

Comparative Study of Ultrasound and Magnetic Resonance Imaging in Evaluation of Non-Traumatic Shoulder Pain in Adult Patients

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ABSTRACT

Background: The 3rd most predominant source of musculoskeletal discomfort is the shoulder joint, which affects 7–26% of the general population.

Aim: This study aimed to evaluate the role of high-resolution ultrasonography in comparison to magnetic resonance imaging in adult patients presented with non-traumatic shoulder pain.

Methods: This was descriptive observational cross-sectional research done on 72 cases presented with symptoms of shoulder pain at Menoufia University Hospital.

Results: MRI findings revealed tendinosis in 69.4% of patients with biceps tendon abnormalities, primarily in the infraspinatus tendon and 56.9% in the teres minor tendon. Joint abnormalities included osteoarthritis in 44.4% of acromioclavicular joints, 50% in the glenohumeral joint/bony margins, subacromion and subdeltoid bursitis in 27.8%, and subcoracoid bursitis in 11.1%. Ultrasound findings revealed tendinosis in 65.3% of biceps tendon abnormalities, 43.1% of supraspinatus, 41.7% of subscapularis, and 11.1% of infraspinatus tendon abnormalities. Agreement between MRI and ultrasound was substantial for supraspinatus tendon and acromioclavicular joint abnormalities, moderate for infraspinatus, and fair for subscapularis and glenohumeral joint abnormalities.

Conclusion: MRI is the preferred imaging modality for non-traumatic shoulder pain due to its detailed visualization of soft tissues and bones. However, ultrasound is a cost-effective, accessible first-line tool for superficial soft tissue conditions. The choice between US and MRI should be based on clinical indications, with ultrasound ideal for routine assessments and MRI reserved for complex or suspected internal joint problems. Combining both techniques can provide a comprehensive diagnostic approach.

Keywords: Ultrasound, Magnetic resonance imaging, Traumatic shoulder pain.

INTRODUCTION

The shoulder joint is the 3rd most frequent source of musculoskeletal pain, impacting seven to twenty-six percent of the general population ⁽¹⁾. Adults exhibited an annual prevalence of 2.4 percent and an annual incidence of 1.5 percent for shoulder problems, respectively ⁽²⁾.

The predominant etiologies of shoulder pain in general care comprise rotator cuff problems, acromioclavicular joint disease, and glenohumeral joint abnormalities ^(3, 4). The optimal imaging techniques for assessing shoulder problems include magnetic resonance imaging and high-resolution ultrasonography. Each of these modalities includes distinct advantages and disadvantages. Accuracy, cost-effectiveness, availability and expertise are critical characteristics that inform the decision-making process on the optimal modality. Currently, high-resolution US demonstrates precision in distinguishing among complete and partial thickness tears, as well as in identifying osteoarthritic alterations, exhibiting strong concordance with magnetic resonance imaging ^(3, 5-7).

The advantages of shoulder high-resolution ultrasound, including low cost, extensive availability, and scanning dynamics, establish it as a preferred technique ⁽⁵⁾. This investigation aimed to assess the efficacy of high-

resolution ultrasonography vs MRI in adult cases with non-traumatic shoulder pain.

PATIENTS AND METHODS

This was a descriptive observational cross-sectional investigation performed on 72 cases presented with symptoms of shoulder pain and a limitation in shoulder movement at Menoufia University patients.

Inclusion criteria: The study included adult patients of all age groups and both sex complaining of shoulder pain.

Exclusion criteria: Those with contraindications to MRI (Metallic implants, claustrophobia and pacemakers). Cases with identified fracture/dislocation and cases who were undergoing shoulder surgery for any cause.

All patients were subjected to the following:

Full clinical examination, including history-taking with age, sex, and presenting complaints. Radiological study involved static and dynamic ultrasound (US) and conventional MRI to assess shoulder pain and movement limitations. Standard US was performed to identify the underlying cause and associated abnormalities, while dynamic US provided additional functional assessment.

Findings from both standard and dynamic US were compared with MRI results to evaluate their diagnostic accuracy and correlation.

Imaging procedures:

Ultrasonography: Ultrasound examination was performed using a high-resolution LOGIC (GE Healthcare, USA) S8/SIEMENS ACUSON REDWOOD (Siemens Healthineers, Germany) unit with 11.0 MHz linear probe, gain set at 63, and tissue depth of 3.8 cm. No specific patient preparation was required, but room temperature was optimized and the case was seated in a backless chair. A systematic scanning approach was used after applying sterile coupling gel. The long head of the biceps tendon was evaluated with the forearm in slight internal rotation and elbow flexed at ninety degrees, scanning along its intra-articular course.

