Comparison of Ultrasound and MRI Findings in Rotator Cuff Injuries

Aarti Anand¹, Shyam Chhadi², Sanchita Bhawalkar³
¹Professor and HOD, Department of Radiodiagnosis, ²Associate Professor, Department of Radiodiagnosis, ³Junior Resident, Department of Radiodiagnosis, Government Medical college and Hospital, Nagpur, Maharashtra, India.

Corresponding author: Dr. Aarti Anand, 165, Shivaji Nagar, Nagpur, Maharashtra, India

DOI: 10.21276/ijcmsr.2018.3.3.21

ABSTRACT

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

Material and Methods: This study was carried out in Department of Radiodiagnosis in Tertiary care centre for 2 years (from December 2014 to November 2016). Sonographic evaluation of shoulder was done on PHILIPS IU 22 machine and MRI examination was performed on 1.5 Tesla Philips Achieva machine. For comparison of rotator cuff pathologies on USG and MRI, SPSS Statistical software version 22.0 was used for statistical calculation.

Results: Partial thickness tears of rotator cuff were seen in 20 tendons on USG and in 22 tendons on MRI. Full thickness tears were present in 15 tendons on USG and in 14 tendons on MRI. USG showed high sensitivity, specificity, accuracy and very good agreement in detecting rotator cuff tears as compared to MRI. Various other findings were noted on MRI, most common of which was joint effusion, followed by bone marrow edema in 7 patients and fractures in 6 patients.

Conclusion: MRI is presently the imaging modality of choice in the evaluation of rotation cuff injuries. USG can effectively serve as a primary screening method in suspected cases of rotator cuff injuries because it is economic and fast and MRI should be used secondarily

Key words: Injuries; MR Imaging; Rotator Cuff; Ultrasound

INTRODUCTION

Shoulder pain is the third most common cause of musculoskeletal pain after back pain and knee pain.¹ The glenohumeral joint being the most mobile and unstable of all the joints, is often prone to injuries. To compensate for its unstable bony anatomy, the shoulder is protected anteriorly, posteriorly, and superiorly by a capsule and tendons that form the rotator cuff. Rotator cuff disease is the most prevalent cause of shoulder pain, occurring in approximately 65% - 70% of patients. Early diagnosis of rotator cuff tear is important because a large number of patients with asymptomatic rotator cuff tears become symptomatic after a short time and lead to irreversible fatty atrophy of the shoulder musculature.² Radiographic findings are usually normal in the acute setting, although in subacute and chronic cases, certain indirect signs help in predicting rotator cuff injury like decreased acromiohumeral distance, subluxation of humeral head and secondary degenerative arthritis of the glenohumeral joint.³ High resolution ultrasound can detect tears, both partial and complete, and also reveal the presence of other abnormalities that mimic rotator cuff tear at clinical examination, including calcific tendinosis, sub acromial- sub deltoid bursitis, greater tuberosity fracture etc. It has its own limitations such as high operator dependency, long learning curve and problems of anisotropy. It has limited utility in evaluation of labral, rotator cuff interval, and in demonstrating subtle bony lesions. MRI is a widely used imaging modality for rotator cuff tear evaluation and now considered the gold standard for rotator cuff imaging. MRI is reported to have consistently high sensitivity (80–97%) and specificity (93–94%) for the diagnosis of rotator cuff pathology.⁴ Because of its multplanar capability it can provide information about rotator cuff tears such as tear dimensions, tear depth, thickness and shape, involvement of adjacent structures and muscle atrophy, all of which have implications for rotator cuff treatment and prognosis.⁵ However the disadvantages include cost, accessibility and patient issues such as claustrophobia and contra-indications owing to metallic implants and electronic devices. Arthrography of the glenohumeral joint is most useful in delineating the presence of a complete tear of the rotator cuff.⁶ Shoulder arthroscopy is a diagnostic method allowing direct visualization of the intraarticular structures of the glenohumeral joint. Once the arthroscopist has become proficient, diagnostic accuracy is superior to double-contrast arthrography.⁷ These days, USG serves as a complementary role to MRI, and there are potential benefits from the combined use of these two modalities. It is often considered...
the first-line imaging modality in the assessment of cuff as well as in nonrotator cuff disorders. In this study, the USG and MRI findings of fifty patients with a clinical suspicion of rotator cuff injury were compared. The aim was to show the effectiveness of ultrasound examination as compared to MRI, in the evaluation of shoulder pain, particularly in cases of rotator cuff injuries and to assess correlation between high resolution ultrasound findings with MRI findings in rotator cuff injuries.

