International Journal of Orthopaedics Research
www.orthopaedicsjournal.in
E-ISSN: 2663-0923, P-ISSN: 2663-0915
Received: 05-10-2020; Accepted: 20-10-2020; Published: 08-11-2020
Volume 2; Issue 4; 2020; Page No. 08-11

Diagnostic efficacy of dynamic ultrasound VS MRI in clinically suspected rotator cuff tears

Syam Gangadharan Nair[1], Anusha Varghese[2], Dileep S Nair[3], Divya Geetha[4], John Thayyil John[5], Tigy Thomas Jacob[6]
[1, 3-5] Department of Orthopaedics, Lourdes Hospital, Kochi, Kerala, India
[2] Department of Radiodiagnosis, Lourdes Hospital, Kochi, Kerala, India
[6] Department of Orthopaedics, Govt. Medical College, Kottayam, Kerala, India

Abstract
Background: The present study aimed to compare the diagnostic efficacy of dynamic ultrasound and MRI in detection of full and partial thickness rotator cuff tears and to find out whether MRI can be replaced by dynamic USG in the diagnosis of rotator cuff injuries of shoulder.
Methods: The study comprised of 116 patients who were clinically suspected to have rotator cuff tears.
Sensitivity, specificity, positive and negative predictive values, accuracy and kappa values were calculated for both imaging modalities, with arthroscopic findings as the comparative standard of reference.
Results: The sensitivity, specificity and diagnostic accuracy of dynamic USG for full and partial thickness rotator cuff tear were 97.1%, 95.7%, 96.6% and 97.8%, 92.9%, 94.8% respectively and the corresponding values for MRI for full and partial thickness rotator cuff tears were 98.6%, 97.8%, 98.3% and 93.5%, 97%, 96% respectively. There is almost perfect agreement between USG, MRI and arthroscopic findings in the detection of partial and full thickness rotator cuff tear as suggested by kappa value of more than 0.81.
Conclusion: Dynamic ultrasonography and MRI have comparable degrees of accuracy for diagnosing rotator cuff tears. The use of dynamic ultrasound study, providing comparable information as that of MRI but less expensive, is therefore recommended for the diagnosis of rotator cuff disorders.

Keywords: dynamic ultrasonography, magnetic resonance imaging, rotator cuff tears, arthroscopy

Introduction
Rotator cuff pathologies are the most common cause of shoulder pain in patients presenting to outpatient department [1]. Common underlying pathologies involving rotator cuff includes tears, tendinitis, impingement and instability. Among them rotaor cuff tear are the most common cause of shoulder pain. Rotator cuff tear can be due to trauma or degeneration [2]. Clinical examinations gives limited information regarding the type and extend of tears. Hence diagnostic modalities are the mainstay for planning the treatment [3]. USG and MRI are the most common imaging techniques used to assess rotator cuff tears. Earlier results of using ultrasound in the detection of rotator cuff tears varied, probably due to the use of low frequency transducers and limited experience [4]. With the advent of high-resolution ultrasound, increased user experience and improved techniques like dynamic studies, the reliability of ultrasound for assessing rotator cuff has improved significantly. It is non-invasive, easily available and less expensive. However, limited movement of shoulder in painful conditions, long learning curve, technical restrictions and insufficient expertise are drawbacks of dynamic ultrasound study [3, 5]. MRI quickly became the favoured investigation for diagnosis of rotator cuff tears, with high sensitivity and accuracy.[6]MRI can provide accurate information about tear dimensions, tear depth or thickness of tear. It also provides additional information regarding the adjacent structures like rotator interval, long head of biceps tendon and coracoacromial arch [7]. The drawbacks of MRI includes its availability, time consuming procedure and expense. In addition, it is absolutely contraindicated in presence of intracerebral aneurysm clips, cardiac pacemakers, automatic defibrillators, metallic orbital foreign bodies and cochlear implants [8]. Therapeutic arthroscopy is considered as the gold standard for diagnosis of shoulder pathology. However, arthroscopy is an invasive technique that involves all the potential complications of a surgical procedure.
Although USG and MRI have been reported to be effective in detection of rotator cuff tears in independent studies [9], few studies comparing the two tests, with use of surgery as the "gold" standard, showed them to have similar specificity but lower sensitivity for detection of full and partial-thickness tears [10, 11].
The purpose of present study is to compare the diagnostic efficacy of dynamic USG and MRI in detection of full thickness and partial thickness rotator cuff tears in symptomatic patients, using arthroscopy as the gold standard.

