High Resolution Sonographic Evaluation Of Painful Shoulder

P Goyal, U Hemal, R Kumar

Citation

Abstract

Purpose: To compare clinical diagnosis established by physical examination with high frequency ultrasonographic findings in patients with painful shoulder. Methods & Materials: Two different radiologists who were blinded to the clinical data, performed sonographic examination on forty patients with painful shoulder and twenty control subjects using 7.5 MHZ linear transducer. Physical examination was performed by one experienced rheumatologist before ultrasonographic examination by using specific maneuvers. Ultrasonography was considered the optimal diagnostic technique. Results: Rotator cuff was the most common structure to show abnormalities on ultrasound. Among the tendon of rotator cuff supraspinatus most commonly showed abnormalities (52.5%). Partial thickness tears of supraspinatus were more common than full-thickness tear. A high sensitivity and specificity of sonography was demonstrated compared to physical examination in the present study. Conclusion: High sensitivity & specificity, non-invasiveness & low cost of high resolution sonography justify its routine utilization for the assessment of painful shoulder.

INTRODUCTION

Painful shoulder is a very common rheumatologic condition that results from periartricular lesions involving the rotator cuff, the biceps tendon, and the subacromio-subdeltoid bursa. The differential diagnosis includes several entities of similar clinical picture. Rotator cuff impingement tendonitis, cuff strain, cuff tear, biceps tendonitis and subacromio-subdeltoid bursitis are the most common lesion found. Because each of this condition have different treatments, their differentiation is essential. In the past, plain radiography and contrast arthrography were the only imaging modalities available for the evaluation of the painful shoulder. Arthrography has been the diagnostic procedure of choice in patients with rotator cuff tear, however it is not painless procedure 74% of patients developed exacerbation of their pain 24-48 hours after injection of contrast material.1 Though it is sensitive and specific in assessment of full thickness tears, it is less sensitive in assessment of small and partial thickness tears and is unable to depict partial tears of the superior surface.2 Ultrasonography (US) offers the same accuracy in diagnosing cuff tears as arthrography. The noninvasive, painless nature of sonography has resulted in high patient acceptance.3,4 Ultrasonography should be primary diagnostic method in screening of shoulder pain because it is economical, fast and reproducible.5

MATERIALS AND METHODS

The study was conducted in Department of Radiology, in close association with Department of Orthopedics, Lady Hardinge Medical College and associated Hospitals, New Delhi during 2005-2006.

All patients with presenting complaint of painful shoulder with clinical diagnosis of periartricular lesions such as rotator cuff impingement tendonitis, cuff strain, cuff tear, biceps tendonitis and subacromio-subdeltoid bursitis were included and the patients with history of trauma and patients having chronic inflammatory arthritis were excluded in the present study.

All forty patients (16 males and 24 females; mean age 45.33 ±11.42 years, range 23-62; mean symptoms duration 2.8 months, range 1-6) and twenty controls (8 males and 12 females; mean age 44.45 ±10.36 years, range 28-60; no present or past episode of painful shoulder) were subjected to detailed history, physical examination and sonographic study.
PHYSICAL EXAMINATION

A thorough physical examination was performed by using following tests:

Speed’s test: This test is most sensitive for provoking biceps tendon pain. It was performed by asking the subject to place the shoulder in 90° forward flexion position with the elbow fully extended and forearm supinated. The subject was then instructed to resist as the examiner attempted to push the patient’s arm downward. The subject with biceps tendonitis tends to complain of pain with this maneuver and exhibits difficulty resisting the examiner’s downward pressure.6

Resisted abduction (Jobe test): Supraspinatus was evaluated using resisted abduction (supraspinatus isolation or Jobe test). To perform the test, the examiner stood in front of the subject, who was asked to abduct the arms to 90° with the elbows fully extended. The subject’s arms were then brought forward to a position 30° anterior to the true coronal plane and maximally rotated so that the thumbs would point downwards. The subject was then asked to push toward the ceiling while the examiner provided resistance. Weakness noticed during this test signified muscle inhibition due to pain or true muscle dysfunction.6