**MATERIAL AND METHODS**

After obtaining permission from hospital ethics committee, this study was carried out in Department of Radiodiagnosis in a Tertiary care centre over a period of 2 years (from December 2014 to November 2016). Fifty cases of all age groups irrespective of sex with clinical suspicion of rotator cuff injuries (both traumatic and degenerative etiology) were included in this observational study. Claustrophobic patients, patients not willing for MRI, patients with metallic implants, cardiac pacemakers, aneurysmal clips, dentures, Cochlear, otologic or other ear implant considered contraindicated for MR imaging were excluded. The sonographic evaluation of shoulder was done on PHILIPS IU 22 machine using its linear high frequency probe. The MRI examination was performed on 1.5 Tesla Philips Achieva machine with shoulder coil centered over the affected shoulder with the patient in supine position. Multiplanar images were obtained in the axial, oblique coronal and oblique sagittal planes. The overall duration of the examination was 20 minutes. For comparison of rotator cuff pathologies on USG and MRI, 2 x 2 contingency tables were made for each to enumerate the true and false positive and negative results of both USG and MRI.

**STATISTICAL ANALYSIS**

The SPSS Statistical software version 22.0 was used for statistical calculation. The ultra-sonographic diagnoses were compared with the respective MRI diagnoses by employing the Cohen kappa inter-rater coefficient of agreement. Values assumed by the coefficient in the analysis performed, were reported with the 95 % confidence intervals. For statistical hypothesis test, $p \leq 0.005$ was considered significant. Kappa coefficient was calculated to measure agreement between USG and MRI pertaining to various rotator cuff findings and it was interpreted as Poor agreement = Less than 0.20, Fair agreement = 0.20 to 0.40, Moderate agreement = 0.40 to 0.60, Good agreement = 0.60 to 0.80, Very good agreement = 0.80 to 1.00.

**RESULTS**

In this study, most patients were in age group of 41 –50 years (30.0 %) followed by 21 – 30 years (26.0 %). Both males and females were included in my study. Involvement of males (56%) was more as compared to females (44%). Duration of presenting symptoms varied from 10days to 3 years with maximum patients (44%) with duration of 1 month to 6 month. Right shoulder was more commonly involved in the study population with 38 patients (76%) showing right shoulder involvement and 12 patients (24%) showing left shoulder involvement. Right hand was dominant in 48 patients(96%) and only 2 patients(4%) had left hand dominance. Out of 50 patients, 18 patients(36%) had history of trauma and 32 patients(64%) did not have history of trauma. 47 patients(94%) presented with pain in shoulder, 34 patients(68%) presented with restriction of movements and 6 patients(12%) had history of dislocation of shoulder. Supraspinatus was the most common tendon involved, with

**Figure-1:** USG showing full thickness tear of right supraspinatus tendon with surrounding collection. Left supraspinatus tendon appear normal in echotexture.

**Figure-2:** Articular surface irregularities of acromion process and clavicle with thickening of acromioclavicular joint noted on both USG and MRI (T2W and PDW coronal images).
35 patients (70%) showing tendon involvement on MRI. 10 patients (20%) had tendinosis, 16 (32%) had partial thickness tear, 11 (22%) had full thickness tear and atrophy was noted in 9 (18%) patients on MRI. Figure 1 shows full thickness tear of right supraspinatus tendon on USG with surrounding collection. Left supraspinatus tendon appear normal in echotexture. Second most common tendon involved in the study was subscapularis - 5 patients (10%) had tendinosis, 3 (6%) had partial thickness tear, 1 (2%) had full thickness tear and atrophy was noted in 5 patients (10%) on MRI. Out of 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 15 tendons (7.5%) on USG and in 14 tendons (07%) on MRI. The different pathological findings of tendinosis, Partial thickness tear (PTT), Full thickness tear (FTT) and muscle atrophy in the four rotator cuff tendons on USG and MRI along with their frequencies is shown in the table 1. Various statistical parameters were calculated for determining diagnostic accuracy of USG over MRI for detecting partial thickness and full thickness tears.

