A comparative study of suspected cases of rotator cuff tears by high frequency ultrasonography and magnetic resonance imaging

Shaista Siddiqui¹, Ibne Ahmad², Aamir Bin Sabir², Shagua Wahab², Zafar Ahmad Khan²

Background
The shoulder is a complex joint with a complex anatomy leading to complex pathological conditions. To unveil the myriad pathologies of the shoulder there is need to understand the anatomy and the pathology of the shoulder joint. Also the available common imaging modalities to assess the shoulder joint should be well known for the proper diagnosis of pathology.

The shoulder joint is a ball and socket type of mobile joint of the body, formed by the humerus, the scapula and the clavicle. The rotator cuff muscles, namely the supraspinatous, infraspinatous, subscapularis and the teres minor have separate origin in the scapula, but converge on the tuberosities of the humerus to form the footprint of the rotator cuff. These muscles converge with the capsule of the glenohumeral joint and form a musculotendinous collar, which surrounds the joint on the anterior, posterior and the superior aspect in order to hold the joint together without any compromise on the joint stability and range of movements [1,2]. The rotator cuff provides substantial anterior dynamic stability to the glenohumeral joint in the end range as well as the midrange of motion [3,4].

Shoulder pain due to rotator cuff abnormalities has been dated back to the early 20th century with the earliest work done by Codman et al in 1934 [5]. The pain and rotator cuff injury can be both acute as in the case of falling on the outstretched hand or may be chronic due to repeated age related insult. The major risk factors are occupational, sports activities and age related degenerative changes [6].

This prospective observational study was performed to compare the role of high frequency USG and MRI in the evaluation of rotator cuff diseases in patients, who presented with clinical history suggestive of painful shoulder and suspected tear.

Materials and Methods
The study was conducted in 35 consecutive patients aged above 15 years, referred from the Orthopaedics, Emergency and the Pain Clinics over a period of 1 year, from April 2017 to May 2018. The patients were initially subjected to high frequency ultrasound followed by 1.5 T MRI. The findings were compared for tears and other secondary changes associated with rotator cuff tear.

Results:
High frequency USG was diagnostic in 57.0% (20/35) of the cases, whereas MRI was diagnostic in 71.0% (25/35) of the cases. 57.0% (20/35) cases showed abnormality detectable on both USG and MRI. Supraspinatous muscle tear was the most commonly implicated and most easily detectable lesion on USG (17/35); however, MRI was able to detect tears also in other rotator cuff muscles apart from supraspinatus. Effusions and other associated findings were better appreciated on MRI.

Conclusions: MRI is far more superior to high frequency USG in detecting both rotator cuff tears and other associated findings with rotator cuff tears. Nevertheless, high frequency USG can be reliably used as an initial screening modality and can also be used as the only modality of investigation in absence of MR facilities.

Keywords: Magnetic Resonance Imaging, Rotator cuff tear, Ultrasonography.
the shoulder. The shoulder joint was assessed by high frequency ultrasound on Toshiba ISTYLE Aplio XG machine using multifrequency Linear probe (7-12 MHz). The tissue harmonic settings was used as it made the tears more conspicuous, with the ultrasound beam perpendicular to the tendon to prevent anisotropy. MRI was performed on 1.5 Tesla superconducting system (MAGNETOM Avanto, Siemens) using a circular polarized coil. Various MRI sequences were obtained with Scout imaging performed in at least two planes. After scout views, T1 weighted spin echo MR images with a short repetition time and a short echo time (repetition time msec/echo time msec= 600/20) was performed in axial plane, followed by T2-weighted turbo spin-echo images with long repetition time and long echo time (3,000-7000/120-150 msec) in axial plane. STIR with repetition time 1500 msec/echo time 30 msec/ inversion time 100 msec images were acquired and other sequences like proton density, gradient echo sequence (GRE) etc. were obtained as and when required, according to the individual needs of the patient. Intravenous Gadolinium was administered in selected cases and post contrast Fat saturated T1-weighted images were obtained. Finally findings of both USG and MRI were compared.

Results
The youngest patient in the study was 19 years of age and the oldest was aged 73 years, with a mean age of about 46 years and a male preponderance. Majority of the patients were in the sixth decade, 9 (25.0%), followed by 8 (22.0%) patients in the fifth decade. The most common complaint was pain in 33 (94.0%) patients, followed by restriction of movements in 20 (57.0%) patients and trauma in 5 (14.0%) patients. Least common complaint was instability observed in only 2 (5.7%) patients. Chronicity of the complaint was seen in 28 (80.0%) patients, with no significant difference in the laterality of the complaint, with the right and the left joints almost equally affected.

