Accuracy of High Resolution Ultrasonography for Diagnosis of Rotator Cuff Tears Considering Magnetic Resonance Imaging as Gold Standard

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Abstract

Objective: To determine the diagnostic accuracy of high-resolution ultrasonography for the diagnosis of rotator cuff tears considering magnetic resonance imaging as gold standard.

Methodology: This correlational study was done using non-probability consecutive sampling technique, at the Department of Orthopaedic Surgery and the Department of Radiology, Services Hospital Lahore from 15th July 2013 till 14th January 2016. All the patients, age between 40 to 70 years, who presented with shoulder pain for last three month, that was not settled with oral analgesic, and were positive for Hawkin’s-Kennedy test, Jobe’s test and drop arm were included in the study. Patients who had fracture of the clavicle, scapula or proximal end of humerus, and patients with prosthetic implants and pacemakers were excluded in the study. All clinical test positive patients underwent ultrasonography (USG) and magnetic resonance imaging (MRI). We calculated specificity, sensitivity, positive predictive value (PPV), negative predictive value (NPV), accuracy and likelihood ratio for ultrasonography.

Results: Out of the total 92 patients, on MRI there were 68 (73.9%) complete and 24 (26.1%) partial Rotator Cuff Tears. USG diagnosed 62 out of 68 complete tears accurately. There were 21 true negative and 03 false positive complete tears. USG showed sensitivity of 91%, specificity of 87% (p-value <0.001 using T-test), positive predictive value (PPV) of 95%, negative predictive value (NPV) of 95%, accuracy of 90.2 %, positive likelihood ratio of 9.55 and negative likelihood ratio of 0.15.

Conclusion: USG of the shoulder with a high definition linear array probe was found a highly accurate and reliable screening test for the Rotator Cuff Tears and it can be used reliably for the start of treatment of the rotator cuff tears.

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Key Words: Diagnostic accuracy, Magnetic Resonance Imaging, Rotator Cuff Tears, Ultrasonography.

Introduction

Rotator cuff tear pathologies are responsible for pain and limitation of range of motion of shoulder. Its incidence is between 30 to 70%¹. To treat a RCT’s, the orthopedic surgeon must know the type of the RCT’s. Clinical evaluation is mandatory in the diagnosis, but it has limitations while determining the
severity of tear. Some radiological investigation is necessary to
determine the extent of the tear pathology. Choice to of
radiological investigations are various including plain & CT
arthrograms, shoulder ultrasound, plain MRI as well as MR
Arthrography.\textsuperscript{2,3}

Non-invasive investigations like shoulder USG and MRI have
do not expose the patient to dangerous ionizing radiations
\textsuperscript{1,4}. The literature revealed that the most
reliable investigation to detect rotator cuff pathology is MRI but it has many
limitations like not readily available everywhere too much
along with many contraindications like prosthetic implants,
pacemakers, and the claustrophobia etc.\textsuperscript{4,5} Another
investigation that has good efficacy is USG of the
shoulder, which is cost effective, readily available
everywhere and permits dynamic imaging.\textsuperscript{6} USG
having a sensitivity of 85\%, specificity 93\% with 77\%
accuracy. The positive and negative predictive values
were 88\% and 72\%.\textsuperscript{6} MRI has sensitivity (up to
100\%) and specificity (up to 99\%) in diagnosing rotator
cuff tears.\textsuperscript{7,8}

In suspicion of rotator cuff tears clinician needs some
cost-effective investigation for confirmation of the
diagnosis. USG of shoulder can serve our purpose
well because USG has better sensitivity and specificity
in the hands of an experienced radiologist. This
study was designed to compare the efficacy of USG
in diagnosing RCT’s with MRI considering the MRI
as gold standard which has 99 to 100 \% sensitivity and
specificity.

