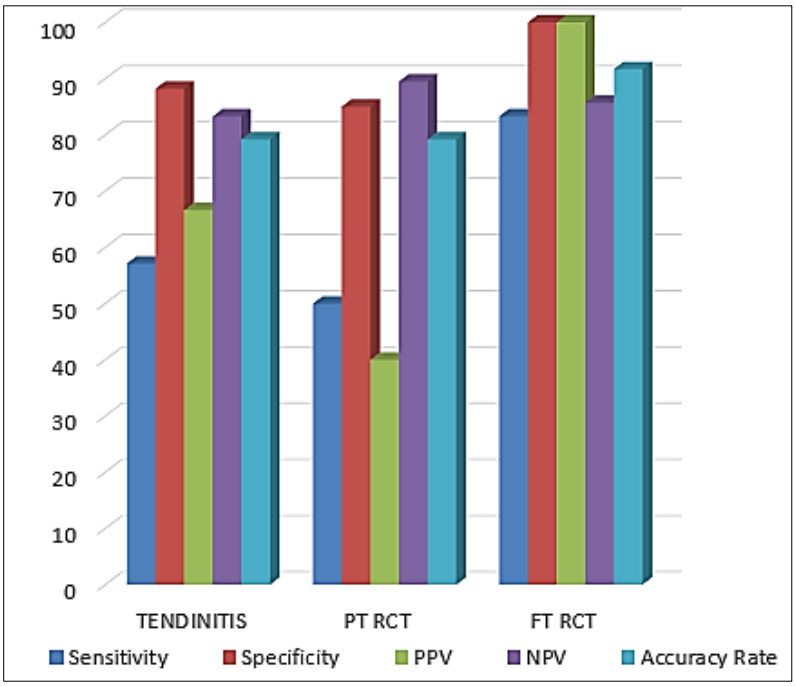
Graph 3: Causes of shoulder pain



Graph 4: Age distribution

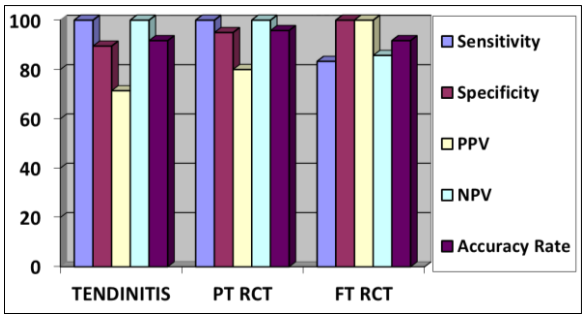


Graph 5: Final Outcome

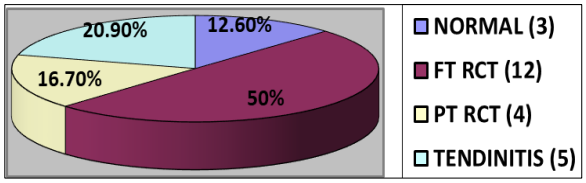


Graph 6: USG Vs Arthroscopy

ISSN 2515-8260 Volume 09, Issue 02, 2022



Graph 7: MRI Vs. Arthroscopy



Graph 8: Final results of shoulder arthroscopy

Table 1: Statistical Analysis-USG Vs Arthroscopy

Disorders	Sensitivity	Specificity	PPV	NPV	Accuracy
Rotator cuff Tendinopathy	80%	78.9%	50%	93.75%	79.2%
PT RCT	50%	85%	40%	93.8%	79.2%
FT RCT	83.3%	100%	100%	85.7%	91.7%

Table 2: Statistical Analysis- MRI Vs Arthroscopy

Disorders	Sensitivity	Specificity	PPV	NPV	Accuracy
Rotator cuff tendinopathy	100%	89.5%	71.4%	100%	91.7%
PT RCT	100%	95%	80%	100%	95.8%
FT RCT	83.3%	100%	100%	85.7%	91.7%

Discussion

In a patient presenting with pain in the shoulder, a wide range of therapeutic options are available, ranging from medical management to physiotherapy to open surgery. The role of diagnostic imaging is to help guide surgical or nonsurgical management. The ideal imaging technique should have a high rate of TPs (true positives) and an acceptable rate of FPs to limit unnecessary surgical intervention.