Resisted external rotation for the infraspinatus tendon: To test the infraspinatus, the subject was asked to place the arms tightly at the sides with the elbows flexed to 90°. The subject was then asked to externally rotate the arms while the examiner provided resistance.6

Resisted internal rotation for the subscapularis tendon: The subject was asked to stand with the elbow flexed to 90° and the hand on the abdomen. The subject was instructed to press the hand down against the abdomen while the examiner attempted to lift the subject’s hand away from the trunk. This method was particularly helpful in assessing the strength of the subscapularis in patients with restricted internal rotation.6

Adduction stress test: In this test, the elbow and shoulder of the subject were extended and then passively adducted behind the back. This maneuver produced pain in case of acromioclavicular joint pathology. Passive cross-chest adduction was also used as a test for acromioclavicular joint symptoms. The examiner stood facing the subject and passively brought the patient’s arm into maximal cross-chest adduction. This maneuver reproduced pain if acromioclavicular joint injury or arthritis was present.6

Charles Neer proposed the concept of the impingement syndrome, to detect this he described Neer impingement sign. To elicit this, the examiner passively flexes the patient’s shoulder to the position of maximal forward flexion while stabilizing the patient’s scapula with the other hand. Reproduction of the patient’s symptomatic pain at maximal forward flexion is designated a positive impingement sign and is considered evidence of impingement syndrome.

ULTRASONOGRAPHY (US)

All patients and controls underwent ultrasonographic examination within 1 week of physical examination with a real time equipment (PHILIPS HDI-ATL-5000 Bothell, Washington) using 7.5MHz Linear phased array transducer. Transverse and longitudinal planes from the Biceps tendon groove, Rotator cuff and transverse planes from posterior Glenohumeral recess, Glenoid labrum and acromioclavicular joint were scanned. In all patients, comparable images of the opposite shoulder were obtained in order to facilitate detection of subtle abnormalities.

Features like tendon thickness, homogeneity of the fibrillar pattern and regularity of the margins, presence of effusion and calcification were studied.

Positioning of patient: The biceps tendon groove, the subscapularis tendon, and the acromioclavicular joint were examined with the arm held in neutral position, the elbow flexed to 90°, and the forearm in a supinated position on top of the thigh.

On the anterior aspect of the shoulder, the long head of biceps tendon was examined in both planes as a fibrillar hyperechoic structure into the humeral groove, surrounded by a 1-2 mm thick hypoechoic halo of fluid within the synovial sheath.

Medial to the biceps tendon, the hyperechoic subscapularis tendon was identified, inserting on the lesser tuberosity, with some fibers continuing across the bicipital groove to form the transverse humeral ligament, better seen when the shoulder of the patient is moved into external rotation.7

Next, the transducer was moved laterally to scan the rotator cuff. The supraspinatus and infraspinatus tendon were examined with the patient’s shoulder in hyperextension and internal rotation in order to expose the supraspinatus from underneath the acromion. These tendons appeared as a hyperechoic homogenous fibrillar layer, convex shaped on transverse images and curved triangular shaped on
longitudinal views, deep to the deltoid muscle covering the humeral head.

The subacromial-subdeltoid bursa was imaged as a hypoechoic line, 1-2 mm thick with a variable amount of peribursal echogenic fat, between the deltoid muscle and the supraspinatus and infraspinatus tendons.

The humeral articular cartilage was seen as a thin hypoechoic layer between the supraspinatus and infraspinatus tendons and the humeral head. The posterior infraspinatus and teres minor tendons were evaluated from a posterior view with the arm in neutral position and the elbow flexed at 90°. A normal small amount of fluid was seen in the glenohumeral joint. The cartilaginous posterior labrum was viewed as a hyperechoic triangle separating the infraspinatus and teres minor tendons from the glenoid.

Impingement syndrome is evaluated by dynamic examination. A dynamic view of the supraspinatus tendon is obtained by moving the patient’s arm from a neutral position to 90° abduction in order to detect encroachment of the acromion into the rotator cuff.