The subscapularis tendon was examined with the elbow resting on the iliac crest and passive internal-external rotation. The supraspinatus tendon has been evaluated with the hand placed on the opposite back pocket, using transverse and longitudinal scanning. The infraspinatus tendon was visualized by placing the hand on the opposite shoulder, with the probe positioned posteriorly over the glenohumeral joint.

The acromioclavicular joint was examined in resting adduction, assessing joint space and irregularities, with dynamic imaging performed by moving the elbow across the chest. Dynamic ultrasound for subacromial impingement was conducted with the patient in resting adduction, evaluating supraspinatus tendon and subacromial-subdeltoid bursa movement during shoulder abduction. Imaging analysis involved both static and dynamic evaluations. Parameters assessed included tendon echotexture, thickness, continuity, bursal distension, cortical irregularities, and dynamic impingement signs.

Magnetic resonance imaging: MRI examination was performed using the PHILIPS MR Systems Achieva (Philips Healthcare, Netherlands) with the case in a supine position, head toward the scanner bore. The arm was positioned neutrally or in slight external rotation using a surface coil around the examined shoulder. Imaging was conducted in multiple planes with various pulse sequences, including coronal T1, T2, PD, and STIR-weighted images (WIs), axial T1 and gradient WIs, and sagittal T2 WIs, ensuring comprehensive assessment of shoulder structures.

MRI analysis focused on evaluating rotator cuff tendons, glenohumeral joint structures, acromioclavicular joint alignment, subacromial-subdeltoid bursa, and labral integrity. Structural integrity, signal intensity, tendon retraction, and fluid-sensitive sequence changes were all assessed.

Ethical approval: The research was permitted through The Ethics Committee of Radiodiagnosis, Interventional Radiology and Medical Imaging Department, Faculty of Medicine, Menoufia University, Egypt. All participants gave written informed consents before enrolment. The research adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

Pre-coded data were entered into the computer utilizing the Statistical Package for the Social Sciences software application, version twenty-three (SPSS). Data have been summarized utilizing the mean and standard deviation for quantitative variables, and frequency and percentage for qualitative factors. **The Chi-square** test was utilized to compare qualitative variables. The Fisher exact test has been utilized when one or more anticipated cell counts were below five. **Validation measures** of screening tests **utilized** to evaluate the efficacy of ultrasound in comparison to magnetic resonance imaging, the gold standard. **The P-value has been evaluated as follows:** Non-significant when $P > 0.05$, significant when $P \leq 0.05$, and highly significant when $P \leq 0.01$.

RESULTS

Table (1) presented that there was different pathology in MRI finding for the same patient, which is why the numbers appear to be large, according to this table Tendinosis in teres minor muscle-tendon abnormalities, osteoarthritis in acromioclavicular joint abnormalities and osteoarthritis in glenohumeral joint/bony margins abnormalities were the most significant MRI finding in our patients. US findings showed different pathology for the same patient, which is why the numbers appear to be large, according to this table. Tendinosis in infraspinatus tendon abnormalities, osteoarthritis in acromioclavicular joint abnormalities and osteoarthritis in glenohumeral joint/bony margins abnormalities were the most significant US finding in our patients.

Table (1): Comparison between MRI and US finding

	MRI findings (N=72)	US finding (N=72)
Biceps tendon abnormalities		
Tendinosis	50 (69.4%)	47 (65.3%)
Full-thickness tear	12 (16.7%)	14 (19.4%)
Supraspinatus tendon abnormalities		
Tendinosis	32 (44.4%)	31 (43.1%)
Partial thickness tear	10 (13.9%)	9 (12.5%)
Full thickness tear	19 (26.4%)	19 (26.4%)
Subscapularis tendon abnormalities		
Tendinosis	29 (40.3%)	30 (41.7%)
Partial thickness tear	22 (30.6%)	20 (27.8%)
Full thickness tear	12 (16.7%)	8 (11.1%)
Infraspinatus tendon abnormalities		
Tendinosis	55 (76.4%)	50 (69.4%)
Partial thickness tear	7 (9.7%)	7 (9.7%)
Teres minor muscle-tendon abnormalities		
Tendinosis	41 (56.9%)	0 (0%)
Atrophy	20 (27.8%)	1 (1.38%)
Acromioclavicular joint abnormalities		
Osteoarthritis	32 (44.4%)	32 (44.4%)
Sub acromion and sub deltoid bursitis	20 (27.8%)	18 (25%)
Sub coracoid bursitis	8 (11.1%)	8 (11.1%)
Glenohumeral joint/bony margins abnormalities		
Osteoarthritis	36 (50%)	31 (43.1%)
Sub acromion and sub deltoid bursitis	25 (34.7%)	24 (33.3%)

Agreement of supraspinatus tendon abnormalities between MRI and US: There was substantial agreement amongst US and MRI in detection of supraspinatus tendon abnormalities with sensitivity of 93.4% and specificity of 90.9% (Table 2).