**Methodology**

This correlational study was done using non-probability
consecutive sampling technique at department
of Orthopedic surgery and department of Radiology
Services Hospital, Lahore from 15\textsuperscript{th} July 2013
till 14\textsuperscript{th} January 2016. Sample size was 92 patients, 40 to 70
years of age, who had three months continued
shoulder pain not being settled with oral analgesic and
positive Hawkin’s - Kenndy, Jobe’s test and drop for
rotator cuff tear arm test were included in the study.
Patients who had fracture of the clavicle, scapula
or proximal end of humerus were excluded from the
study. Patients with prosthetic implants and pacemakers
were also excluded from the study.

After Institutional and Ethical Review Board permission
informed written consent was obtained with reference number IRB/2014/78/SIMS dated 16/07/2104. The plain radiographs of shoulder AP and lateral view
of patients were taken in the Radiology Department of
Services hospital Lahore. All clinical test positive patients
underwent USG and MRI respectively. Ultrasound
ography of the patients was performed by the Musculoskeletal Radiologist in the same hospital. MRI of
shoulder was done at the Radiology Department of the
Sir Ganga Ram Hospital, Lahore. Data was collected
on daily basis from the out-patient department. Findings
of the patients were noted from all the investigations on the printed questionnaire. Questionnaires
were put into the files according to the date, to main-
tain accuracy.

**Tear Positive on Ultrasoundography**: Complete and partial
tear of supraspinatus tendon, with anechoic or
hypoechoic defect extending from the articular to the
bursal surface or a contour defect of the subdeltoid fat
plane extending medial to the junction of the humeral
head and greater tuberosity or a hypoechoic, mixed
hypoechoic or echogenic defect incompletely travers-
ing the supraspinatus tendon, but extending to the
articular or bursal surface or a contour defect of the
subdeltoid fat plane not extending medial to the junc-
tion of the humeral head and greater tuberosity was
regarded as tear positive.

**Tear Positive on MRI**: A well-localized area with
increased signal intensity on T1-weighted and T2-
weighted images from the bursal to the articular
surface was taken as complete tear or incomplete fluid
across the tendon was taken as partial tear.

Analysis of data was done using SPSS version-20. Quantitative variables were summarized using mean ± standard deviation while qualitative variables were
summarized using frequency and percentages. Stat-
istical parameters in terms of sensitivity, specificity,
accuracy, likelihood ratio and in terms of positive and
negative predictive value were calculated for ultrason-
ography.

**Results**

92 patients in total were included in the study. Out of
92 patients, 44 (47.8\%) patients were males while 48
(52.2%) were females. Mean age was 49.4 ± 12.4 years with age range of (40-70 years). 41 (44.6%) were labour workers. Housewives were 26 (28.3%) and the reason for their shoulder pain was found to be house-hold cleaning while sports men (mostly athletes) were 16 (17.4%) (Table 1). T-test was used as test of significance for P value, all P values < 0.05 were significant.

Out of the total 92 patients, on MRI there were 68 (73.9%) complete and 24 (26.1%) partial RCT’s. USG diagnosed 62 out of 68 complete tears (sensitivity of 91%) accurately. There were 21 true negative and 03 false positive complete tears (specificity 87%) (p-value < 0.001). The positive predictive (PPV) value was 95%, negative predictive value (NPV) 77% and accuracy 90.2% (Table 2). The positive likelihood ratio and negative likelihood ratio was 9.55 and 0.15 for USG respectively.

