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Accuracy of High Resolution Sonographic Evaluation of Painful Shoulder

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Authors' contributions

This work was carried out in collaboration between both authors. Author PS designed the study, wrote the protocol and wrote the first draft of the manuscript. Author RR managed the literature search. Both authors read and approved the final manuscript.

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ABSTRACT

Painful shoulder is a very common condition that results from periarticular lesions involving the rotator cuff, the biceps tendon, and the subacromio-subdeltoid bursa. Ultrasonography [1] (USG) has advantage of offering a dynamic examination enabling an assessment of both the range of movement and muscular coordination.

Imaging Protocol and Correlation: All fifty patients (25 males and 25 females; range 26-67 years; mean symptoms duration 2.4 months) with symptomatic shoulder as case and asymptomatic shoulder as control were subjected to detailed clinical history, physical examination and sonographic study.

Results: Most rotator cuff lesions involved the "critical zone" (an area of relative avascularity 1 cm proximal to the point of insertion on the greater tuberosity) in the anterior aspect of tendons. Supraspinatus tendon most commonly showed abnormality on ultrasound (26%). Subscapularis (4%) and infraspinatus (4%) were the next common tendons to show abnormality. Teres minor was normal in all the patients. Partial thickness tears of supraspinatus tendon were more common than full thickness tears in the present study. Articular surface partial-thickness tear was most common type of partial-thickness tear in our study.

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Conclusion: We can conclude that sonography is an attractive screening modality for the rotator cuff in patients with painful shoulder. In nut shell, a well performed ultrasound examination in most cases obviates the need for the more invasive arthrography and the more cumbersome and expensive MRI examination. Based on these results it appears that ultrasonography can be used as the initial imaging test for many patients with suspected abnormalities of the rotator cuff or biceps tendon.

Keywords: Sonography; periarticular; arthrography; subacromio-subdeltoid.

1. INTRODUCTION

Painful shoulder is a very common rheumatologic condition that results from periarticular lesions involving the rotator cuff, the biceps tendon, and the subacromio- subdeltoid bursa. Ultrasonography [1] (USG) has advantage of offering a dynamic examination enabling an assessment of both the range of movement and muscular coordination.

Magnetic resonance imaging (MRI) is potentially superior to sonography in several regards because it is less operator dependent, shows intraosseous pathology and is superior in depicting the extent of granulation tissue, effusion, erosion, partial tears and tendonitis. However, MRI is less available, much more expensive and time consuming. Patient complain claustrophobia and the induction of pain caused by the long duration of the examination with the joint immobilized in MRI.

2. MATERIALS AND METHODS

The study was conducted in Department of Radiodiagnosis, Deen Dayal Upadhyay Hospital, Delhi over two year period.

2.1 Inclusion Criteria

All patients with complain of painful shoulder with clinical diagnosis of periarticular lesions such as rotator cuff impingement, tendonitis, cuff strain, cuff tear, biceps tendonitis and subacromio-subdeltoid bursitis were included in the study.

2.2 Exclusion Criteria

1. Patients with history of trauma.
2. Patients having chronic inflammatory arthritis.

2.2.1 Imaging protocol and correlation

All fifty patients (25 males and 25 females; range 26-67 years; mean symptoms duration 2.4 months) with symptomatic shoulder as case and asymptomatic shoulder as control were subjected to detailed clinical history, physical examination and sonographic study.

2.2.2 Physical examination

A thorough physical examination was performed by using following tests:

1. Bicep tendon was evaluated using Speed test.
2. Supraspinatus was evaluated using supraspinatus isolation or Jobe test.
3. Resisted external rotation for the infraspinatus tendon.
4. Resisted internal rotation for the subscapularis tendon (SBT).
5. Adduction stress test for acromio-clavicular joint pathology.

2.2.3 Speed's test [2]

Speed test is most sensitive for provoking biceps tendon pain. It is performed by asking the subject to place the shoulder in 90° forward flexion position with the elbow fully extended and forearm supinated. The subject is then instructed to resist as the examiner attempts 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.

2.2.4 Supraspinatous isolation or Jobe test [2]

Supraspinatus is evaluated using supraspinatus isolation or Jobe test. To perform the test, the examiner stands in front of the subject, who is asked to abduct the arms to 90° with the elbows fully extended. The subject's arms is then brought forward to a position 30° anterior to the true coronal plane and maximally rotated so that the thumb points downwards. The subject is then asked to push toward the ceiling while the examiner provides resistance. Weakness noticed during this test signifies muscle inhibition due to pain or true muscle dysfunction.

2.2.5 Resisted external rotation for the infraspinatus tendon

To test the infraspinatus, the subject is asked to place the arms tightly at the sides with the elbows flexed to 90°. The subject is then asked to externally rotate the arms while the examiner provides resistance. Pain during this examination signifies infraspinatus pathology.

2.2.6 Resisted internal rotation for the subscapularis tendon

The subject is asked to stand with the elbow flexed to 90° and the hand on the abdomen. The subject is instructed to press the hand down against the abdomen while the examiner attempts to lift the subject's hand away from the trunk. This method is particularly helpful in assessing the strength of the subscapularis in patients with restricted internal rotation.

2.2.7 Adduction stress test

In this test, the elbow and shoulder of the subject are extended and then passively adducted behind the back. This maneuver produces pain in case of acromio-clavicular joint pathology. Passive cross-chest adduction is also used as a test for acromio-clavicular joint symptoms. The examiner stands facing the subject and passively brings the patient's arm into maximal cross-chest adduction. This maneuver reproduces pain if acromio-clavicular joint injury or arthritis is present.

2.2.8 Ultrasonography

All patients (with symptomatic shoulder as case and asymptomatic shoulder as control) underwent ultrasonographic examination within 1 week of physical examination with a real time equipment (Philips En Visor Version C.0.2) using 7.5 MHz linear phased array transducer. Transverse and longitudinal planes from the biceps tendon (BT) groove, rotator cuff and transverse planes from posterior glenohumeral recess, glenoid labrum and acromioclavicular joint (ACJ) 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 (Figs. 2,3,4,5,6).