Our study involved the patients visiting the OPD of our hospital with shoulder pain and weakness which may be traumatic/non traumatic, whose history and clinical examination is strongly suggestive of rotator cuff pathology. These patients were sent for USG followed by MRI imaging. The diagnosis is confirmed by arthroscopy.

Ultrasound vs. Arthroscopy

The earlier sonographic results for the detection of rotator cuff pathology was highly variable and unreliable, probably due to the use of low frequency and low resolution transducers (5MHZ) and limited experience with the examination procedure. Subsequently, technical improvements such as 7.5-14 MHZ linear array transducers and better penetration of ultrasound beam, as well as increased experience and detailed knowledge of shoulder anatomy and pathology has significantly improved sonographic results and reliability.

The prevalence of cuff pathology in our study based on gender (sex), age group, side affected and cause of the pain (trauma /nontraumatic) correlates well with study carried by various researchers [1]. Our study indicated that the rotator cuff tendinopathy and tears are more common in males with advancing age and right shoulder involvement being more prevalent. It suggests that tendon degeneration occurs as part of ageing, leading to progressive tendon failure and eventual rupture [2].

A total of 5 cases of rotator cuff tendinopathy were seen arthroscopically. The ultrasound

correctly identified four (4) cases (true positive) and missed one (1) case of tendinopathy which was reported as normal. There were 3 cases in our study in whom the final arthroscopy result was suggestive of a normal rotator cuff. Out of these three (3) cases, the ultrasound reported two (2) of them as likely tendinitis/tendinopathy, while the other one case was misdiagnosed as likely Partial thickness tear. This patient misdiagnosed as PT RCT on USG had subacromial bursitis.

There were four (4) cases of partial thickness rotator cuff tears detected on shoulder arthroscopy. The ultrasound was able to detect 2 cases only (true positive).In the remaining two cases of arthroscopically detected PT RCT, the ultrasound misdiagnosed it as tendinitis/tendinopathy. Difficulty distinguishing tendinopathy from an articular side partial thickness tear was a potent source of error inherent with the test. This error occurred in one patient with painful limited range of movement due to which visualization of the torn tendon was difficult. We were unable to determine the cause of error in the other case. Waldt *et al*. [3] showed that the diagnosis of small partial thickness tears are restricted because of difficulties in differentiation among fiber tearing, tendinitis, synovitic changes and fraying at tendon margins.

Our study revealed that the USG shoulder for partial thickness tears had a sensitivity, specificity, PPV, NPV and accuracy rate of 50%, 85%, 40%, 89.5%, 79.2% respectively. In comparison a study by Sharlene A *et al*. (27) showed sensitivity, specificity, PPV, NPV and accuracy rate of 67%, 85%, 77%, 77%, 77% respectively for partial-thickness rotator cuff tears.

Our study involving 24 patients with shoulder pain had a total of 12 patients with full thickness rotator cuff tears detected arthroscopically. The shoulder ultrasound correctly diagnosed a total of 10 cases as FT RCT(True positive).The remaining two cases of FT RCT were underdiagnosed as PT RCT (False negative) on ultrasound examination. It was due to misinterpretation of the finding. In these two cases an extensive partial-thickness tear rather than a full-thickness tear was diagnosed. A review of the images showed a contour deformity. Clinically, a failure to distinguish extensive partial thickness tear from full thickness tears may not be important because orthopaedic surgeons generally treat extensive partial thickness tears or large bursal side tears as if they were full thickness ones.