Materials and Methods
This prospective study comprised of 116 patients who were clinically diagnosed to have rotator cuff tears. Those patients who d prior rotator cuff repair, previous reconstructions, those in whom MRI was contraindicated were excluded from the study.

Eachpatient underwent preoperative Dynamic USG and MRI by the same radiologist followed by arthroscopic evaluation and intervention of rotator cuff injury. USG, MRI and Arthroscopic findings were statistically compared.

Ultrasonography

Dynamic Ultrasonography was performed using GE Logiq P6 Pro and voluson ultrasound unit (GE Healthcare, San Jose, California), with 8-10 MHz transducers. Shoulder USG examinations were performed in a standardized fashion, with the subject in a seated position. Evaluation included the rotator cuff musculature tendons, acromioclavicular joint and long head biceps tendon. The supraspinatus was evaluated in both Crass and modified Crass positions. Dynamic imaging was performed for abduction/adduction of the arm in the coronal plane to evaluate for sub acromial impingement and internal/external rotation of the arm at the level of the subscapularis for evaluation of sub coracoid impingement (Figure 1).

Magnetic Resonance Imaging (MRI)

All MRI examinations were performed with 1.5 T MR system (brand: GE Medical Systems, Milwaukee, WI, USA). All the patients underwent routine MRI. The routine MRI of shoulder consisted of coronal T2WI with FS and T1WI turbo spin echo, sagittal T2WI with FS and axial T2WI with FS. A field view of 200 mm was used, the slice thickness was 3 mm, the imaging matrix was 320 mm × 320 mm and overall imaging time was 4 minutes. All the MRI findings were reported by the same radiologists. (Figure 2)

Arthroscopy

All arthroscopic examinations and operative procedures were done by the same surgeon. A thorough diagnostic arthroscopy was first done. The biceps anchor, biceps exit, rotator cuff, labrum and the humeral head were inspected to rule out any intra articular pathology. Rotator cuff was examined from both the articular and the bursal side. Partial thickness rotator cuff tears were managed conservatively by shoulder physiotherapy and capsular stretching exercise. FTTs were repaired arthroscopically with suture anchors (Figure 3).

Statistical analysis

Sensitivity, specificity, PPV, NPV and accuracy were calculated for both imaging modalities, with arthroscopic findings as the comparative standard of reference.

Agreement between USG and MRI with arthroscopic findings are assessed using kappa statistics. K-statistics were interpreted based on guidelines proposed by Landis and Koch[100], with values less than 0 defined as poor or no agreement, values of 0 to 0.20 defined as slight agreement, values of 0.21 to 0.40 defined as fair agreement, values of 0.41 to 0.60 defined as moderate agreement, values of 0.61 to 0.80 defined as substantial agreement, and values of 0.81 to 1.00 defined as almost perfect agreement.

Results

Patient Demographics

36.2% of patients were in the age group of 51-60 years, 31.9% in the age group of above 60 years, 23.3%in the age group 41-50 years, and 8.6% 40 years. The mean age of the study population was 56.2years (Figure 4).

60.3% of the patients were male and 39.7% were female. The average age for male was 54.04 years with standard deviation 12.18. The minimum and maximum age for male was 24 and 76 years respectively. The average age for female was 59.39 years with standard deviation 6.856. The minimum and maximum age for female was 50 and 72 years respectively (Figure 5).

Out of 116 patients included in the study, 65.5% of the cases were having rotator cuff tear of right shoulder and 34.5% of patients had left sided rotator cuff tear (Figure 6).