2.2.9 Positioning of patient

1. The biceps tendon groove, the subscapularis tendon, and the acromio-clavicular joint were examined with the arm held in neutral position, the elbow flexed to 90^0, and the forearm in a supinated position on top of the thigh [3].
2. 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 [4].
3. The infraspinatus and teres minor tendons were evaluated from a posterior view with the arm in neutral position and the elbow flexed at 90°.
4. Impingement syndrome was evaluated by dynamic examination [5]. A dynamic view of the supraspinatus tendon (ST) was 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.

USG findings from the clinically evaluated painful shoulders (cases) and asymptomatic shoulders (controls) were recorded

3. RESULTS

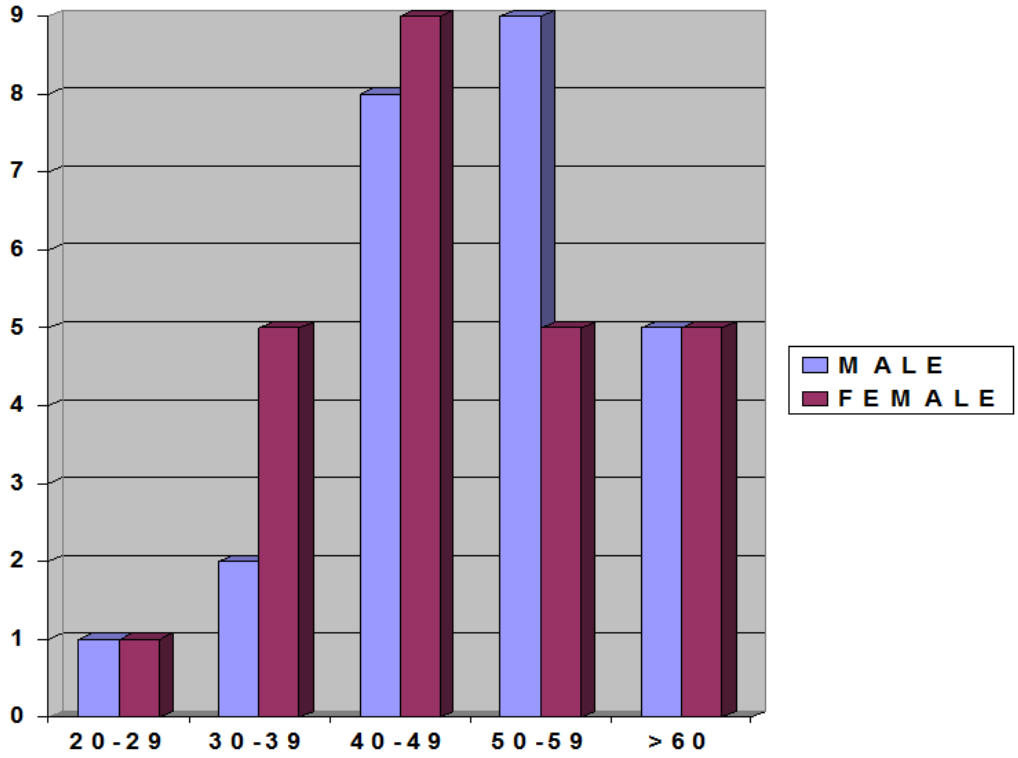
All fifty patients (25 males and 25 females) were subjected to detailed history, physical examination and sonographic study. Maximum numbers of patients were in the age group of 40-59 years (Bar Chart I). There were 25 males and 25 females in the study suggesting no sex predilection for rotator cuff tears.

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 χ^2 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.

The Speed's test was positive in 9 (18%) painful shoulders, Jobe test in 13 (26%) painful shoulders, resisted external rotation in 2 (4%) painful shoulders, resisted internal rotation in 2 (4%) painful shoulders and adduction stress test in 10 (20%) painful shoulders. Adduction stress test was positive in 1 asymptomatic shoulder.

Table 1. Ultrasonographic diagnostic criteria of shoulder abnormalities [3,4,6,7,8,9]

Shoulder abnormality	Diagnostic criteria
Biceps sheath effusion	Thickness of the hypoechoic halo of fluid surrounding the biceps tendon >2 mm
Biceps tendonitis	Increased fluid within the synovial sheath and tendon hypoechogenicity and/or thickening.
Biceps tendon tear	Partial or complete interruption of the tendon fibers, separation of the ends and hypoechoic fluid filling the defect.
Biceps tendon subluxation	Empty bicipital groove and identification of the displaced tendon.
Rotator cuff tendonitis	Tendon hypoechogenicity or tendon thickening with or without internal hypo or hyperechoic foci with poorly defined margins.
Rotator cuff partial-thickness tear	Hypoechoic fiber discontinuity involving the bursal or articular surface or intrasubstance hypoechoic defect or focal tendon thinning.
Rotator cuff full-thickness tear	Non-visualization of tendon or fiber discontinuity from the humeral head to the subacromial-subdeltoid bursa.
Rotator cuff calcification	Hyper reflective foci or lines with acoustic shadowing.
Rotator cuff impingement	Buckling of the cuff/rippling effect as the cuff passes beneath the coracoacromial arch or fluid distending the subacromial-subdeltoid bursa or thickened bursa in front of the acromion while the arm is abducted.
Subacromial-subdeltoid (SASD) bursitis	Hypoechoic fluid filled bursa >2mm thick.
Acromioclavicular degenerative changes	Cortical irregularities or osteophytes, usually accompanied by intra-articular hypoechoic fluid displacing joint capsule.
Glenohumeral joint (GHJ) effusion	Distance from the posterior infraspinatus tendon >2 mm.