Rotator cuff tear appeared as hypoechoic or anechoic defects, with fluid in the area of the torn tendon. Tears involving the entire thickness of the tendon was designated as full thickness tear and incomplete involvement as partial thickness tear. Non-visualization or absence of the rotator cuff, focal partial or full thickness discontinuity of the rotator cuff, focal thinning of the rotator cuff, loss of convexity of the outer border of the rotator cuff, hypoechoic defect of the articular or the bursal side of the rotator cuff or within the tendon were considered abnormal and considered tears.

High frequency ultrasound helped to detect tear in 20 (57.0%) patients. Supraspinatus was the most commonly affected muscle in 17 (85.0%) patients, followed by subscapularis in 3 (8.5%) patients. However, ultrasonography could not detect any tear in the infraspinatous and teres minor muscles [Table 1].

Ultrasonography most commonly detected partial thickness tear in 9 (52.9%) patients, followed by full thickness in 5 (29.4%) patients and tendinosis in 3 (17.6%) patients in the supraspinatus muscle (Fig 1).

The additional findings obtained on ultrasonography, was presence of fluid along the biceps tendon and joint effusion, followed by irregularity of the greater tuberosity and osteoarthritis of the acromioclavicular joint (Fig 2).

On MRI, the tears appeared as an area of altered signal intensity in the tendinous portion of the muscle near its insertion point with partial or complete discontinuity of its fibres, with retraction of the tendon. Shoulder MRI detected a tear in 25 (71.0%) patients. The most common muscle

Figure 1: Shows the tendon pathologies on ultrasonography (A) shows heterogeneous appearance of the tendon consistent with tendinosis (B) shows a hypoechoic defect at the articular side of the supraspinatous tendon consistent with partial thickness tear (C) Shows a linear defect in the supraspinatous tendon extending from the bursal to the articular surface with interposed fluid consistent with full thickness tear

Figure 2: Shows the additional findings seen on USG shoulder (A) Cortical irregularity of the greater tuberosity (B) fluid around the biceps tendon (C) acromioclavicular joint arthritis
implicated was supraspinatous in 19(76.0%) patients, followed by subscapularis in 5(20.0%) patients. 1(4.0%) patient showed tear in the infraspinatous muscle. However, no tear was noted in teres minor muscle (Table 2).

Partial thickness tear was most commonly seen in 13(68.4%) patients, followed by full thickness tear in 5(26.3%) patients and tendonosis in 1(5.2%) patients in the supraspinatous muscle (Fig 3).

Most common associated findings were fluid along the biceps tendon, marrow edema and irregularity of the greater tuberosity and osteoarthritis of the acromioclavicular joint [Figure4].

On comparison of these two modalities in our study, it was seen that USG detected 20 (57.0%) tear in rotator cuff muscles, whereas MRI detected 25(71.0%) tear. Supraspinatous was the most commonly affected muscle detected on both USG (17 out of the 19 cases) and MRI (19 out of the 25 cases).

On ultrasonography, partial thickness supraspinatous tear were detected in 9(52.0%) cases while on MRI in 13(68.0%) cases. However, the accuracy to detect full thickness tears in supraspinatous muscle was equal on both USG and MRI, 5(%) each. But MRI proved to be superior in detecting tears in subscapularis and infraspinatous muscles, 5(20.0%), as compared to the USG, 3(15.0%).

Discussion

The wide age distribution is consistent with the varied etiology of shoulder pain. In the younger age group, the main causes are faulty posture and trauma, whereas in the elderly, age related degenerative changes due to repeated microtrauma and alteration of the vascular supply of the region are the main cause of rotator cuff dysfunction [6,7]. With advancing age the gender difference is not significant, probably because the cause of rotator cuff dysfunction in this age group is the normal aging process and age related degeneration [8]. This theory is more or less seconded by the fact that none of the studies on rotator cuff tears mention any gender predilection. The above findings were consistent with our study.

Crass et al, Zehetgruber et al and Teefay et al have independently reported greater than 90.0% accuracy, sensitivity and specificity of ultrasound in the detection of any tear, whether partial or full thickness [9,10,11]. Brandt et al and Seibold et al have showed the sensitivity and the specificity of USG between 57.0%-95.0% and 76.0%-94.0% respectively [12,13]. Von Holsbeek et al showed a 93.0% sensitivity and 94.0% specificity in detecting partial thickness tear by using the criterion of mixed hypo-hyper echogenicity and focal hypoechoic lesion involving either the articular or the bursal surface of the tendon. This was because of insinuation of fluid between the muscle fibres.