Table 1 lists the US diagnostic criteria for shoulder abnormalities, which are based on those widely described in the literature.

Table 1 - Ultrasonographic diagnostic criteria of shoulder abnormalities

<table>
<thead>
<tr>
<th>Shoulder abnormality</th>
<th>Diagnostic criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps tendon effusion</td>
<td>Tenderness of the biceps tendon</td>
</tr>
<tr>
<td>Biceps tendon subluxation</td>
<td>Tenderness of the biceps tendon</td>
</tr>
<tr>
<td>Rotator cuff subacute</td>
<td>Full thickness tear</td>
</tr>
<tr>
<td>Rotator cuff partial-thickness tear</td>
<td>Non-visualization of tendon or fiber discontinuity</td>
</tr>
<tr>
<td>Rotator cuff full-thickness tear</td>
<td></td>
</tr>
</tbody>
</table>

US findings from the clinically evaluated painful shoulders, asymptomatic opposite shoulders and both shoulders of controls were recorded.

Statistical analysis of data was done after compiling and tabulation. Data were analyzed with the Statistical Package for the Social Sciences (SPSS, SPSS Inc software, Chicago, IL, USA). Statistical analysis was performed using the χ² test. A p value < .05 was considered to be statistically significant. The sensitivity, specificity, positive predictive value and negative predictive value of physical examination with respect to sonography were calculated and compared using a 2×2 table.

RESULTS

All forty patients (16 men and 24 women; mean age 45.33±11.42 years, range 23-62; mean symptoms duration 2.8 months, range 1-6) and twenty controls (8 men and 12 women; mean age 44.45±10.36 years, range 28-60; no present or past episode of painful shoulder) were subjected to detailed history, physical examination and sonographic study.

The maximum numbers of patients were in the age group of 41-60 years.
PHYSICAL EXAMINATION (PE)

The chief complaints of patients were pain and limitation of shoulder movements. All forty cases with painful shoulders and twenty controls underwent Physical examination. Physical examination was positive in 35 painful shoulders; negative in all forty asymptomatic shoulders of cases and twenty controls.

Figure 2

Table 2: No. of +ve painful shoulders on physical examination

<table>
<thead>
<tr>
<th>Shoulder lesion</th>
<th>No. of +ve painful shoulders (n=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps tendon pathology</td>
<td>14</td>
</tr>
<tr>
<td>SS lesion (resisted abduction test)</td>
<td>31</td>
</tr>
<tr>
<td>IS lesion (resisted external rotation)</td>
<td>1</td>
</tr>
<tr>
<td>SB lesion (resisted internal rotation)</td>
<td>4</td>
</tr>
<tr>
<td>ACCE joint abnormality</td>
<td>9</td>
</tr>
</tbody>
</table>

The speed’s test was positive in 14 (35%) painful shoulders, resisted abduction test in 31 (77.5%), resisted external rotation in 1 (2.5%), resisted internal rotation in 4 (10%) and adduction stress test in 9 (22.5%) painful shoulders.

ULTRASONOGRAPHIC (US) FINDINGS

Sonographic examination of all cases and controls was performed within 1 week of PE and the various anatomic structures were systematically reviewed. Sonography showed the presence of alteration in 33 (82.5%) painful shoulders. Observations on individual structures were recorded.

SUPRASPINATUS TENDON

Ultrasound showed supraspinatus lesions in 21 (52.50%) of painful shoulders, 2 (5%) asymptomatic shoulders and in 1 (2.5%) control. Full-thickness tear (Fig.1) was detected in 4 (10%) of painful shoulders. Partial-thickness tear (Fig.2) was seen in 10 (25%) of painful shoulders, 1 (2.50%) asymptomatic shoulder and in 1 (2.5%) control.

Tendonitis was detected in 5 (12.50%) of painful shoulders and 1 (2.50%) asymptomatic shoulder. Tendonitis was not seen in controls. Calcific tendonitis and thinning of supraspinatus tendon each was seen in 1 (2.50%) of painful shoulders. Full-thickness tear, calcific tendonitis and thinning of tendon were not seen in asymptomatic shoulders and controls.