Bar chart I. Age-Sex distribution

Fig. 1. Greater tuberosity sclerosis seen on radiograph

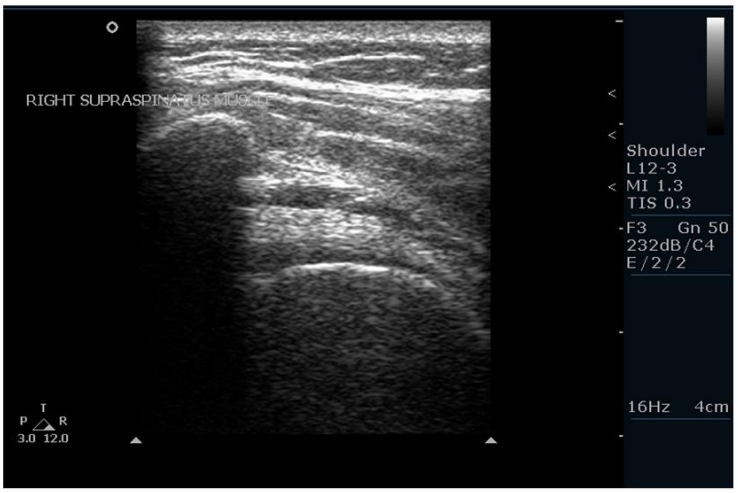


Fig. 2A. Normal supraspinatus tendon (L.S)

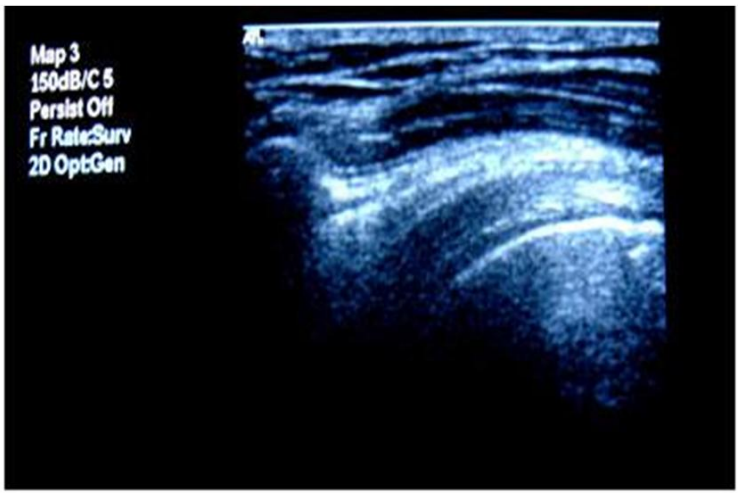


Fig. 2B. Normal supraspinatus tendon (T.S)

USG (Bar Chart II) showed supraspinatus lesions (Figs. 7,8,9) in 13 (26%) painful shoulders and 1 (2%) asymptomatic shoulder. Full-thickness tear was detected in 1 (2%) painful shoulder. Partial-thickness tear was seen in 11 (22%) painful shoulders and 1 (2.50%) asymptomatic shoulder. Calcific tendonitis was detected in 1 (2%) painful shoulder. Complete tear of long head of biceps tendon was found in 1 (2%) painful shoulder. The presence of fluid in tendon sheath was seen in 8 (16%) painful shoulders (Figs. 11,12). Subscapularis showed tendinosis in 2 (4%) painful shoulders (Fig. 10).

Infraspinatus partial thickness tear was seen in 2 (4%) painful shoulders. Teres minor was normal in all patients in our study. Degenerative changes (osteophytes and capsular hypertrophy) alone were seen in 18 (36%) painful shoulders and 9 (18%) asymptomatic shoulders (Figs. 13,14). Presence of fluid in joint alone was seen in 5 (10%) painful shoulders (Bar Chart II). Degenerative changes and presence of fluid in joint both were seen in 5 (10%) painful shoulders. Abnormality in the form of fluid in the glenohumeral joint cavity was detected in 4 (8%) painful shoulders. Fluid in the joint cavity was associated with rotator cuff tear (Bar Chart II).

Irregularity of greater tuberosity (IGT) was identified in 7 (14%) painful shoulders and 2 (4%) asymptomatic shoulders (Fig. 15). Rotator cuff tear was associated with irregularity of greater tuberosity in 3 (6%) painful shoulders. Fluid in subacromial-subdeltoid bursa was seen in 10 (20%) painful shoulders (Fig. 16). Rotator cuff tear was associated with subacromial-subdeltoid bursa effusion in 6 (12%) painful shoulders. Buckling of supraspinatus tendon in association with subacromial-subdeltoid bursal effusion was seen in 7 (14%) painful shoulders (Fig. 17).

MRI was done in 10 painful shoulders (Figs. 18,19,20). Maximum findings were in concordance with ultrasonographic findings. Extra findings which were found on MRI and not on ultrasound were presence of fluid in acromio-clavicular joint in 1 patient and fluid in subcoracoid recess in 1 patient. The one finding which was not seen on MRI but was seen on ultrasound was calcific tendonitis.

4. DISCUSSION

The present study was carried out to identify site and entity of alteration in patient with painful shoulder, to compare clinical diagnosis established by physical examination with high frequency ultrasonographic findings and to correlate ultrasonographic findings with asymptomatic shoulders (control).

Sensitivity of physical examination with respect to ultrasound (Bar Chart III) was good in the clinical diagnosis of supraspinatus and bicep tendon lesion. Sensitivity of physical examination with respect to ultrasound was low in clinical diagnosis of lesions in acromio-clavicular joint,