USG showed high sensitivity, specificity, accuracy and very good agreement in detecting rotator cuff tears as compared to MRI. Peri-bicipital fluid was present in 20 patients (40%) on MRI and bursal fluid (in subacromial subdeltoid/subcoracoid bursa) was present in 33 patients (66%) on MRI. Acromio-clavicular joint hypertrophy was noted in 9 patients (18%) on MRI and in 7 patients (14%) on USG. Fig 2. Type II acromion was the most common type of acromion noted in the study population, seen in 35 patients (70%) followed by Type I acromion found in 10 patients (20%) and Type III in 5 patients (10%). Various other findings were noted on MRI, most common of which was joint effusion, seen in 17 patients (34%) followed by bone marrow edema in 7 patients (14%), fractures in 6 patients (12%) and least common finding was ganglion cyst which was seen in 1 patient (2%) only.

**DISCUSSION**

Various techniques are used for evaluating patients with shoulder pain including clinical examination, X-ray, arthrography, USG, CT scan and MRI. Conventional MRI is sensitive and specific, but cannot be used as a first line of investigation. However, USG is a non-invasive, relatively inexpensive modality that can be used. This study aimed at comparison of ultrasound and MRI findings of 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 who stated that the prevalence of rotator cuff disease increases with age. 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 Yamamoto et al. 18 patients (36.0%) had a history of trauma to the affected shoulder. 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. Maximum patients (44.0%) had duration of symptoms in the range of 1–6 months. Rotator cuff pathologies included partial, full thickness tears, tendinosis and muscle atrophy. Supraspinatus tendon was the commonest tendon to be involved in our study. USG detected 64% patients and MRI detected 70% patients with supraspinatus tendon involvement. This is comparable to the study by Zlatkin et al wherein they found that supraspinatus tendon involvement in around 80% of their cases. Supraspinatus involvement was followed by subscapularis tendon(24%) and infraspinatus tendon(14%) and least involved tendon was teres minor(4%). 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 9 patients (18%) on USG. Supraspinatus muscle atrophy was seen in 7 patients(14%) on USG and in 9 patients (18%) on MRI. USG showed high accuracy of 96% in detecting supraspinatus atrophy. This finding corresponded with study by Viviane et al. In case of subscapularis tendon, there were 3 cases(6%) of partial thickness tear, 1 full thickness tear(2%). Ultrasound detected 5 patients(10%) with partial thickness tears, out of which 2 cases(4%) were falsely positive and correctly detected 1 case(2%) of full thickness tear. Tendinosis of subscapularis was seen in 5 patients(10%). Full thickness tear of subscapularis tendon was associated with biceps tendon dislocation. This is in concordance with previous study by Adams et al. The false positive results on ultrasound in supraspinatus and subscapularis tendons can be explained due to scanning pitfall like anisotropy. Anisotropy has been described by Jacobson as the most common scanning pitfall where the normal hyperechoic tendon appears hypoechoic if tendon is not perpendicular to sound beam. Ultrasound correctly detected 1 case each of partial thickness tear, full thickness tear and tendinosis of infraspinatus tendon and missed one case of full thickness tear which was detected on MRI. Atrophy was seen in 3 patients(6%) on USG and in 5 patients(10%) on MRI. Similarly, in case of teres minor tendon involvement, Ultrasound correctly detected 1 case each of partial thickness tear, full thickness tear and tendinosis and missed one case each of partial thickness tear and tendinosis which were detected on MRI. Atrophy was seen in 1 patient(2%) on USG and in 2 patients(4%) on MRI. Teres minor tear were associated with other rotator cuff tear. This finding is corresponding to Darren Fitzpatrick study who concluded that isolated teres major rupture is uncommon. Considering all tendons(50 patients-200tendons) of rotator cuff together, partial thickness tears were noticed in total 20 tendons(10%) on USG and in 22 tendons(11%) on MRI. Overall Full thickness tears were present in 15 tendons (7.5%) on USG and in 14 tendons (07%) on MRI. Kappa coefficient for agreement between USG and MRI was calculated and was found to be 0.947 for partial thickness tears and 0.963 for full thickness tears. Thus it was interpreted as very good agreement(0.80–1.00). The statistical parameters of ultrasonography and magnetic resonance imaging for the diagnosis of rotator cuff tears were in concordance with previous studies. These parameters for full thickness tears were in discordance with study by Martin Hervas who concluded that USG has low sensitivity(67.9%) but high specificity(100%) for full thickness tears of rotator cuff. And the findings were also in concordance with de Jesus JO et al who concluded that USG and MRI are not statistically different in sensitivity and specificity for detecting full thickness tear. Peri-bicipital fluid was present in 20 patients(40%) on MRI and in 18 patients(36%) on USG. (Fig3) Bursitis(subacromial subdeltoid/ subcoracoid bursitis) was present in 35 patients(70%) on MRI and in 32 patients(64%) on USG. USG showed sensitivity of 85% and specificity of 96.6% in detecting peribicipital fluid. And, sensitivity for bursitis on USG was 91.43% and specificity of 100%. In most of the cases peribicipital fluid and bursitis were associated with rotator cuff tears. These findings are in concordance with study by Hollister et al. In this study, USG findings of all patients were correlated with MRI findings. However, MRI additionally picked up other findings like bone marrow edema, fractures, joint effusion, adhesive capsulitis, ganglion cyst, degenerative changes in humeral head including subchondral cysts. Hill sachs and Bankart lesion were also easily appreciated on MRI than on USG. This advantage of MRI over USG in reliably detecting non rotator cuff pathologies is in concordance with previous studies by Papatheodorou et al and Diana Gaitini. Acromio-clavicular joint hypertrophy was detected on USG with sensitivity of 75% and specificity of 100%. Different types of acromion were also noted on MRI with most common type being Type II (concave undersurface). This finding was in concordance with Getz et al who concluded from their study that type II is most common type.