Our study revealed that the USG shoulder for full thickness tears had a sensitivity, specificity, PPV, NPV and accuracy rate of 83.3%, 100%, 100%, 85.7%, 91.7% respectively. Similarly, a study on detection of rotator cuff tears using USG and MRI by Matthieu JCM *et al*. [3] showed a showed sensitivity, specificity, PPV, NPV and accuracy rate of 95%, 80%, 88%, 98%, 94% respectively for full-thickness rotator cuff tears for ultrasound imaging.

The results of our study using USG shoulder proves that it is quite reliable in diagnosing FT RCT while the results are variable with regards to tendinopathy and PT RCT. The differentiation between tendinopathy and PT RCT requires experience and a thorough knowledge of shoulder anatomy and pathology.

MRI vs. Arthroscopy

The role of MR imaging is ever increasing in the evaluation of patients with disorders of the shoulder. The diagnosis of rotator cuff tears has been extensively studied. Although the rotator cuff tear is the most common cause of pain in shoulder, rotator cuff tear has remained clinically elusive. The impingement tests like Hawkins- Kennedy test and Neer's tests have been shown to be sensitive, but these clinical tests are limited by their lack of specificity to rotator cuff tears [4]. MR imaging has emerged as the study of choice to evaluate the status of the rotator cuff tears.

MR imaging is a non-invasive examination that is highly accurate. Varying sensitivity, specificity and accuracy of MRI has been reported in literature regarding diagnosis of all

(complete and partial) rotator cuff tears. The sensitivity [93.75%], specificity [100%] positive predictive value (100%), negative predictive value (88.9%) of rotator cuff tears in our study is comparable to that of Zlatkin *et al*. [5], who studied thirty one symptomatic patients on a 1.5 T MRI, and found a sensitivity of 90%, specificity of 93% positive predictive value (98%), negative predictive value (68%) each for all (complete and partial) rotator cuff tears.

The sensitivity [93.75%], specificity [100%] of all (complete and partial) rotator cuff tears in our study is also comparable to that of Joseph *et al* [6], who analyzed 65 articles reporting the sensitivities and specificities of MRI for the diagnosis of rotator cuff tears found a sensitivity of 85.5%, specificity of 90.4%. The higher specificity of our study was due to absence of false positive findings. One patient was falsely interpreted as rotator cuff tendinopathy on MRI, were found to be normal on arthroscopy. This was mainly because of failure to clearly visualize intact rotator cuff tendon. We had two cases with a normal rotator cuff finding in both MRI and arthroscopy.

The diagnosis of partial tears is particularly important because many orthopedic surgeons will operate to relieve impingement of the supraspinatus tendon before it progresses to a full-thickness tear. Many previous studies have quoted difficulty in diagnosing partial rotator cuff tears (4). Our sensitivity [100%] and specificity [95%] for diagnosis of partial rotator cuff tears are better compared to Andrew *et al*. [7], their sensitivity of MR Imaging for detecting partial rotator cuff tears ranged from 80 to 85%, and the specificity ranged from 70 to 78%. This higher sensitivity and specificity is due to lower false negative (nil) and false positive (1) cases respectively.

One case was falsely interpreted as partial thickness tear on MRI which was found to be a full thickness tear on arthroscopy.

Of the four (4) cases correctly interpreted partial rotator cuff tears on MRI, one patient had bursal surface tear. The rest three had partial articular surface tear.

Our sensitivity [83.3%], specificity [100%] and accuracy [91.7%] for diagnosis of full thickness tears are comparable to Andrew *et al*. [7] who studied forty-four patients on 1.5 T MRI, followed by subsequent arthroscopy and found a sensitivity of 80%, specificity of 94% and accuracy of 89%. One patient with full thickness tear of subscapularis tendon was misinterpreted as partial tears. This patient presented with pain since 5 weeks due to trauma [accidental fall]. On MRI, there was diffuse increase in signal intensity with preserved continuity on all sequences, which was promptly reported as partial tear, which on subsequent arthroscopy was found to have full thickness tear. Although fibrous scar was not reported on arthroscopy, this tear was likely a chronic tear in view of history of the patient. Timothy *et al*. [8] in his study found that mature fibrous scar tissue has the same imaging characteristics as a tendon; therefore, a chronic rotator cuff tears may appear as intact bands on MRI.