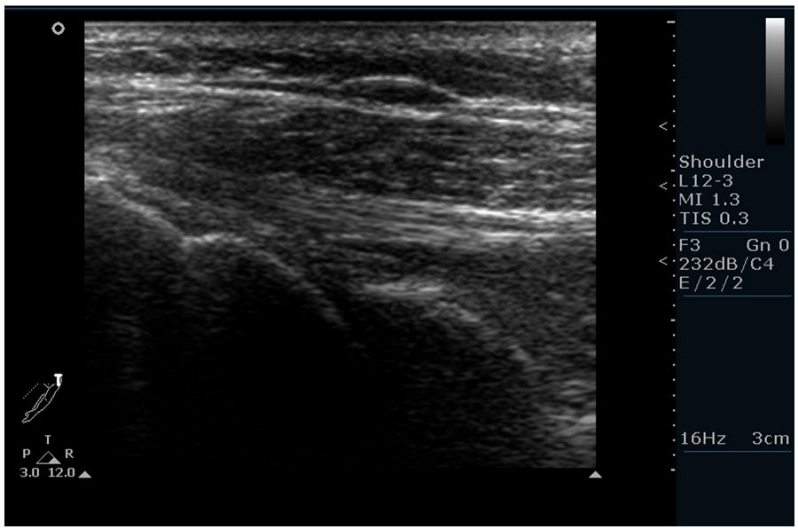
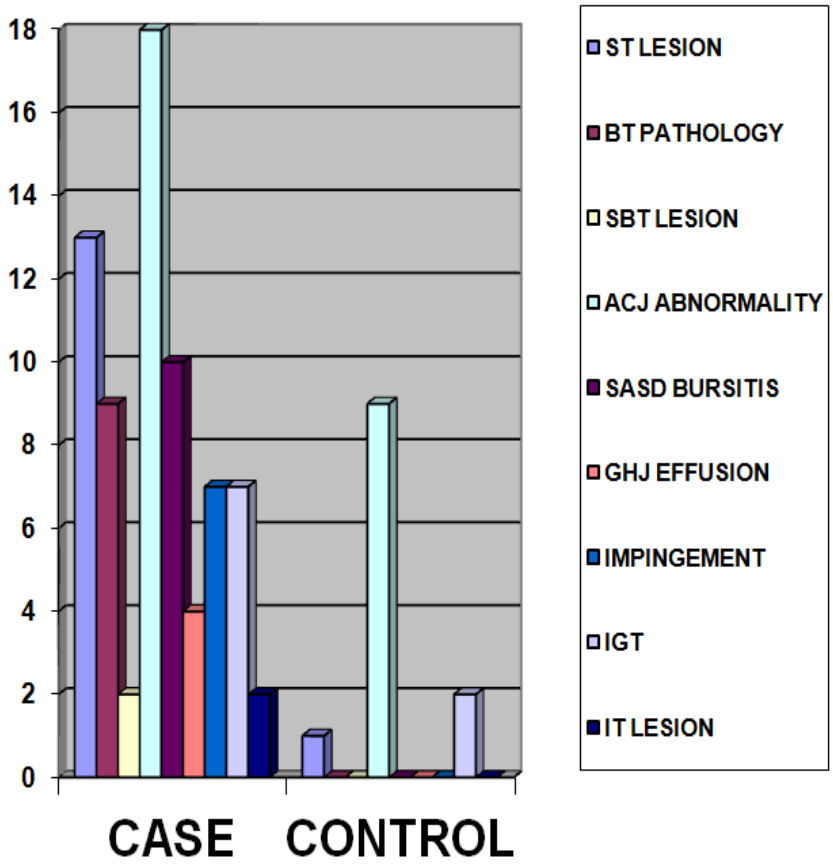


Fig. 3. Normal infraspinatus tendon (L.S) and glenohumeral joint

infraspinatus and subscapularis tendon. Physical examination was unable to differentiate rotator cuff tendonitis from tear, and partial-thickness tears from full-thickness tear. On ultrasound almost whole of the spectrum of pathologies was found in our study except for adhesive capsulitis, glenohumeral instability, labral pathology and soft tissue tumors.



Bar chart II. Sonographic findings in painful shoulders and asymptomatic shoulders

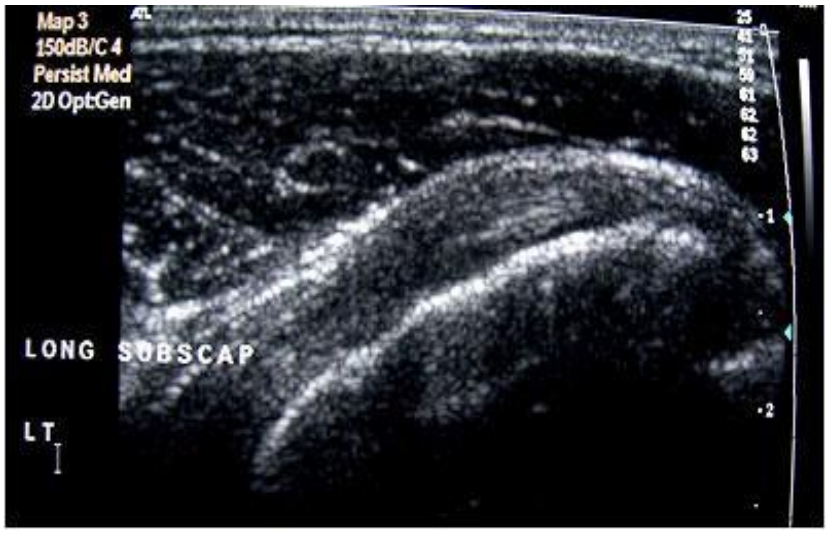
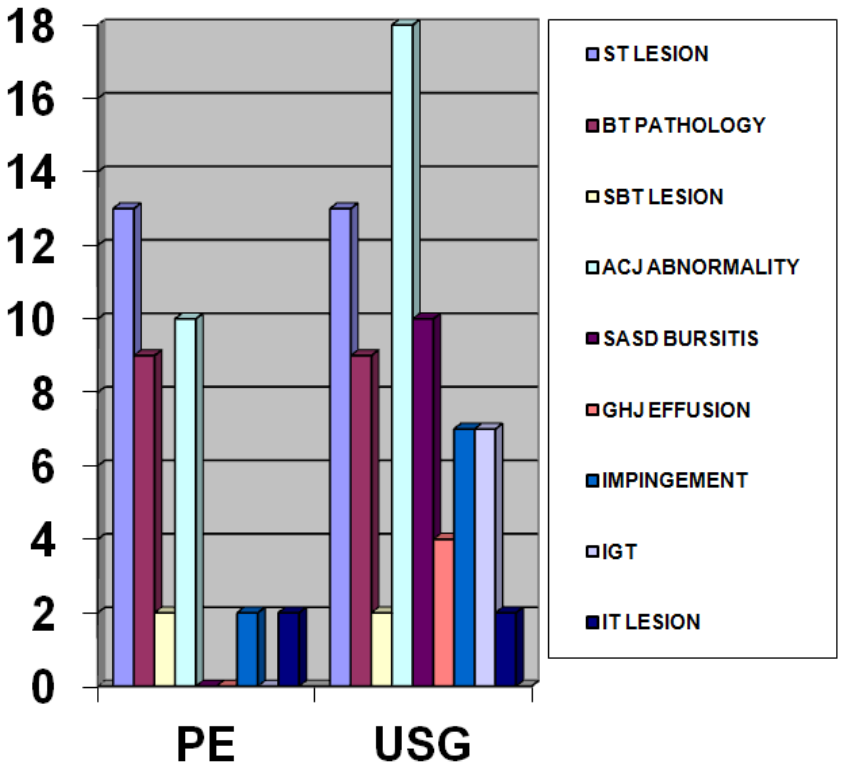


Fig. 4. Normal subscapularis tendon (L.S)

Most rotator cuff lesions involved the "critical zone" (an area of relative avascularity 1 cm proximal to the point of insertion on the greater tuberosity) in the anterior aspect of tendons. Supraspinatus tendon most commonly showed abnormality on ultrasound (26%). Subscapularis (4%) and infraspinatus (4 %) were the next common tendons to show abnormality. Teres minor was normal in all the patients. Partial thickness tears of supraspinatus tendon were more common than full thickness tears in the present study. Articular surface partial-thickness tear was most common type of partial-thickness tear in our study.