**CONCLUSION**

USG and MRI imaging play a very vital role in diagnosis and management rotator cuff tears. From the present study certain inferences were drawn. Rotator cuff injuries most commonly involve the dominant hand. The incidence increases with increase in age. The most common tendon involved in rotator cuff injuries is supraspinatus tendon, followed by subscapularis tendon. Ultrasound has a high sensitivity of 90.90% and specificity of 100.0% for partial thickness tears, and for full thickness tears, sensitivity of 100.0% and a specificity of 99.46%. The observed degree of agreement between ultrasound and MRI for partial thickness tears was 99.0%, with a Kappa coefficient of 0.947. And for full thickness tears, observed degree of agreement was 99.5% with a Kappa coefficient of 0.963. These statistical parameters suggest very good agreement between USG and MRI in detecting rotator cuff injuries. Thus, USG can be considered almost equally effective as compared to MRI, in the evaluation of rotator cuff injuries. When considering cost and availability, ultrasonography definitely scores over MRI. Its wide availability in almost all clinical settings and low cost makes ultrasound an ideal first line imaging modality of choice in the evaluation of rotator cuff injuries. The most clinically important aspect when selecting a shoulder imaging modality for rotator cuff injury evaluation is the capacity to
properly detect and characterise a full-thickness rotator cuff tear since it constitutes a key indication for surgical repair. In this context, MRI scores over ultrasound in accurately defining and documenting a full thickness tear. Nevertheless, the ready availability of USG allows it to remain as the first line investigation of choice. The use of USG, providing equivalent information to MRI but less expensive, is therefore recommended for the diagnosis of rotator cuff tears. Though operator dependent, a well performed USG can effectively serve as a primary diagnostic method and screening of all suspected cases of rotator cuff injuries because it is economic and fast and MRI should be used secondarily.

REFERENCES