BICEPS TENDON PATHOLOGY

Alteration in long head of biceps tendon were found in 14 (35%) painful shoulders, 2 (5%) asymptomatic shoulders and in 2 (5%) controls. The presence of fluid in tendon sheath (Fig.3) was seen in 7 (17.50%) painful shoulders and 1 (2.50%) asymptomatic shoulder. No control showed fluid in tendon sheath. Partial subluxation was seen in 3 (7.50%) of painful shoulders, 1 (2.50%) asymptomatic shoulder and 2 (5%) controls. Partial-thickness tear and tendonitis of long head of biceps, each was seen only in 1 (2.50%) painful shoulder. No control and asymptomatic shoulder showed tear and tendonitis.

SUBSCAPULARIS TENDON

Subscapularis showed alteration in 4 painful shoulders, 2 (5%) tendonitis and 2 (5%) partial–thickness tear. Subscapularis tendon was normal in all asymptomatic shoulders and controls.

INFRASPINATUS TENDON

Only 2 (5%) of painful shoulders and 1 (2.50%) asymptomatic shoulder showed tendonitis of infraspinatus. Infraspinatus tendon was normal in all controls.

TERES MINOR

Teres minor was normal in all study groups.

ACROMIOCLAVICULAR JOINT

Acromioclavicular joint abnormality was found in 14 (35%) of painful shoulders, 1 (2.5%) asymptomatic shoulder and 1 (2.5%) control. Degenerative changes (osteophytes and capsular hypertrophy) alone were seen in 4 (10%) of painful shoulders, 1 (2.50%) asymptomatic shoulder and 1 (2.5%) control. Presence of fluid in joint alone was seen only in 2 (5%) painful shoulders. Degenerative changes and presence of fluid in joint both (Fig.4) were seen in 8 (20%) of painful shoulders only. Asymptomatic shoulders and controls did not show fluid alone and in combination with degenerative changes.

GLENOHUMERAL JOINT

Abnormality in the form of fluid in the joint cavity was detected in 1 (2.5%) of painful shoulder only. Fluid in the joint cavity was associated with rotator cuff tear. Glenohumeral joint did not show any abnormality in asymptomatic shoulders and controls.

GREATER TUBEROSITY IRREGULARITY

Irregularity of greater tuberosity was identified in 5
(12.50%) painful shoulders and 1 (2.50%) asymptomatic shoulder. No abnormality detected in controls. Rotator cuff tear was associated with irregularity of greater tuberosity in 3 (7.50%) of painful shoulders.

**SUBACROMIAL-SUBDELTOID BURSA (SASD BURSA)**

Fluid in subacromial-subdeltoid bursa (Fig.1) was seen in 3 (7.50%) painful shoulders in association with rotator cuff lesion. SASD bursa was normal in asymptomatic shoulders and controls.

**IMPINGEMENT**

One painful shoulder showed buckling of supraspinatus tendon in association with SASD bursal fluid. Impingement was not seen in asymptomatic shoulders and controls.

**Figure 3**

Fig.1: Full-thickness tear (non visualization of supraspinatus tendon) with fluid in subacromian-subdeltoid bursa.

**Figure 5**

Fig.3: Transverse section of biceps tendon in the bicipital groove shows fluid in tendon sheath.

**Figure 6**

Fig.4: Degenerative changes with fluid in the acromioclavicular joint.

**Figure 7**

Table 3: Sonographic findings with the spectrum of the specific alterations among the various anatomic structures of the shoulder.
Table 4: Sonographic findings in cases (painful shoulders) and asymptomatic shoulders of cases

