

Role of Ultrasonography in Evaluation of Rotator Cuff in Patients of Chronic Shoulder Pain in Comparison to Magnetic Resonance Imaging

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Abstract

Introduction: Shoulder pain is one of the most common complaints encountered in orthopedic practice, and approximately 1% of adults consult a general practitioner with new shoulder pain annually.

Aims and Objectives: To evaluate the accuracy of ultrasonography (USG) in comparison to magnetic resonance imaging (MRI) in assessing rotator cuff pathology in terms of sensitivity and specificity.

Materials and Methods: Our study is observational, prospective study with cross-sectional data collection done in a period of September 2015 to September 2016. 51 patients with chronic shoulder pain and those who fulfilled our inclusion criteria were selected as the study population. USG was done to assess rotator cuff followed by MRI.

Result: In our study for assessing partial tendon tear USG was 92.9% sensitive, 86% specific, had 72% positive predictive value (PPV), 97% negative predictive value (NPV), and 88% accuracy in comparison to MRI. For assessing complete tendon tear USG showed 100% sensitivity, 97% specificity, 90% PPV, 100% NPV, and 98% accuracy.

Conclusion: Ultrasound proved to be highly accurate in evaluating partial tendon tear and complete tear. Thus, USG can be used as primary screening modality while assessing rotator cuff pathology.

Key words: High resolution ultrasonography, Magnetic resonance imaging, Rotator cuff pathology

INTRODUCTION

Shoulder pain is one of the most common complaints encountered in orthopedic practice and approximately 1% of adults consult a general practitioner with new shoulder pain annually¹⁻⁵ magnetic resonance imaging (MRI) is an excellent modality because of its multiplanar capability and is reliable technique for the evaluation of rotator cuff tendon, however, because of low availability and

considering cost factor ultrasonography (USG) can be used as screening modality. It has gained its place in literature along with MRI. Cost effectiveness and ready availability are its biggest advantages in several clinical settings. The real-time capability of ultrasound in conducting dynamic studies in areas like shoulder is a very big asset. It helps to do quick comparison with the contralateral side, which is of great help in many difficult situations.

MATERIALS AND METHODS

Our study is observational (diagnostic analytical), prospective study with cross-sectional data collection in a period of September 2015 to September 2016 done at the Department of Radiodiagnosis, Pt. Jawahar Lal Nehru Memorial Medical College, Raipur, Chhattisgarh, India.

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After obtaining approval from Ethics Committee, we prospectively searched for patients having chronic shoulder pain of more than 3 months. USG followed by MRI was done in our department.

The inclusion criteria of the study were, patients having chronic shoulder pain, suspected to be arising from the musculotendinous tissues around the glenohumeral joint or features suggestive of rotator cuff tear on physical examination such as Drop Arm sign and external rotation lag sign.

The exclusion criteria of the study were patient having arthritis of joint, any previous surgical intervention, having contraindication to MR evaluation such as patient with pacemaker, claustrophobia, and metallic implants.

We included a total of 51 patient of chronic shoulder pain. The mean interval between sonography and MRI was 10 days (range, 5-15 days).

USG assessment of rotator cuff was by experienced radiologist using Toshiba Aplio MX ultrasound machine having high frequency small part probe. We assessed following factors in each patient: Status of subscapularis, supraspinatus, infraspinatus and teres minor tendon, fluid in subdeltoid and subcoracoid bursa (SCB), assessment of biceps tendon, fluid in biceps tendon sheath (BTS), and acromioclavicular joint (ACJ). Acromiohumeral distance was assessed. Comparison with contralateral side was done. Dynamic evaluation for shoulder impingement was done.

MRI of these patients was performed on MAGNETOM Skyra, Siemens, Germany and accessories including pelvic phased-array coil 3T field strength. 70 cm open bore design, 173 cm system length, approximately 35 m² room size. RF Tim (204 × 48) (204 × 64) (204 × 128), Gradient strength – XQ Gradients (45 mT/m @ 200 T/m/s). Zero Helium boil-off technology pressure injector.

The following sequences were performed: Proton density weighted images with fat saturation in the axial, coronal oblique and sagittal oblique plane with a slice thickness of 3 mm, a field of view (FOV) of 180 mm and TR/TE – 4300/40, voxel size 0.5 mm × 0.5 mm × 3 mm. T2 weighted images in the oblique coronal plane with a slice thickness of 3 mm, FOV of 180 mm and TR/TE – 3100/76. Short T1 inversion recovery images in the coronal plane with a slice thickness of 3 mm, a FOV of 180 mm, and TR/TE – 3630/52. T1 weighted image in sagittal and coronal plane with slice thickness of 3 mm, a FOV of 180 mm and TR/TE – 600/10.