Table 1: Frequency of the rotator cuff muscle involvement on ultrasonography

<table>
<thead>
<tr>
<th>USG findings</th>
<th>Supraspinatous tear</th>
<th>Subscapularis tear</th>
<th>Infraspinatous tear</th>
<th>Teres minor tear</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of cases</td>
<td>17</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Percentage</td>
<td>48.00%</td>
<td>8.50%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 2: Frequency of the rotator cuff muscle involvement on MRI

<table>
<thead>
<tr>
<th>MRI findings</th>
<th>Supraspinatous tear</th>
<th>Subscapularis tear</th>
<th>Infraspinatous tear</th>
<th>Teres minor tear</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cases</td>
<td>19</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Percentage</td>
<td>76.00%</td>
<td>20.00%</td>
<td>4.00%</td>
<td>0%</td>
</tr>
</tbody>
</table>
They also showed these tears were associated with the irregularity and pitting of the greater tuberosity [14]. Another study by Abd-ElGawad E showed US had sensitivity, specificity and accuracy of 92.3%, 92.6% and 92.5%, respectively in diagnosing partial thickness tears; 92.6%, 94% and 95%, respectively in diagnosing full thickness tears while MRI had sensitivity, specificity and accuracy of 84.6%, 92.6% and 90%, respectively in diagnosing partial thickness tears; 100%, 88.2% and 95%, respectively in diagnosing full thickness tears [15]. Similar findings were shown by Lenza et al [16]. These findings were again reinstated in our study.

Wohlwend et al stated that sonography showed the greater tuberosity to be irregular in 36 (90.0%) of shoulders with a rotator cuff tear and irregular in only 12 (11.0%) of shoulders without a rotator cuff tear. When the greater tuberosity was irregular, sonography showed 36 (75.0%) of shoulders to have rotator cuff tears and when the greater tuberosity was normal, 102 (96.0%) of the rotator cuffs were normal [17].

Jacobson et al noted that the combination of greater tuberosity irregularity and fluid in the shoulder joint in ultrasonography was helpful in the diagnosis of tears, with a sensitivity of 60.0% and a specificity of 100.0% [18].

Seibold et al reported sensitivity and specificity for partial thickness tears on MR imaging between 35.0%- 92.0% and 85.0%-99.0% respectively [13].

Crass et al and Middleton et al performed a pioneer study on the comparative role of USG and MRI in rotator cuff tears and stated that US was as accurate as magnetic resonance imaging in the detection of supraspinatus tendon tears [19,20]. Another study which compared the roles of high frequency USG and MRI in rotator cuff tears showed a good correlation between the two [21].

Teefey et al in a study comparing US with MR imaging using arthroscopy as the standard of reference, demonstrated an overall diagnostic accuracy of 87.0% for both modalities in identifying rotator cuff tears and absence of such tears. USG helped correctly identify 45 (97.8%) full-thickness tears and 13 (68.4%) partial-thickness tears, whereas MR imaging helped correctly identify 46 (100.0%) full-thickness tears and 12 (63.2%) partial-thickness tears [11].

de Jesus et al reported 60-100% sensitivity and specificity in a comparative study on different diagnostic modalities like USG, MR and MR arthrography [22]. They attributed this wide variation to small sample size, differing study designs, varying quality of imaging equipment and differing imaging criteria for diagnosis.

Dinnes and Roy et al and evaluated the diagnostic effectiveness of MRI, MR arthrography, ultrasound and clinical examination in the evaluation of a painful shoulder, with rotator cuff tears as the disease endpoint and concluded that either MRI or ultrasound could be used for equal detection of full-thickness rotator cuff tears but ultrasound is a more cost-effective test [23,24]. This fact is again showed in our study.

Rutten et al aimed to check whether ultrasound of the shoulder was operator dependent and related to experience. In a study on 71 patients who underwent shoulder surgery and found that the sensitivity, specificity and accuracy for detecting full-thickness tears by the experienced and general radiologists was 94.0% each and 89.0%, 91.0% and 90.0% respectively. They also reported sensitivity, specificity and accuracy for detecting partial-thickness tears by the experienced and general radiologists to be 100.0%, 32.0% and 57.0% and 84.0%, 35.0% and 53.0% respectively [25].

**Conclusion**

Ultrasound is as accurate as MRI in the detection of full-thickness tears and secondary signs of rotator cuff tears, with slight discrepancy in partial thickness tears. Ultrasound may be the most cost-effective imaging method for screening of rotator cuff tears, though MRI is preferable when surgery or tendon repair is being contemplated and in post-operative assessment of the shoulder.

**References**

57.
5. Codman EA. The shoulder: The rupture of the supraspinatus tendon and other lesions in and about the subacromial bursa. The shoulder, 2nd ed., Boston,
Siddiqui S et al

Conflict of Interest: Nil.
Source of Support: None

Conict of Interest: Nil.
Source of Support: None

How to Cite this Article