In present study out of the 116 patients 70 patients were having full thickness tear and 46 were having PTT. Out of the 46 cases of PTT USG correctly identified 45 cases and MRI identified 43 cases. Out of the 70 cases of full thickness tear USG correctly identified 68 cases MRI identified 69 cases (Table 1)

The sensitivity, specificity, PPV and NPV of USG for detecting full thickness rotator cuff tear (FTT) is 97.1%, 95.7%, 97.1% and 95.7% respectively and the corresponding values of MRI for detecting FTT is 98.6%, 97.8%, 98.5% and 97.6% respectively. The diagnostic accuracy of USG and MRI for FTT is 96.6% and 98.3% suggesting that USG and MRI has comparable accuracy in detecting FTT with slightly better accuracy for MRI. Kappa value of more than 0.81 indicates that there is almost perfect agreement with USG, MRI and arthroscopic findings (Table 2).

The sensitivity, specificity, PPV and NPV of USG for detecting partial thickness rotator cuff tear (PTT) is 97.8%, 92.9%, 90.0% and 98.5% respectively and the corresponding values of MRI for detecting PTT is 93.5%, 97.1%, 95.6% and 95.8%respectively. The higher sensitivity of PTT may be due to the fact that PTT's with only mild thickening of tendon may be missed on MRI and misdiagnosed as tendinosis, while USG can frequently diagnose these tears due to its ability to perform real time dynamic examination. The diagnostic accuracy of USG and MRI for PTT is 94.8% and 95.7% respectively. This shows that both USG and MRI has comparable accuracy in detecting PTT. Kappa value of more than 0.81 indicates that there is almost perfect agreement with USG, MRI and arthroscopic findings (Table 3).

Fig 1: USG showing Full-thickness (a) and partial thickness tear (b) of the supraspinatus tendon

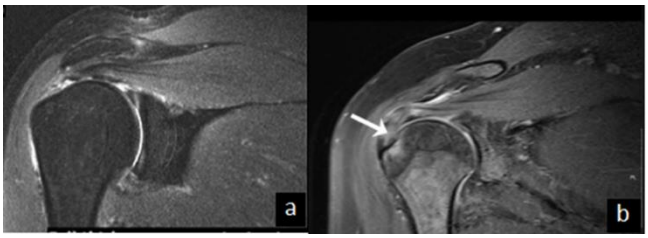

Fig 2: MRI showing full thickness (a) and partial thickness (b) rotator cuff tear

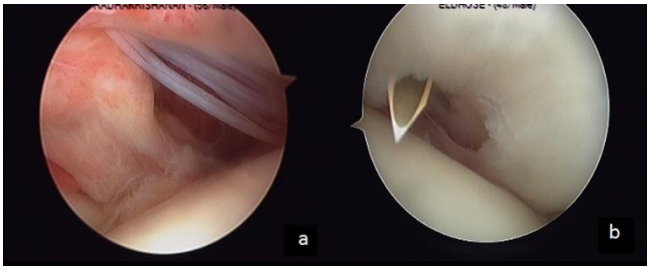

Fig 3: Arthoscopic view of full thickness (a) and partial thickness (b) rotator cuff tear