Similarly, another two experienced MRI-trained radiologists examined the images. The examiners were blinded to the USG findings.

Statistical Evaluation

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy for assessment of partial and complete tendon tear using USG in comparison to MRI was calculated using two by two contingency tables. Chi-square/Fisher exact test has been used to find the significance of study parameters on categorical scale between two and more groups.

RESULTS

There were total - 51 cases of chronic shoulder pain on whom USG followed by MRI was done in the Department of Radiodiagnosis, Pt. Jawahar Lal Nehru Memorial Medical College.

On USG supraspinatus tendon was the most common tendon to be involved in our study. 31 patients were detected with supraspinatus tendon pathologies (Table 1). Out of 31 patients of supraspinatus involvement – 17 patients had partial tendon tear among which 10 patients had articular surface tendon tear, 6 patients had bursal surface tear, and 1 patient had intrasubstance tear. 10 had complete tear of supraspinatus tendon. 4 patients had supraspinatus tendinosis. 1 patient was detected to have partial subscapularis muscle tear. 1 had complete tear of biceps.

A total of 23 patients were detected to have fluid in subacromial-subdeltoid bursa (SADB) fluid. Out of which 9 had complete tear, 12 had partial tear, and 2 had tendinosis. 38 patients had fluid in BTS on USG. In 38 patients detected have fluid in BTS, 10 patients had complete tendon tear of supraspinatus, 15 patients had partial tendon tear of supraspinatus, 4 patients had supraspinatus tendinosis, 1 patient had partial tendon tear of subscapularis, and 8 patients were reported as normal. 5 patients had ACJ hypertrophy on USG. In 5 patients detected to have ACJ hypertrophy on USG, all had complete tendon tear of supraspinatus. 15 patients had fluid in SCB fluid on USG. In 10 patients detected to have fluid in SCB on USG, 7 patients had complete tendon tear of supraspinatus, 6 patients were detected to have partial tendon tear of supraspinatus, 1 patient had partial tendon tear of subscapularis, and 1 patient had supraspinatus tendinosis.

On MRI also, supraspinatus tendon was the most common tendon to be involved in our study. 37 patients were detected with supraspinatus tendon pathologies (Table 2). Out of 37 patients detected to have supraspinatus pathologies – 13 had partial tendon tear in which 10 patients had articular surface partial tendon tear and 3 patients had bursal surface

Table 1: Ultrasonography findings in patients of chronic shoulder pain

Tendon	Partial thickness tear	Full thickness tear	Tendinosis
Supraspinatus	17 (52%) 10 - Articular 6- Bursal 1- Intrasubstance tear	10 (30%) 5 - Small 1 - Medium 4 - Large	4 (12%)
Subscapularis	1 (3%)	0	0
Infraspinatus	0	0	0
Teres minor	0	0	0

Table 2: MRI findings in patients of chronic shoulder pain

Tendon	Partial thickness tear	Full thickness tear	Tendinosis/tendinitis
Supraspinatus	Tendinitis	9 (24%) 4 - Small 1 - Medium 4 - Large	13 (35%)
Subscapularis	1 (3%)	0	0
Infraspinatus	0	0	0
Teres minor	0	0	0

MRI: Magnetic resonance imaging

tendon tear. 9 patients had complete tendon tear and 13 patients had tendinosis. 1 patient was detected to have partial subscapularis muscle tear with reduced coracohumeral distance. 1 had complete tendon tear of biceps.

A total of 24 patients had fluid in SADB. Out of 24 patients who were detected to have fluid in SADB detected on MRI, 9 patients had complete tendon tear, 11 patients had partial tendon tear, and 5 patients had tendinosis/tendinitis. 40 patients had BTS on MRI. In 40 patients detected to have BTS fluid on MRI, 8 patients had complete tendon tear of supraspinatus, 12 patients had partial tendon tear of supraspinatus, 14 patients had supraspinatus tendinosis, 1 patient had partial tendon tear of subscapularis, and 5 patients were reported as normal.

A total of 36 patients had ACJ hypertrophy on MRI. In 36 patients who were detected to have ACJ hypertrophy on MRI, 6 patients had complete tendon tear of supraspinatus, 10 patients had partial tendon tear of supraspinatus, 12 patients had supraspinatus tendinosis, 1 had partial tendon tear of supraspinatus, and 7 patients were reported as normal. 23 patients had fluid in SCB fluid on MRI. Out of 23 patients having fluid in SCB on MRI, 9 patients had complete tendon tear of supraspinatus, 10 patients had partial tendon tear of supraspinatus, 3 patients had supraspinatus tendinosis, 1 had partial tendon tear of supraspinatus, and 1 was reported as normal.