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Patients (painful shoulder)</th>
<th>Patients (asymptomatic shoulder)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS lesion</td>
<td>22 (52.50%)</td>
<td>9 (21.00%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Biceps tendon pathology</td>
<td>14 (33.00%)</td>
<td>7 (17.00%)</td>
<td>0.001</td>
</tr>
<tr>
<td>SB lesion</td>
<td>4 (10.00%)</td>
<td>0 (0.00%)</td>
<td>0.40</td>
</tr>
<tr>
<td>ACCL joint abnormality</td>
<td>15 (37.50%)</td>
<td>5 (12.50%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SASD bursitis</td>
<td>3 (7.50%)</td>
<td>0 (0.00%)</td>
<td>0.77</td>
</tr>
<tr>
<td>GH effusion</td>
<td>3 (7.50%)</td>
<td>0 (0.00%)</td>
<td>0.31</td>
</tr>
<tr>
<td>Impingement</td>
<td>2 (5.00%)</td>
<td>0 (0.00%)</td>
<td>0.31</td>
</tr>
<tr>
<td>Infraspinatus lesion</td>
<td>3 (7.50%)</td>
<td>0 (0.00%)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Values are number of shoulders; SS = supraspinatus; SB = subscapularis; ACCL = acromioclavicular; * = not significant.

Table 5: Sonographic findings in patients (painful shoulders) and controls.

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Patients</th>
<th>Control</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS lesion</td>
<td>22 (52.50%)</td>
<td>9 (21.00%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Biceps tendon pathology</td>
<td>14 (33.00%)</td>
<td>7 (17.00%)</td>
<td>0.001</td>
</tr>
<tr>
<td>SB lesion</td>
<td>4 (10.00%)</td>
<td>0 (0.00%)</td>
<td>0.40</td>
</tr>
<tr>
<td>ACCL joint abnormality</td>
<td>15 (37.50%)</td>
<td>5 (12.50%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SASD bursitis</td>
<td>3 (7.50%)</td>
<td>0 (0.00%)</td>
<td>0.77</td>
</tr>
<tr>
<td>GH effusion</td>
<td>3 (7.50%)</td>
<td>0 (0.00%)</td>
<td>0.31</td>
</tr>
<tr>
<td>Impingement</td>
<td>2 (5.00%)</td>
<td>0 (0.00%)</td>
<td>0.31</td>
</tr>
<tr>
<td>Infraspinatus lesion</td>
<td>3 (7.50%)</td>
<td>0 (0.00%)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Values are number of shoulders; SS = supraspinatus; SB = subscapularis; ACCL = acromioclavicular; * = not significant.

Table 6: Comparison of Physical examination (PE) and Ultrasonography (US)

<table>
<thead>
<tr>
<th>Lesion</th>
<th>PE</th>
<th>US</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS lesion</td>
<td>21 (52.50%)</td>
<td>21 (52.50%)</td>
<td></td>
</tr>
<tr>
<td>Biceps tendon pathology</td>
<td>14 (33.00%)</td>
<td>14 (33.00%)</td>
<td></td>
</tr>
<tr>
<td>SB lesion</td>
<td>9 (22.50%)</td>
<td>9 (22.50%)</td>
<td></td>
</tr>
<tr>
<td>ACCL joint abnormality</td>
<td>10 (25.00%)</td>
<td>10 (25.00%)</td>
<td></td>
</tr>
<tr>
<td>SASD bursitis</td>
<td>6 (15.00%)</td>
<td>6 (15.00%)</td>
<td></td>
</tr>
<tr>
<td>GH effusion</td>
<td>10 (25.00%)</td>
<td>10 (25.00%)</td>
<td></td>
</tr>
<tr>
<td>Impingement</td>
<td>10 (25.00%)</td>
<td>10 (25.00%)</td>
<td></td>
</tr>
<tr>
<td>Infraspinatus lesion</td>
<td>10 (25.00%)</td>
<td>10 (25.00%)</td>
<td></td>
</tr>
</tbody>
</table>

Values are number of painful shoulders; SS = supraspinatus; PE = physical examination; US = ultrasonography; ACCL = acromioclavicular.

Table 7 shows the sensitivity, specificity, positive predictive value and negative predictive value of PE with respect to US in detection of above lesions. Sensitivity was good in the clinical diagnosis of supraspinatus lesion and low in other shoulder lesions, especially the infraspinatus and the acromioclavicular joint. Specificity was high for the lesion of infraspinatus, subscapularis and the acromioclavicular joint. However, it was fairly good for the biceps tendon pathology and very low for the lesion of the supraspinatus tendon.