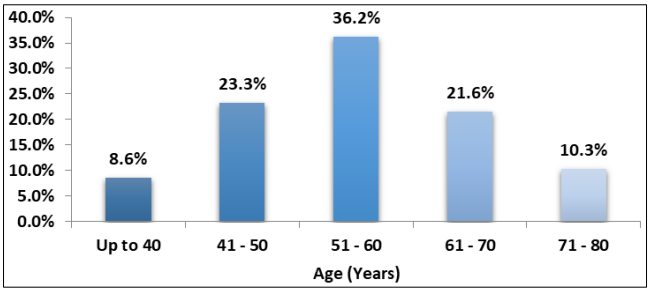

Fig 4: Graph showing distribution of age in the study population

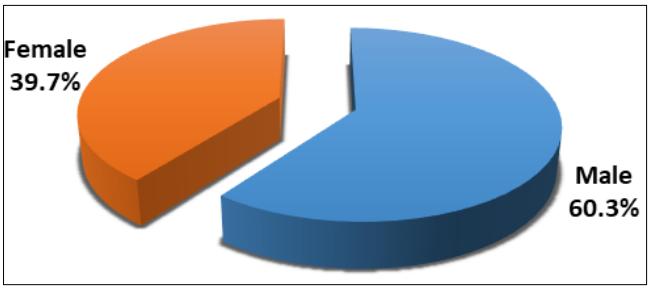

Fig 5: Graph showing distribution of sex in the study population

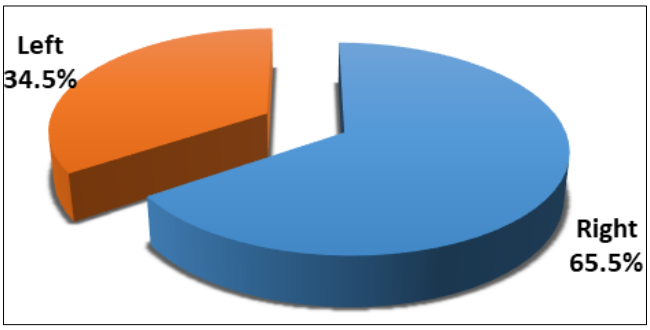

Fig 6: Graph showing distribution of side of injury in the study population

Table 1: Comparison of Dynamic USG and MRI findings

Rotator cuff pathologies	Rotator cuff pathologies		
	USG	MRI	Arthroscopy
PTT	45	43	46
FTT	68	69	70
Total rotator cuff tears	113	112	116

Table 2: Diagnostic values of Dynamic USG vs MRI for FTT

Comparing Diagnostic efficacy of USG and MRI for Full Thickness RC tear						
	Sensitivity	Specificity	PPV	NPV	Accuracy	Kappa Value
USG	97.1%	95.7%	97.1%	95.7%	96.6%	0.928
MRI	98.6%	97.8%	98.6%	97.8%	98.3%	0.964

Discussion

Shoulder disorders are very common among the general population. The location of shoulder pain is very poor indicator of its pathology and clinical assessment reveals limited information to arrive at the diagnosis [12]. Plain radiography, often used to supplement the clinical examination, also has limited diagnostic role in rotator cuff tears. Traditionally arthrography has been used through years to detect rotator cuff tears. Both USG and MRI have been developed as new imaging techniques for shoulder pathologies in the past few decades [13]. The purpose of this study was to evaluate the ability of USG and MRI to detect rotator cuff tears in clinically suspected patients, compared to arthroscopy.

In 2104, study done by Jyoti Aggrawal et al. [14] revealed that the sensitivity and specificity of USG for detecting PTT is 99.8% and 94.5%% respectively and sensitivity and specificity of MRI for detecting PTT is 100% and 94.5%. USG had a sensitivity and specificity of 100% and 90% for detecting FTT respectively and MRI had sensitivity and specificity of 100% and 96% for detecting FTT. The diagnostic accuracy of USG and MRI for PTT is 90 % and 92% respectively and that of USG and MRI for FTT is 97 and 97.6% respectively.

In 2017, study done by Hiral Hapani et al. [15] showed that the sensitivity and specificity of USG for detecting PTT is 90% and 100% and that of MRI is 100% and 100%. The sensitivity and specificity of USG for detecting FTT is 99.8% and 94.5% and that of MRI is 100% and 94.5% respectively.

In 2014, study done by Jean-Sébastien Roy et al. [16] to compare the diagnostic accuracy of USG and MRI for characterisation of rotator cuff disorder showed that the sensitivity and specificity of USG for detecting PTT is 68% and 94% and that of MRI is 67% and 94% respectively. The sensitivity and specificity of USG for detecting FTT is 91% and 93% and that of MRI is 90% and 93% respectively. The high sensitivity of USG and MRI in present study compared to Jean-Sébastien Roy et al could be due to the selection of patients with strong suspicion of tear and exaggerated positive case inclusion in present study.

Analysis of the results obtained from the presents study also points out that USG is as accurate as MRI for assessment of both full thickness and partial thickness rotator cuff tears. Considering the cost effectivemess and ease of availability dynamic USG can be considered a better option than MRI for evaluating rotator cuff tears in experienced hands.

Limitations of the Study

Results of our study might have been affected by our limited sample size. Since the study was a unicentric, the sample size belonged to a particular geographic area only. While examining the data there were several variables that appeared to affect the agreement of the image interpretation and surgical observations and warrant further analysis. These variables included age of the

patient, time elapsed between imaging and surgery, and body mass index.

Conclusion

Much research has been done examining the effectiveness of USG and MRI in diagnosing rotator cuff tears. Safety, cost, availability and impact of the results of clinical management are key elements in choosing the right imaging modality. Regarding safety, beside some specific contraindications for MRI, both USG and MRI are non-invasive tests. Claustrophobia can be an issue with MRI.