On MRI 1 patient had labral injury with Hill-Sachs deformity. 1 patient had signal intensity changes in the form of hyperintensity in SGHL. Type II acromion was the most common acromion in our study (85%). 4 patients had inferolateral tilt of acromion.

DISCUSSION

Our study shows among 51 patients, the most common age group of patients presenting with a rotator cuff injury was in the 41-50 years range constituting 46% of the cases with the mean age of 44.5 years. Males were the majority of the patients constituting around 60% of the cases. Majority (63%) patients in our study had right hand dominance. These results are in concordance with the observations seen by Urwin *et al.*³ who proposed that rotator cuff tears tend prevails in the dominant arm.

Supraspinatus tendon was the most common tendon involved in our study. On USG 31 patients and on MRI 37 patients had supraspinatus pathology. This is comparable to research study by Vijayvargiya *et al.*,¹³ Saraya and El Bakry,¹⁴ Khanduri *et al.*,¹⁵ and Burbank *et al.*⁷

The supraspinatus muscle is vulnerable to tearing due to its anatomic position and the biomechanics of the shoulder complex.^{8,9}

In our study out of 51 cases, 13 patients were detected to have partial tendon tear of supraspinatus and 1 patient had partial tendon tear of subscapularis on MRI whereas USG demonstrated partial tendon tear of supraspinatus in 17 patients and partial tendon tear of subscapularis in 1 patient. On USG there were 4 false positive cases probably due to anisotropy related artifacts Thus, ultrasound was 92.9% sensitive, 86% specific had 72% PPV, 97% NPV and was 88% accurate in diagnosing partial tendon tear which correlated well with studies by Vijayvargiya *et al.*,¹³ Saraya and El Bakry,¹⁴ Khanduri *et al.*,⁶ and Bhatnagar *et al.*¹² (Table 3).

In our study among the 13 partial tendon tear of supraspinatus, 10 had articular surface tendon tear whereas 3 had bursal surface tendon tear. This shows articular surface tear were more common than bursa surface tear. Similar result was observed by Khanduri *et al.*,¹⁵ Vlychou *et al.*,⁸ and Modi *et al.*¹⁰ and partial tendon tear of subscapularis was found in only 1 case results correlated with study conducted by Codman *et al.* who found subscapularis involvement was 3.5% in rotator cuff pathologies. In our study, partial tendon tear of subscapularis was associated with subcoracoid impingement and had reduced coracohumeral distance of 7 mm (Figures 1 and 2).

Table 3: Comparison between ultrasonography and MRI in assessment of rotator cuff pathology

Type of lesion	USG	MRI	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Complete tendon tear	10	9	100	97.6	90	100	98
Partial tendon tear	18	14	92.9	86.5	72.2	97	88
Tendinosis	4	13	30.8	100	100	80.9	82.35
Subacromial SCB fluid	23	24	95.83	100	100	96.43	98
SCB fluid	10	24	41	100	100	65.8	72.5
BTS	38	40	90	81.8	94.7	70	88
ACJ hypertrophy	5	31	13	100	100	32	39

USG: Ultrasonography, MRI: Magnetic resonance imaging, PPV: Positive predictive value, NPV: Negative predictive value, BTS: Biceps tendon sheath, SCB: Subcoracoid bursa, and ACJ: Acromioclavicular joint

A total of 10 patients were detected to have complete tendon tear on USG whereas 9 patients were confirmed to have complete tendon tear on MRI. 1 patient who was over diagnosed as complete tendon tear on USG had Grade 3 partial tendon tear of supraspinatus. Thus, USG was 100% sensitive, 97% specific, had 90% PPV, 100% NPV, and was 98% accurate in diagnosing complete tendon tear which correlated well with studies by Vijayvargiya *et al.*,¹³ Saraya and El Bakry,¹⁴ Khanduri *et al.*¹⁵ Lenza *et al.*,¹¹ and Bhatnagar *et al.*¹² (Table 3 and Figures 3; 4).

A total of 13 patients were detected as having supraspinatus tendinosis on MRI whereas only 4 patients were detected to have supraspinatus tendinosis on USG. This showed USG had 30% sensitivity, 100% specificity and 100% PPV, 80.9% NPV, and 82.35% accuracy in diagnosing tendinosis (Table 3 and Figure 5).