PE was unable to differentiate rotator cuff tendonitis from tear, and partial-thickness tears from full-thickness tear. Moreover, it missed 3 SASD bursal fluids, 5 greater tuberosity irregularities, 1 rotator cuff impingement and 1 glenohumeral joint effusion.

DISCUSSION

Out of forty patients, twenty four were women and 16 were men. Women were affected more commonly than men which are in accordance with the study conducted by Naredo.
Age of cases range from 23-62 years. The maximum number of patients belonged to 41-50 years in men and 51-60 years in women. Mean age of the patients was 45.33±11.42 years, which is younger than the patients in the study done by Naredo et al, 2002 (mean age 57.5 years) and Iagnocco et al, 2003 (57.9 years). The most probable reason is different study population.

The main presenting symptoms of cases were pain and limitation of movements. Mean duration of symptoms was 2.8 months. Physical examination was positive in 35 painful shoulders. Physical examination was able to detect supraspinatus lesion in 77.5%, biceps tendon pathology in 35%, infraspinatus lesion in 2.5%, subscapularis lesion in 10% and lesion in acromioclavicular joint in 22.5%.

In our study Physical examination was able to detect supraspinatus lesion in 77.50% which is in accordance with the findings in the study by Naredo et al, 2002. Biceps tendon pathology, infraspinatus lesions, subscapularis lesions and lesion of acromioclavicular joint detected by Physical examination in present study fairly correlate with the findings in the study by Iagnocco et al, 2003. Slight different is probably due to different study population.

**Figure 13**

Table 9: Comparison of Physical examination and ultrasonographic findings.

<table>
<thead>
<tr>
<th>Shoulder lesion</th>
<th>S(%)</th>
<th>Sp(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps tendon pathology</td>
<td>73.4</td>
<td>86.5</td>
</tr>
<tr>
<td>SS lesion</td>
<td>90.4</td>
<td>94.4</td>
</tr>
<tr>
<td>ES lesion</td>
<td>90.0</td>
<td>94.2</td>
</tr>
<tr>
<td>BCL lesion</td>
<td>75.0</td>
<td>94.4</td>
</tr>
<tr>
<td>ACCL joint abnormality</td>
<td>51.7</td>
<td>93.4</td>
</tr>
<tr>
<td>Naredo et al</td>
<td>84.6</td>
<td>80.0</td>
</tr>
<tr>
<td>Iagnocco et al</td>
<td>73.6</td>
<td>58.3</td>
</tr>
</tbody>
</table>

Although good amount of individual lesions are detectable by physical examination, still lower efficacy to detect pathology in painful shoulder and to differentiate between the various causes of the same, as compared to ultrasound, was seen in present study. Other studies have also found lower sensitivity and specificity to detect various pathologies by physical examination. Reason for this could be the fact that any positional maneuver used to detect rotator cuff lesion is likely to compress or stretch the biceps tendon and the subacromial-subdeltoid bursa. More over, it is difficult to distinguish between various rotator cuff diseases like tendinitis, partial thickness or full thickness tear by physical examination alone.

**SPECTRUM OF THE ULTRASONOGRAPHIC FINDINGS IN THE CURRENT STUDY**

Almost whole of the spectrum of pathologies was found in our study except for adhesive capsulitis, glenohumeral instability and labral pathology and soft tissue tumors. Adhesive capsulitis has non-specific findings on ultrasound. Soft tissue tumors are usually large and extensive by the time they reach tertiary set-up and it is uncommon for them to present solely as pain as a symptom. Glenohumeral instability and labral pathologies are usually seen in patients with past history of trauma, which is one of the exclusion criteria in present study.

**ROTATOR CUFF DISEASE**

Rotator cuff was the most common structure to show abnormality on ultrasound in our study. 27 painful shoulders had rotator cuff abnormality out of the 40 painful shoulders i.e. 67.5%. This is in concordance with the previous studies. In study done by Hawkins et al, 1989. 60% of the shoulder abnormalities had been attributed to rotator cuff abnormalities. Most rotator cuff lesions involved the “critical zone” in the anterior aspect of tendons as in previous study.