When considering cost and availability, dynamic USG is much cheaper and easily available than MRI. Dynamic ultrasonography and magnetic resonance imaging have comparable degrees of accuracy for diagnosing rotator cuff tears. The use of dynamic USG study, providing comparable information as that of MRI but less expensive, is therefore recommended for the diagnosis of rotator cuff disorders.

MRI may be the preferred imaging modality in clinical situations where other shoulder pathologies such as articular cartilage injuries or labral tears (eg, in cases where glenohumeral instability in younger patients or osteoarthritis in older patients overlap with rotator cuff disorders) coexist.

Thus, the choice of which imaging test to perform should not be based on accuracy considerations alone. Rather, it should be based on the inherent strengths and weaknesses of each test, patient concerns, the clinical information being sought, and the experience of radiologist at the individual institution.

References

1. Martín-Hervás C, Romero J, Navas-Acién A, Reboiras JJ, Munuera L. Ultrasonographic and magnetic resonance images of rotator cuff lesions compared with arthroscopy or open surgery findings. J Shoulder Elbow Surg. 2001; 10(5):410-5.
2. Bianchi S, Martinoli C. Ultrasound MuscloskeletalSyst. 2007; 12(4):246-56.
3. Le Corroller T, Cohen M, Aswad R, Pauly V, Champsaur P. Sonography of the painful shoulder: role of the operator's experience. Skeletal radiol. 2008; 37(11):979-86.
4. Brandt TD, Cardone BW, Grant TH, Post M, Weiss CA. Rotator cuff sonography: a reassessment. Radiology. 1989; 173(2):323-7.
5. Teefey SA. Shoulder sonography: why we do it. J Ultrasound Med. 2012; 31(9):1325-31. doi: 10.7863/jum.2012.31.9.1325.
6. Iannotti JP, Zlatkin MB, Esterhai JL, Kressel HY, Dalinka MK, Spindler KP. Magnetic resonance imaging of the shoulder. Sensitivity, specificity, and predictive value. J Bone Joint Surg Am. 1991; 73(1):17-29.
7. Morag Y, Jacobson JA, Miller B, De Maeseneer M, Girish G, Jamadar D. MR imaging of rotator cuff injury: what the clinician needs to know. Radiographics. 2006; 26(4):1045-65
8. Whiting P, Rutjes AW, Reitsma JB, Bossuyt PM, Kleijnen J. The development of QUADAS: a tool for the quality assessment of studies of diagnostic accuracy included in systematic reviews. BMC Med Res Methodol, 2003, 3:25
9. Darai N, Pokhrel S, Shu R, Zhang X, Liu J, Teng G, et al. Comparison with Surgical Findings for the Accuracy of Routine MRI in Rotator Cuff Tears. Open J Radiol. 2016; 6(02):73.
10. Martín-Hervás C, Romero J, Navas-Acién A, Reboiras JJ, Munuera L. Ultrasonographic and magnetic resonance images of rotator cuff lesions compared with arthroscopy or open surgery findings. J Shoulder Elbow Surg. 2001; 10(5):410-5.
11. Rutten MJ, Jager GJ, Blickman JG. US of the Rotator Cuff: Pitfalls, Limitations, and Artifacts 1. Radiographics. 2006; 26(2):589-604.
12. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33(1):159-74.
13. Milosavljevic J, Elvin A, Rahme H. Ultrasonography of the rotator cuff: a comparison with arthroscopy in one-hundred-and-ninety consecutive cases. ActaRadiol. 2005; 46(8):858-65.
14. Aggrawal J, Bansal RP, Shah V. USG and MRI correlation of. Surgery, 2014, 41:0.
15. Hiral Hapani, Mahak Sood, Anjana Trivedi, Anirudh Chawla, Ishita Virda, Krushndas Radadiya, et al. Ultrasound, MRI and arthroscopic correlation of rotator cuff tears. International Journal of Contemporary Medical Research. 2017; 4(3):650-652.
16. Roy JS, Braën C, Leblond J, Desmeules F, Dionne CE, MacDermid JC, et al. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. Br J Sports Med. 2015; 49(20):1316-28.