A comparative study by Matthieu *et al*. [3] reported a sensitivity, specificity, PPV, NPV and accuracy rate of 100%, 91%, 85%, 100%, 94% respectively for full-thickness rotator cuff tears using MRI in comparison to surgical findings.

Rotator cuff tendinosis

Rotator cuff tendinosis is an accumulation of microscopic injuries that fail to heal properly; it becomes increasingly important for radiologists to identify supraspinatus tendinosis in earlystages because ultimately it leads to partial thickness tearing in the weakened tendon. The supraspinatus tendon sustains injury more often than the other muscles and tendons that make up the rotator cuff. Unlike a tear, tendinitis or tendinosis may respond to conservative therapy and not require an invasive procedure, so it is important to distinguish between these entities [9].

In the acute phase, physical examination of the supraspinatus tendinosis can be difficult because of the presence of pain. As a result, in many patient's supraspinatus tendinosis

ISSN 2515-8260 Volume 09, Issue 02, 2022

remain undiagnosed at the initial clinical evaluation. The sensitivity [100%], specificity [89.5%] and accuracy [91.7%] of supraspinatus tendinosis of our study in comparison to that of Richard Kijowski *et al*. [10] who studied sixty one patients with shoulder pain on a 1.5 T MRI, and found a sensitivity of 78.72%, specificity of 98.94% and accuracy of 98.84% for supraspinatus tendinosis. Our study revealed 100% sensitivity as there were no false negative cases while the lower specificity was due to the two false positive cases found on MRI.
One patient with normal rotator cuff on arthroscopy was interpreted as having tendinosis on MRI. The MRI overdiagnosis may be due to magic angle phenomenon or even inability of the arthroscope to detect tears within the tendon substance or tendon articular surface.

Conclusion

Our findings indicate that shoulder ultrasonography can be a valuable non-invasive procedure for imaging of the rotator cuff. It obviates the need for further imaging in most of the cases of rotator cuff tears /pathology. It is comparable with MRI in terms of accuracy, sensitivity and PPV for detecting full thickness rotator cuff tears. It provides bilateral information, is better tolerated, allows patient viewing of real time information, and is less expensive. However, in the detection of tendinopathy and partial tears of the rotator cuff both imaging modalities are less accurate.
It should be noted that following USG of the shoulder performed by a dedicated radiologist, MRI offers little additional value, with regard to the detection of rotator cuff tears.
Of course local setting and other factors such as equipment availability, personal expertise and preference, patient preference and cost effectiveness may play a role in choosing which imaging technique will be used. In developing countries with majority of the people belonging to low socioeconomic status, USG can be offered as the primary modality of investigation in cases where rotator cuff pathology is suspected.
However, it should be noted that USG shoulder is operator dependent and has a steep learning curve. Inter observer variation is quite high.
The MRI is a relatively expensive procedure. Most of the studies have demonstrated that both MRI and USG have comparable accuracy for detecting full-thickness and partial-thickness tears [11, 12]. Regarding the rotator cuff tears our results demonstrate that the sensitivity and specificity are significantly high for full thickness tear than partial thickness tears, which are comparable to Andrew *et al*. [7]
MRI has the additional value to assess fatty infiltration of the rotator cuff and muscle atrophy which has a role in the final treatment decision. However, USG can also depict fatty infiltration and atrophy of the rotator cuff as reliably as MRI [13, 14].
It has to be noted that in the present study, the MRI also detected additional intra-articular pathologies like SLAP tears, Bankart's lesion, ALPSA, PASTA lesions which changed our strategy of surgical intervention. However, these lesions are not included in our study.
Thus, we agree with Zlatkin *et al*. [15] who stated that MRI is the most appropriate screening tool before arthroscopy. It is preferable to diagnostic arthroscopy in most patients because it avoids the surgical risks. Also concerning the economic burden especially in a country like India, MRI may decrease unjustified arthroscopies.
When an investigator has comparable experience with both imaging tests, the decision regarding which test to perform for rotator cuff assessment does not have to be based on accuracy concerns. The choice can be based on other factors, such as the importance of ancillary clinical information (regarding lesions of the glenoid labrum, joint capsule or surrounding muscle or bone), the presence of an implanted device, patient tolerance and cost.