In our study, among the tendons of rotator cuff, Supraspinatus tendon most commonly showed abnormality on ultrasound (52.5%). Subscapularis was the next common tendon to show abnormality (10%). Only in 5% rotator cuff lesions Infraspinatus tendon was involved. Teres minor was normal in all the patients.

As in our study, the studies done by Iagnocco et al, 2003 and Naredo et al, 2002 also showed supraspinatus to be the most commonly involved tendon and teres minor least commonly involved. However, in our study subscapularis was more commonly showed abnormality as compared to infraspinatus. While in the studies of Iagnocco et al and Naredo et al, infraspinatus was more frequently involved. This variability could be due to different in sample size.

The reason for frequent involvement of supraspinatus tendon is because of the characteristic anatomical location of it between two bones (head of humerus and acromion). It gets compressed during forward flexion of shoulder joint. This leads to ischemia and later degeneration of the tendon.
Partial thickness tears were more common than full thickness tears in the present study. Partial thickness tear is seen in younger age group of 40-60 years than full thickness tears. The reason of finding partial thickness tear more commonly than full thickness tears in our study is due to large number of the patients included in our study belonging to the 40-60 age group.

Brenkke et al, 1992\textsuperscript{20} and Hawkins et al, 1989\textsuperscript{18} studies also showed partial thickness tears to be commoner of the two. Articular surface partial-thickness tears was most common type of partial-thickness tear in our study in accordance with previous study by Holsbeeck et al, 1992.\textsuperscript{21}

Statistically significant findings observed in partial thickness tears as compared to control shoulders were focal hypoechoic areas, focal discontinuity of fibers, focal thinning of tendon as was seen in previous studies.\textsuperscript{14, 18, 20, 21}

Statistically significant findings observed in full thickness tears as compared to control shoulders were non-visualization of tendon, herniation of deltoid and subacromial-subdeltoid bursa in the cuff as was seen in previous studies.\textsuperscript{14,15,22,23,24}

Statistically significant findings observed in full thickness tears as compared to control shoulders were focal hypoechoic areas, focal discontinuity of fibers, focal thinning of tendon as was seen in previous studies.\textsuperscript{14,18,20,21}

**BICEPS TENDON PATHOLOGY**

Alterations of the long head of the biceps were found in 14 of the 40 painful shoulders (35%) which are statistically significant as compared to controls. Alterations observed were tendonitis, fluid around the tendon, partial thickness tear and partial subluxation. Rotator cuff tears were observed in 6 of the 14 patients with biceps tendon alterations. Most commonly observed pathology of biceps tendon in association with the rotator cuff tears was tendon sheath effusion. These findings are in accordance with Iagnocco et al, 2003 and Naredo et al, 2002.

Biceps tendon is subject to mechanical forces that contribute to cuff impingement because of it anterior location in the impingement area. Also, the synovial sheath of the biceps is an extension of the glenohumeral synovial membrane. Hence the frequent association of cuff tears with biceps tendon abnormalities is observed.

**SUBACROMIAL-SUBDELTOID (SASD) BURSA**

SASD bursal fluid was found in 3(7.5%) painful shoulder in our study which is not significant statistically as compared to controls. Out of three, two were associated with the rotator cuff tear and one with impingement of supraspinatus tendon which is in accordance with the study done by Hollister et al, 1995 (specificity 96%)\textsuperscript{25} and in the study by Van Holsbeeck MT et al, 1993 (specificity 90%)\textsuperscript{26} for the diagnosis of rotator cuff tears.

Fluid within both bursa and joint in the presence of a full-thickness tear of the rotator cuff is due to direct communication between the two compartments through the defect, akin to the positive findings during a single-contrast arthrogram. Fluid in a partial-thickness tear is more likely due to direct mechanical irritation of the bursa by impingement or fenestrations within the partially torn cuff, allowing the communication. In full-thickness tears, the volume of fluid within the bursa is far greater than that seen in partial-thickness tears or impingement.