Bar chart III. Comparison of physical examination and ultrasound findings

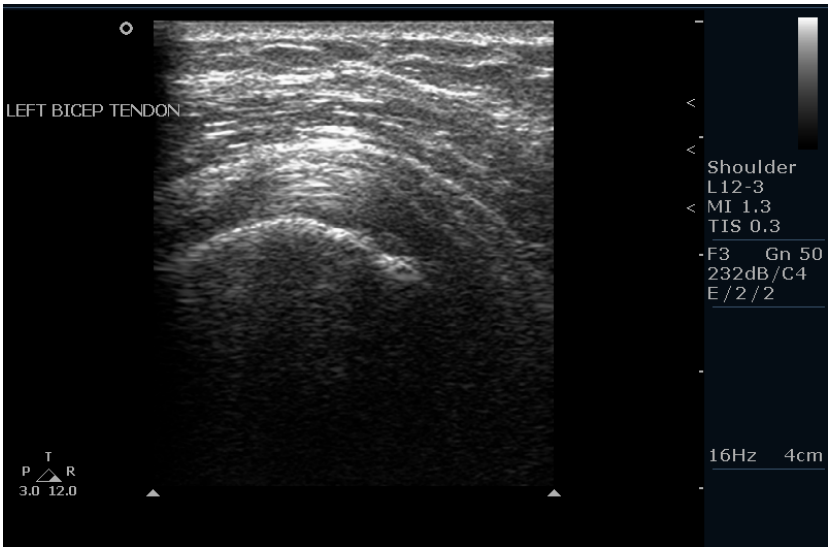


Fig. 5A. Normal bicep tendon (L.S)

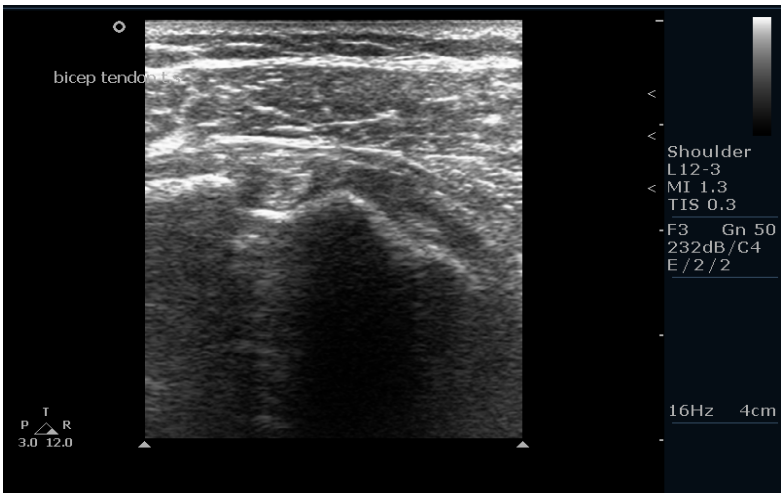


Fig. 5B. Normal bicep tendon (T.S)