A total of 23 patients had fluid in SADB on USG whereas 24 were confirmed to have fluid in SADB on MRI. This showed USG had 95.83% sensitivity, 100% specificity and 100% PPV, 96.43% NPV, and 98% accuracy in detecting SADB fluid in comparison to MRI which correlated well with studies conducted by Vijayvargiya *et al.*¹³ and Shrestha and Alam⁹ (Table 3).

Out of 24 cases of fluid in SCB detected on MRI only 10 were detected on USG. Thus, USG showed 41% sensitivity, 100% specificity, 100% PPV, 65.8% NPV, and 72.5% accuracy in assessing SCB fluid (Table 3).

Out of 37 cases of ACJ hypertrophy detected on MRI, only 5 were detected on USG. Thus, USG had 13% sensitivity, 100% specificity, 100% PPV, 32% NPV, and 39% accuracy in assessing ACJ hypertrophy which correlates with study conducted by Vijayvargiya *et al.*¹³ and shows MRI is more sensitive for detection of ACJ hypertrophy (Table 3).

Out of 40 patients who were detected to have fluid in BTS on MRI, 38 patients were correctly detected to have fluid in BTS on USG. This showed USG had 90% sensitivity, 81% specificity and 94% PPV, 69% NPV, and

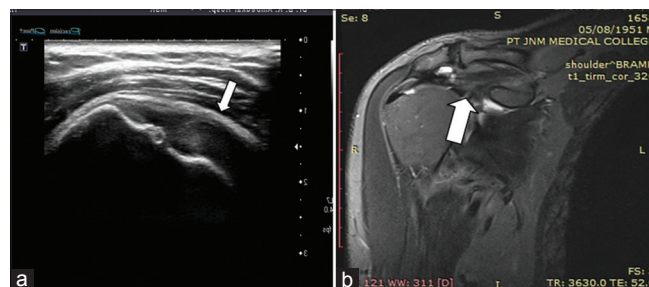


Figure 1: (a) Ultrasonography – articular surface partial tendon tear of supraspinatus tendon at 1 cm proximal to greater tuberosity, (b) magnetic resonance imaging proton density weighted coronal oblique image – Grade 1 articular surface tendon tear 1 cm proximal to greater tuberosity

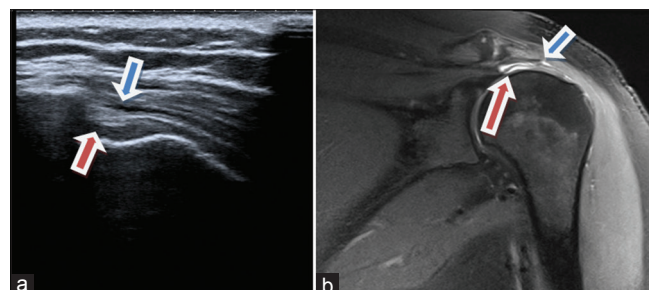


Figure 2: (a) On ultrasonography thinned out supraspinatus tendon (red arrow) with reduced acromiohumeral distance and minimal fluid in subdeltoid bursa (blue arrow), (b) magnetic resonance imaging proton density weighted coronal oblique image with fat saturation - supraspinatus tendon tear with few spared fibers and reduced acromiohumeral distance with minimal subdeltoid fluid (blue arrow)

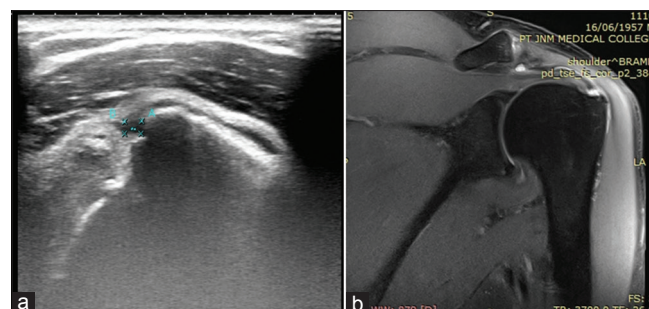


Figure 3: Complete tear of supraspinatus tendon at its attachment site with subdeltoid bursa fluid in lateral dependent region. (a) On ultrasonography and (b) on magnetic resonance imaging – proton density weighted coronal image with fat sat

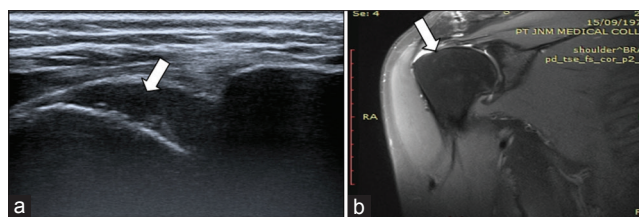


Figure 4: (a) On ultrasonography (USG) - Complete tear of supraspinatus at its attachment site is seen which is replaced by fluid (a) on USG and (b) on magnetic resonance imaging proton density weighted image with fat saturation