ISSN 2515-8260 Volume 09, Issue 02, 2022

References

1. 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;77:296-98.
2. Brandt TD, Cardone BW, Grant TH, *et al*. Rotator cuff sonography: A reassessment. Radiology. 1989;173:323-327.
3. Matthieu JCM Rutten, Gert-Jan Spaargaren, *et al*. Detection of rotator cuff tears: the value of MRI following ultrasound. Eur Radiol. 2010;20:450-457.
4. Baert AL, Baudrez V, Bearcroft PWP, Berquist TH. Imaging of the Shoulder Techniques and Applications, 35-57.
5. Zlatkin MB, Ianotti JP, Roberts MC, Esterhai JL, Dalinka ML. Rotator cuff tears: diagnostic performance of MR imaging. Radiology. 1989;172:223-9.
6. Joseph O de Jesus, Laurence Parker, Andrea J Frangos, Levon N Nazarian. Accuracy of MRI, MRA rthrography and Ultrasound in the Diagnosis of Rotator Cuff Tears: A Meta Analysis.AJR:192, 2009 Jun.
7. Andrew M Evanch, Richard G Stiles, William A Fajman, Sara P Flower, Thomas Macha, Michael C Brunner, *et al*. MR Imaging Diagnosis of Rotator Cuff Tears; AJR 151:751-754, 1988 Oct.
8. Timothy E Farley, Christian H Neumann, Lynn S Steinbach, Arlon J Jahnke. Full-Thickness Tears of the Rotator Cuff of the Shoulder: Diagnosis with MR Imaging. AJR158:347-351, 1992 Feb.
9. Mya Lay Sein, Judie Walton, James Linklater, Craig Harris, Tej Dugal, Richard Appleyard, *et al*. Reliability of MRI assessment of supraspinatus tendinopathy. Br J Sports Med, 2007, 4.
10. Richard Kijowski, Joshua M Farber, Jorge Medina, William Morrison, Jun Ying, Kenneth Buckwalter. Comparison of Fat-Suppressed T2-Weighted Fast Spin-Echo Sequence and Modified STIR Sequence in the Evaluation of the Rotator Cuff Tendon; AJR. 2005;185:371-378.
11. Teefey SA, Rubin DA, Middleton WD, Hildebolt CF, Leibold RA, Yamaguchi K. Detection and quantification of rotator cuff tears. Comparison of ultrasonographic, magnetic resonance imaging, and arthroscopic findings in seventy-one consecutive cases J Bone Joint Surg. Am. 2004;86:708-16.
12. Dinnes J, Loveman E, *et al*. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: A systematic review. Health technol Assess. 2003;7:1-66.
13. Khoury V, Cardinal E, Brassard P. Atrophy and fatty infiltration of the supraspinatus muscle: Sonography verses MRI. Am J Roentgenol. 2008;190:1105-1111.
14. Strobel K, Hodler J, *et al*. Fatty atrophy of supraspinatus and infraspinatus muscles: Accuracy of ultrasound. Radiology. 2005;237:584-589.
15. Zlatkin MB, Hoffman C, Shellock FG. Assessment of the rotator cuff and glenoid labrum using an extremity MR system: MR results compared to surgical findings from a multi-center study. J Magn Reson Imaging. 2004 May;19(5):623-31.