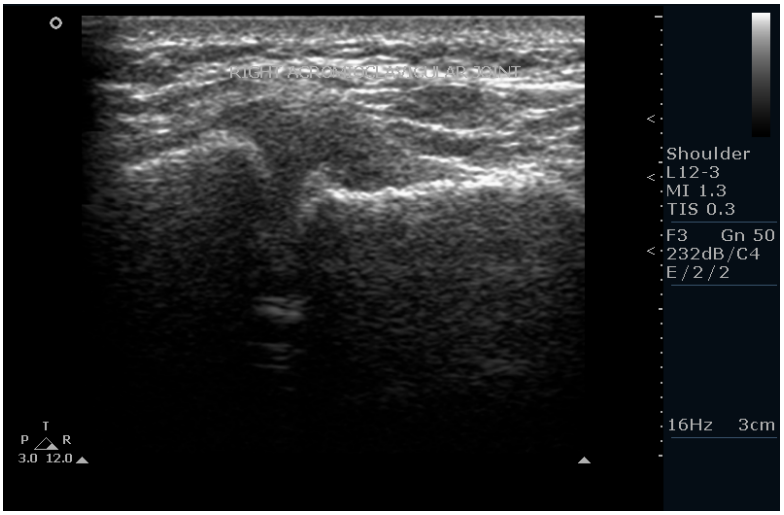


Fig. 6. Normal acromioclavicular joint

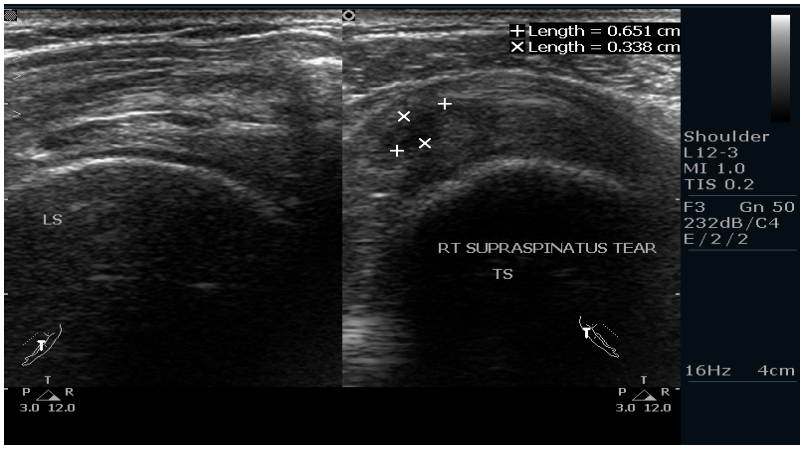


Fig. 7. Bursal surface supraspinatus tear

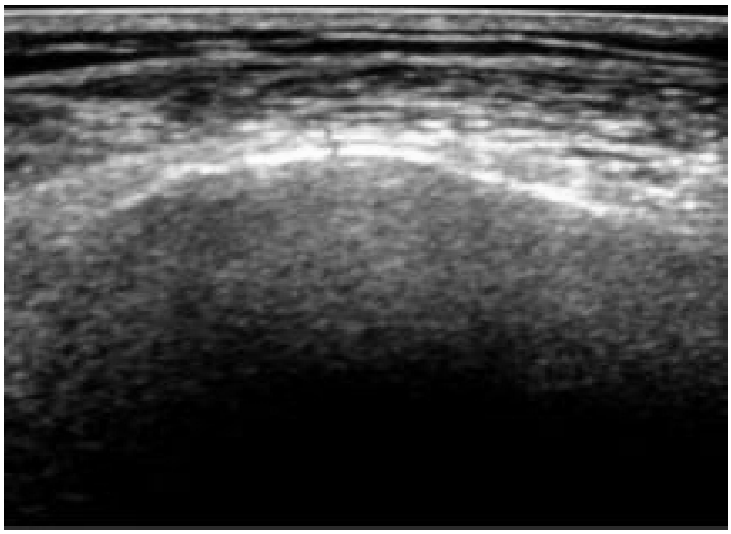


Fig. 8. Full thickness supraspinatus tear (T.S)

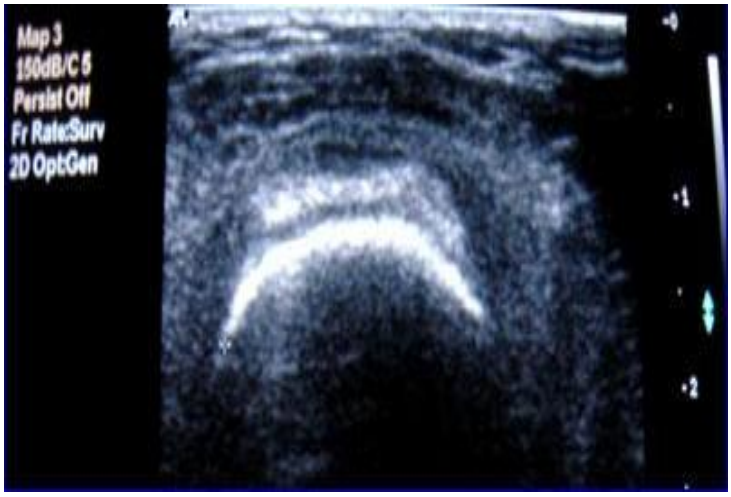


Fig. 9. Supraspinatus calcific tendonitis

Fig. 10. Right subscapularis tendonitis (L.S)

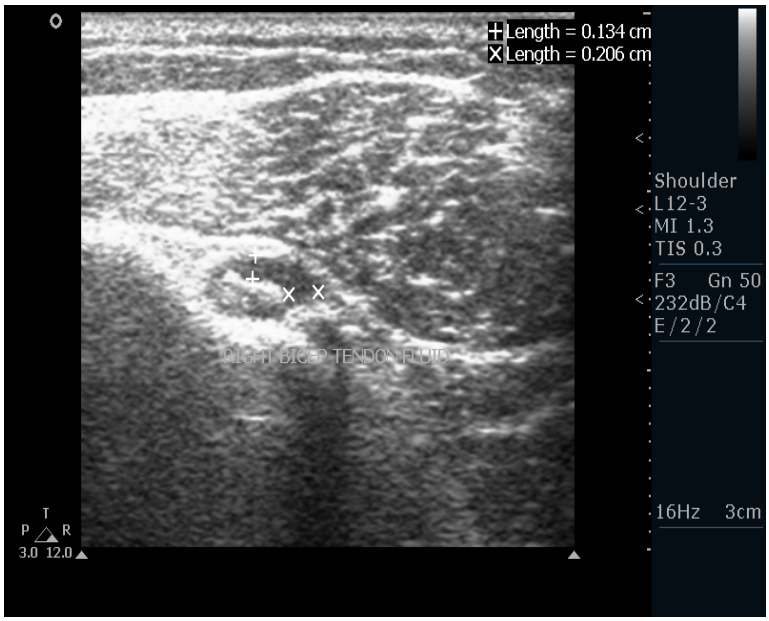


Fig. 11. Bicep tendon sheath effusion (T.S)

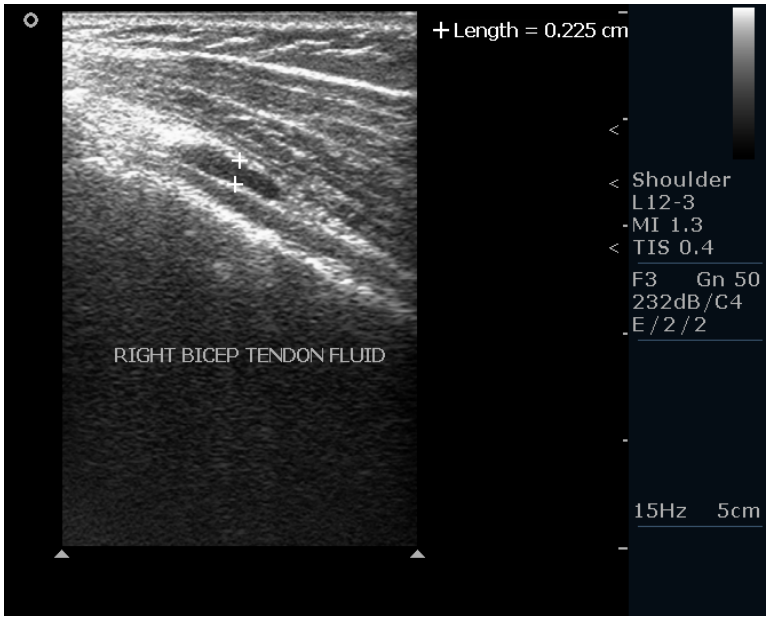


Fig. 12. Bicep tendon sheath effusion (L.S)

Statistically significant findings observed in partial thickness tears as compared to control shoulders were focal hypoechoic areas and focal discontinuity of fibers. Statistically significant findings observed in full thickness tears as compared to control shoulders were non-visualization of tendon and herniation of deltoid and subacromial-subdeltoid bursa in the cuff.