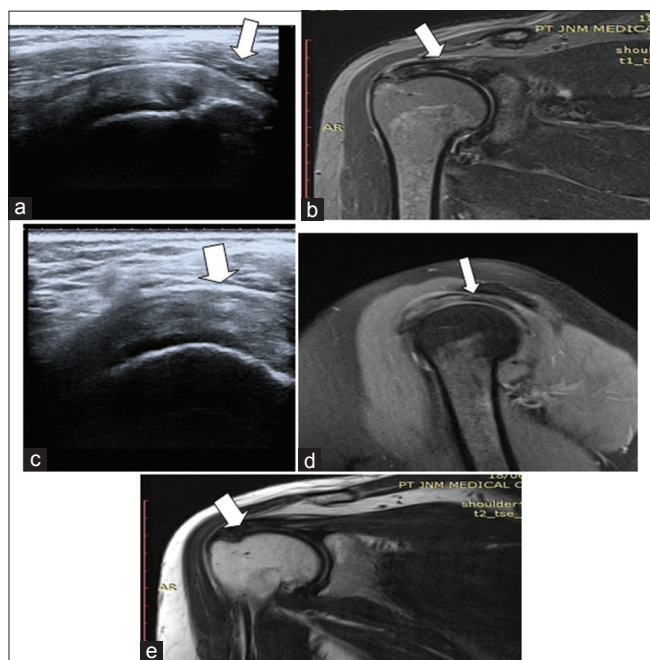


Figure 5: Supraspinatus tendon (arrow) appears thickened and heterogeneous. (a) On ultrasonography (USG) in its longitudinal view, (b) pd sequence coronal plane on magnetic resonance imaging (MRI), (c) USG in its transverse view, (d) pd sequence axial plane on MRI, and (e) T2W Sequence coronal plane on MRI. F/S/O supraspinatus tendinosis on MRI

88% accuracy in detecting bicep tendon sheath fluid. Our study showed that USG was sensitive in detecting fluid in BTS which does not correlate with studies conducted by Vijayvargiya *et al.*¹³ and Hollister *et al.*³ according to which MRI is more sensitive in detecting fluid in BTS (Table 3).

Among 42 patients having Type II acromion, 5 patients had complete tendon tear of supraspinatus, 13 patients had partial tendon tear of supraspinatus, 10 patients had supraspinatus tendinosis, and 14 were reported as normal (Table 3).

In 4 patients having Type I acromion, 1 patient had complete tendon tear of supraspinatus, 1 patient had supraspinatus tendon tear, 1 patient had partial tendon

tear of subscapularis, and 1 patient was reported as normal.

In 5 patients having Type III acromion, 2 patients had complete tendon tear of supraspinatus, 2 patients had supraspinatus tendinosis, and 1 patient had partial tendon tear of supraspinatus.

Few studies have also shown correlation between acromion tilt and rotator cuff pathology. According to Banas *et al.* it was the inferolateral acromion process which was associated with rotator cuff pathology, but in our study, 4 patients had inferolateral tilt of acromion out of which only 1 patient had complete tear, 1 patient had tendinosis, and 2 were normal, so no significance correlation was seen between lower acromion tilt and rotator cuff tear in our study.

CONCLUSION

In our study, USG proved to be highly accurate in evaluating partial tendon tear and complete tear. Thus, USG is almost equally effective as MRI for rotator cuff tears but not for other pathologies. Because of high resolution and better soft tissue assessment, MRI should be used to evaluate overall joint including labral, capsular or ligamentous pathologies before planning any surgery. Hence, USG can be used as a first line of investigating a case of shoulder joint pain to rule out rotator cuff pathologies, but MRI is the gold standard in the evaluation of rotator cuff pathologies because MRI is the most sensitive and specific modality for the establishment of shoulder pain.

Case 1: Patient came with chief complain of pain since 3 months (articular surface partial tendon tear)

Case 2: Patients came with chief complaint of pain and restriction of movement since 5 months (Grade 3 partial tear with few spared fibers of supraspinatus)

Case 3: (complete tear)

Clinical profile – patient came with chief complain of pain since 5 months with restriction of motion.

Case 4: (complete tear of supraspinatus)

The patient came with chief complaint of restriction of movements of the right shoulder with pain on overhead movements like combing.

Case 5: Patient came with chief complaint of pain since 3 months

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