### Table 1: Demographic data of age, gender and occupation:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency (N=92) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (in years)</strong></td>
<td>(Mean ± S.D) 49.65 ± 12.42</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>• Male</td>
<td>44 (47.8%)</td>
</tr>
<tr>
<td>• Female</td>
<td>48 (52.2%)</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
</tr>
<tr>
<td>• Labor Workers</td>
<td>41 (44.6%)</td>
</tr>
<tr>
<td>• Housewives</td>
<td>26 (28.3%)</td>
</tr>
<tr>
<td>• Sports men</td>
<td>16 (17.4%)</td>
</tr>
<tr>
<td>• People with crutches</td>
<td>06 (6.5%)</td>
</tr>
<tr>
<td>• Others</td>
<td>03 (3.2%)</td>
</tr>
</tbody>
</table>

### Table 2: Accuracy of high resolution ultrasonography for rotator cuff tears:

<table>
<thead>
<tr>
<th></th>
<th>Full Thickness Tear</th>
<th>Partial Thickness Tear</th>
<th>Total</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasound (USG)</td>
<td>62</td>
<td>03</td>
<td>65</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Magnetic Resonance Imaging (MRI)</td>
<td>68</td>
<td>24</td>
<td>92</td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity = 91%
Specificity = 87%
Positive Predictive value = 95%
Negative Predictive value = 77%
Diagnostic Accuracy= 90.2%
Discussion

Rotator cuff pathologies are frequently faced by the orthopedic surgeons in patients with shoulder pain and its incidence is between 30 to 70%. Out of 92 patients, 44 (47.8%) patients were males while 48 (52.2%) patients were females. Subharwal et al. had 68.3% females and 32.7% males’ patients in their study.

With mean age 49.4 ± 12.4 years, patient presented in different age groups with minimum age of 40 years and maximum age of 70 years. Fischer et al. reported mean age of the patient was 68.3 years (range 49-81). The difference in mean age was due to inclusion of 40 to 70 years old patients in our study as compared to 40-81 years in their study.

Our study showed the sensitivity of 91%, specificity 87% while the PPV was 95% and NPV was calculated to be 77% for USG. Diagnostic accuracy was 90.2%. Van Holsbeek et al. showed a sensitivity of 93% which is better than our study. These results show reliability of shoulder ultrasound and accurate screening test for the RCT’s. Literature has shown a wide range of variability in the results of shoulder USG for the RCT’s. Naqvi et al. reported USG 80% and 89% sensitivity and specificity respectively.

The findings of Okoroha et al. are consistent with findings of our study. Matthieu et al. showed 65% specificity for USG which is low as compared to our study. Roy et al. reported 91% sensitivity and 86% specificity for USG. For USG, the finding of his study is consistent with our study. In our study, USG has shown good results in detection of RCT. Our findings are similar to many studies and differ from other studies as well. The probable reason behind this difference can be due to lack of comfort, knowledge and training in USG and hesitation of Orthopaedic surgeon to incorporate USG in diagnosis of RCT. USG is cheap, effective and easily available modality. With awareness, and accuracy in training the use of USG can be incorporated as a reliable tool for diagnosis of rotator cuff tears. In developing country like Pakistan, MRI requires too much cost, long waiting time, and has contraindications. Such limitation with MRI can be avoided with better knowledge and training of USG amongst orthopedic surgeon. Butterfly IQ diagnostic ultrasound which is new handy device is changing the way of medical practice in diagnosis of RCT without radiations. This will change the practice of ionizing radiation exposure and expensive MRI for diagnosis of RCT.

The limitation with this method of USG is that the operator of the USG must be very competent in the musculoskeletal ultrasound which is the main determinant of the accuracy of the USG shoulder otherwise the results are not much favorable and accurate. We didn’t measure the extent of thickness of RCT’s.

To our knowledge limited work has been undertaken before in Pakistan so our study will be helpful in establishing the local data for the accuracy of ultrasonography of the shoulder for RCT’s and it will serve as a guide for the future research on this subject. Furt-
her, we recommend the confirmation of RCT’s tears on shoulder arthroscopy.

**Conclusion**

Ultrasoundography of the shoulder with a high definition linear array probe is a highly accurate and reliable diagnostic test for the RCT’s and it can be used reliably for the start of treatment of the rotator cuff tears.

**Ethical Approval:** Given

**Conflict of Interest:** The authors declare no conflict of interest

**Funding Source:** None

**References:**