Alterations of the long head of the biceps were found in 9 (18%) painful shoulders (cases) which was statistically significant as compared to controls. Alterations observed were fluid around the tendon and full thickness tear. Rotator cuff tears were observed in 2 of the 9 patients with biceps tendon alterations. Most commonly observed pathology of biceps tendon in association with the rotator cuff tears was tendon sheath effusion.

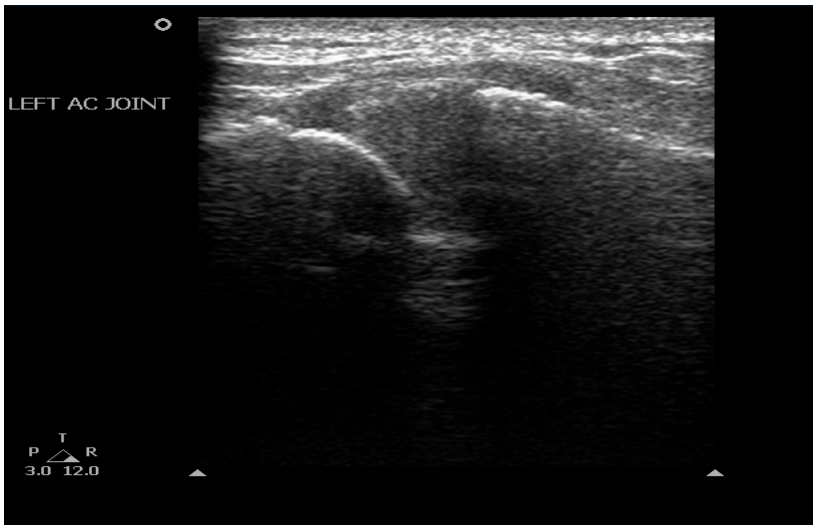


Fig. 13. Degenerative change acromioclavicular joint

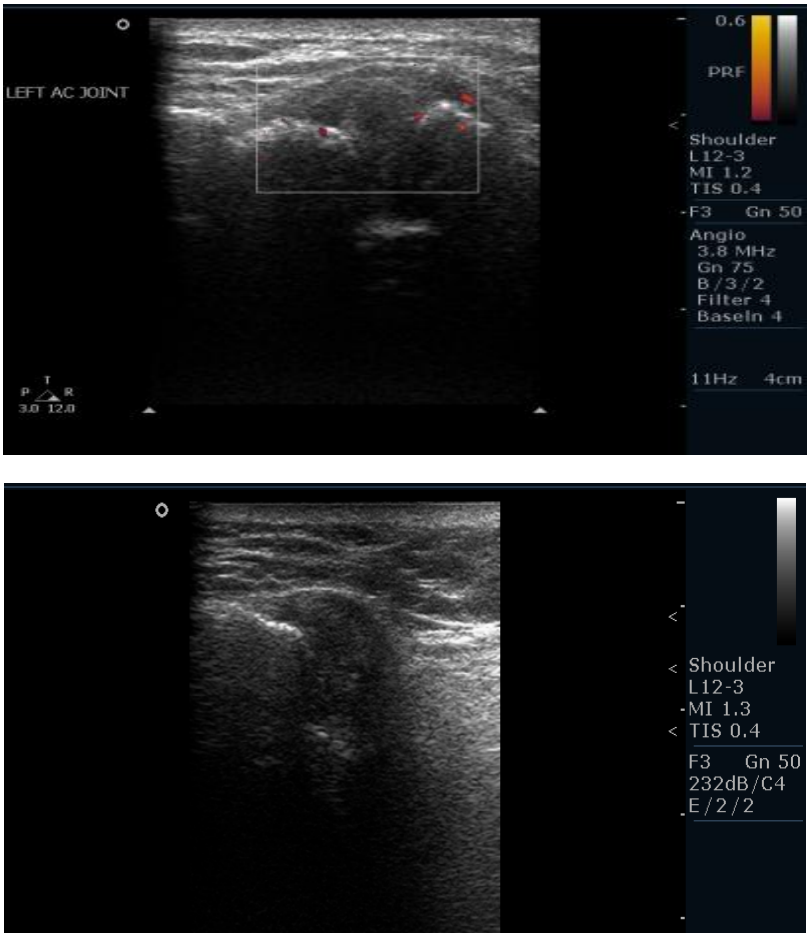


Fig. 14. Degenerative change acromioclavicular joint with effusion

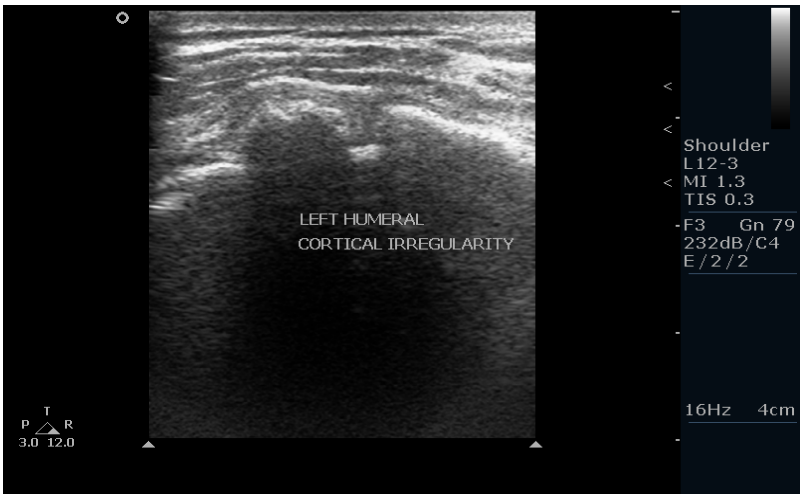


Fig. 15. Humeral cortical surface irregularity

Fig. 16. Subacromial-subdeltoid bursitis

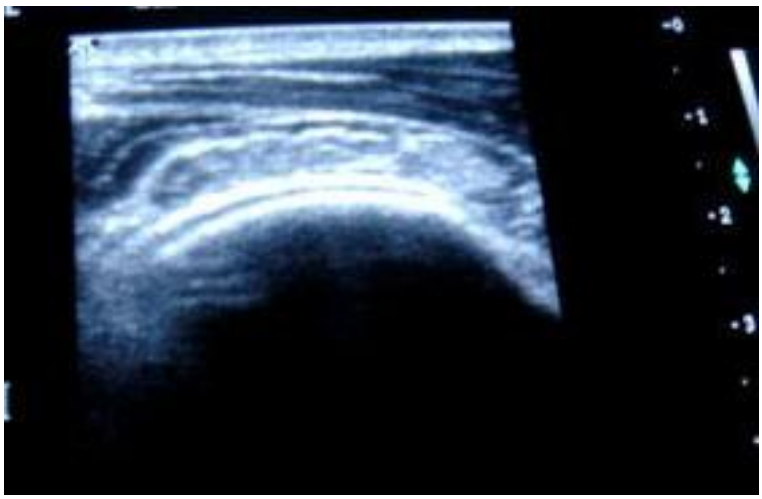


Fig. 17. Supraspinatus impingement

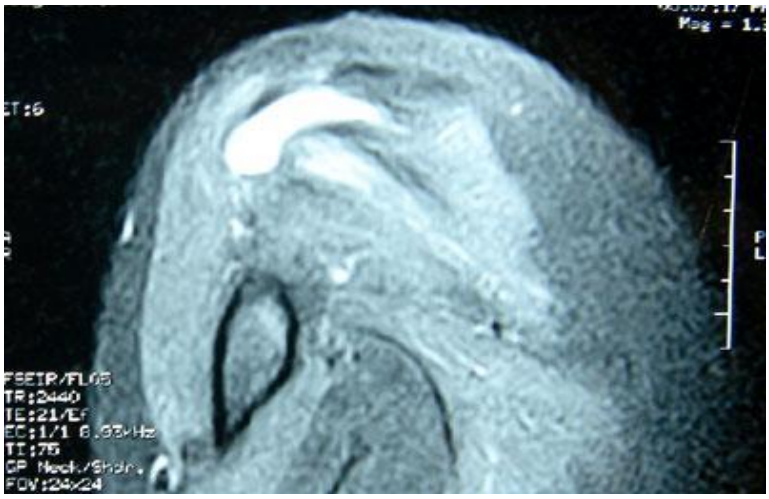


Fig. 18. MRI image showing glenohumeral joint effusion

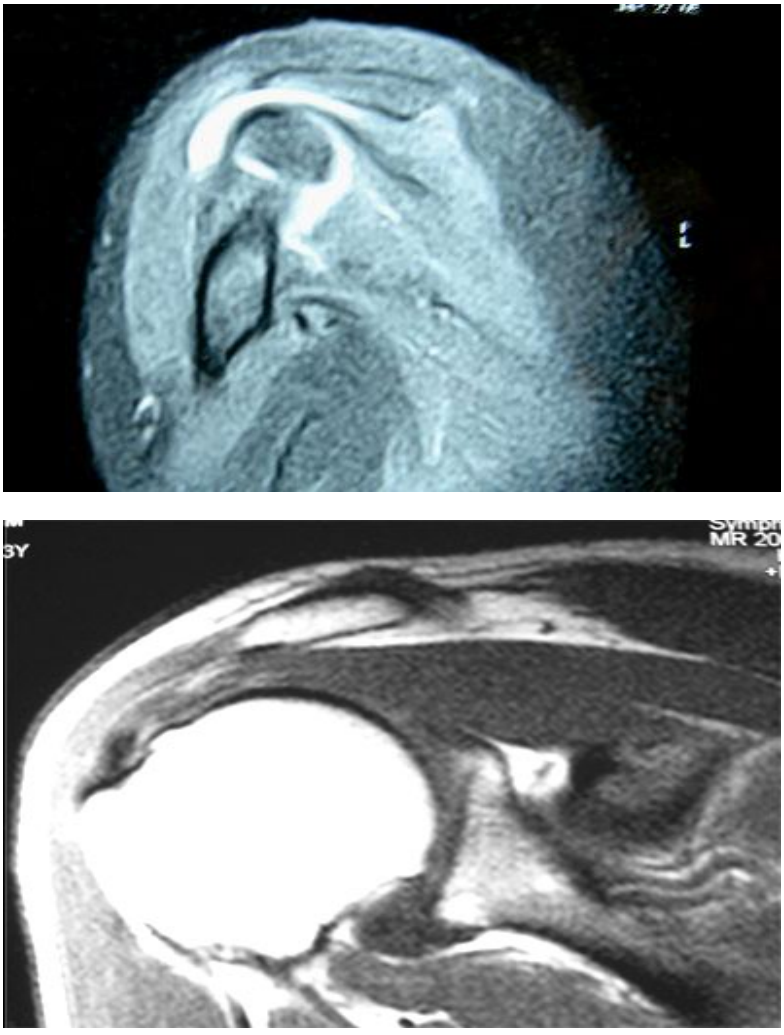


Fig. 19. MRI image showing partial supraspinatus tear with SASD bursal effusion

Fig. 20. MRI image showing type III acromian with reduced acromio-humeral distance & glenohumeral joint effusion

Acromioclavicular joint abnormalities were found in 18 (36%) of painful shoulders (cases) in present study which is statistically significant as compared to controls. Abnormalities were degenerative changes (osteophytes and capsular hypertrophy) and presence of fluid in joint. Irregularity of greater tuberosity was identified in 7 (14%) painful shoulders (cases) which is statistically insignificant as compared to controls. Rotator cuff tear was associated with irregularity of greater tuberosity in 3 (6%) of painful shoulders.

Our case study has few limitations. First of all, study group was very small. Secondly, asymptomatic shoulder was taken as control. We therefore feel that results of our study needs further validation with study having large number of symptomatic patients as cases and asymptomatic patients as control.

4. CONCLUSION

Most rotator cuff lesions involved the "critical zone" (an area of relative avascularity 1 cm proximal to the point of insertion on the greater tuberosity) in the anterior aspect of tendons. Supraspinatus tendon most commonly showed abnormality on ultrasound. Subscapularis and infraspinatus were the next common tendons to show abnormality. Teres minor was normal in all the patients.

We can conclude that sonography is an attractive screening modality for the rotator cuff in patients presenting with painful shoulder. In nut shell, a well performed ultrasound examination in most cases obviates the need for the more invasive arthrography and the more cumbersome and expensive MRI examination. Based on these results it appears that ultrasonography can be used as the initial imaging test for many patients with suspected abnormalities of the rotator cuff or biceps tendon.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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