**ACROMIOCLAVICULAR JOINT ABNORMALITY**

Acromioclavicular joint abnormalities were found in 14 (35%) of painful shoulders in present study which is statistically significant as compared to controls. Degenerative changes (osteoophytes and capsular hypertrophy) alone were seen in 4 (10%) of painful shoulders.

Presence of fluid in joint alone was seen only in 2 (5%) painful shoulders. Degenerative changes and presence of fluid in joint both were seen in 8 (20%) of painful shoulders only. The findings in our study was in accordance with the study by Iagnocco et al,2003 but ACCL joint abnormality as a cause of painful shoulder was observed less frequently as compared to the study by Naredo et al, 2002.

**GREATER TUBEROSITY IRREGULARITY**

In our study irregularity of greater tuberosity was identified in 5 (12.50%) painful shoulders which is statistically significant as compared to controls. Rotator cuff tear was associated with irregularity of greater tuberosity in 3 (7.50%) of painful shoulders. Cortical irregularity of greater tuberosity was considered to be one of the secondary sonographic signs of full-thickness tear by Middleton WD et al, 1989\textsuperscript{23} and Dondelinger RF et al, 1995\textsuperscript{24} in their studies. In 2 painful shoulders there was no association between rotator cuff tear and irregularity of greater tuberosity in our study, the changes may be due to aging process, as 1 asymptomatic shoulder also showed irregularity of greater tuberosity.

**CALCIFIC TENDONITIS**

Calcific tendonitis was seen in one (2.5%) painful shoulder in our study. Hyper-reflective lines were seen without acoustic shadowing. Calcium deposits were seen in
supraspinatus tendon. MRI of this painful shoulder was normal. Absence of shadowing seen in this case may be due to soft form of stage 3 calcific tendonitis. Calcific tendonitis seen in present study occurred less commonly than the study by Naredo et al, 2003 this may be due to less mean duration of symptoms (2.8 months) in our study cohort as compared to study by Naredo et al, 2003 (mean duration of symptoms group I-3.3 months and group II-8.6 months).

GLENOHUMERAL JOINT EFFUSION

In our study only one (2.5%) painful shoulder showed abnormality in the form of fluid in the joint cavity which is not significant statistically as compared to controls. Fluid in the joint cavity was associated with rotator cuff tear. This finding is less common than the studies done by Iagnocco et al, 2003(11.2%) and Naredo et al, 2003 (group I -12%, group II-7%). This may be due to different study population and different sample size and limited numbers of subjects with synovitis.

IMPEINGEMENT

Impingement is rarely an isolated finding. There are usually secondary changes within the supraspinatus tendon or the subacromial bursa. The presence of a fluid collection alone in the subacromial-subdeltoid bursa has been used as a further criterion for the presence of early-stage impingement syndrome, i.e., Neer grade 1.

One (2.5%) painful shoulder showed buckling of supraspinatus tendon in association with SASD bursal fluid in our study which is not significant statistically as compared to controls. This finding is less common than the study done by Naredo et al, 2002. This may be due to different study population and different in age range.

From above discussion we observed that high frequency ultrasonography is an accurate, non-invasive and cheap imaging technique available to assess the shoulder lesions with high sensitivity and specificity as concluded from study by Teefy SA, et al, 2000.

In conclusion, the high sensitivity and specificity, non-invasiveness and low costs of High Resolution Sonography justify its routine utilization for the assessment of painful shoulder.

References

Author Information

Pradeep Goyal, MD
Senior Resident, Department of Radiology Lady Hardinge Medical College & associated SSK Hospital and KSC Hospital New Delhi-110001

Upma Hemal, MD
Professor, Department of Radiology Lady Hardinge Medical College & associated SSK Hospital and KSC Hospital New Delhi-110001

Ramesh Kumar, MS
Professor, Department of Orthopaedics Lady Hardinge Medical College & associated SSK Hospital and KSC Hospital New Delhi-110001