Table (2): Cross-tabulation for agreement of supraspinatus tendon abnormalities between MRI and US

US supraspinatus tendon abnormalities	MRI supraspinatus tendon abnormalities				Total	Kappa	P value
	No	Tendinosis	Partial-thickness tear	Full-thickness tear			
No	9	1	2	1	13	0.7	<0.001
Tendinosis	0	31	0	0	31		
Partial-thickness tear	1	0	8	0	9		
Full-thickness tear	1	0	0	18	19		
Total	11	32	10	19	72		
Sensitivity	93.4%						
Specificity	90.9%						

Agreement of subscapularis tendon abnormalities between MRI and US: There was fair agreement among US and MRI in detection of subscapularis tendon abnormalities with sensitivity 82.5% and specificity of 66.7%. There was moderate agreement among US and MRI in recognition of infraspinatus tendon abnormalities with sensitivity of 80.6% and specificity of 70% (Table 3).

Table (3): Cross-tabulation for agreement of subscapularis tendon abnormalities between MRI and US

US subscapularis tendon abnormalities	MRI subscapularis tendon abnormalities				Total	Kappa	P value
	No	Tendinosis	Partial-thickness tear	Full-thickness tear			
No	6	2	3	3	14	0.356	0.005
Tendinosis	1	27	1	1	30		
Partial-thickness tear	1	0	18	1	20		
Full-thickness tear	1	0	0	7	8		
Total	9	29	22	12	72		
Sensitivity	82.5%						
Specificity	66.7 %						

Agreement of infraspinatus tendon abnormalities between MRI and US: There was moderate agreement among US and MRI in detection of infraspinatus tendon abnormalities with sensitivity of 80.6% and specificity of 70% (Table 4).

Table (4): Cross-tabulation for agreement of infraspinatus tendon abnormalities between MRI and US

US infraspinatus tendon abnormalities	MRI infraspinatus tendon abnormalities			Total	Kappa	P value
	No	Tendinosis	Partial-thickness tear			
No	7	5	3	15	0.571	<0.001
Tendinosis	2	47	1	50		
Partial-thickness tear	1	3	3	7		
Total	10	55	7	72		
Sensitivity	80.6%					
Specificity	70%					

Agreement of acromioclavicular joint abnormalities between MRI and US: There was substantial agreement among US and MRI and high significance in detection of Acromioclavicular joint abnormalities with sensitivity of 93.3% and specificity of 91.6% (Table 5).

Table (5): Cross-tabulation for agreement of acromioclavicular joint abnormalities between MRI and US

US Acromioclavicular joint abnormalities	MRI Acromioclavicular joint abnormalities				Total	Kappa	p value
	No	Osteoarthritis	Sub acromion and sub deltoid bursitis	Sub coracoid bursitis			
No	11	2	1	0	14	0.773	0.001
Osteoarthritis	1	30	1	0	32		
Sub acromion and sub deltoid bursitis	0	0	18	0	18		
Sub coracoid bursitis	0	0	0	8	8		
Total	12	32	20	8	72		
Sensitivity	93.3%						
Specificity	91.6%						

Agreement of glenohumeral joint/bony margins abnormalities between MRI and US: There was fair agreement between US and MRI and significance in detection of glenohumeral joint/bony margins abnormalities with sensitivity of 78.7% and specificity of 72.7% (Table 6).

Table (6): Cross-tabulation for agreement of glenohumeral joint/bony margins anomalies between MRI and US

US Glenohumeral joint/bony margins abnormalities	MRI Glenohumeral joint/bony margins abnormalities			Total	Kappa	p value
	No	Osteoarthritis	Sub acromion and sub deltoid bursitis			
No	8	5	4	17	0.375	0.002
Osteoarthritis	2	28	1	31		
Sub acromion and sub deltoid bursitis	1	3	20	24		
Total	11	36	25	72		
Sensitivity	78.7%					
Specificity	72.7%					

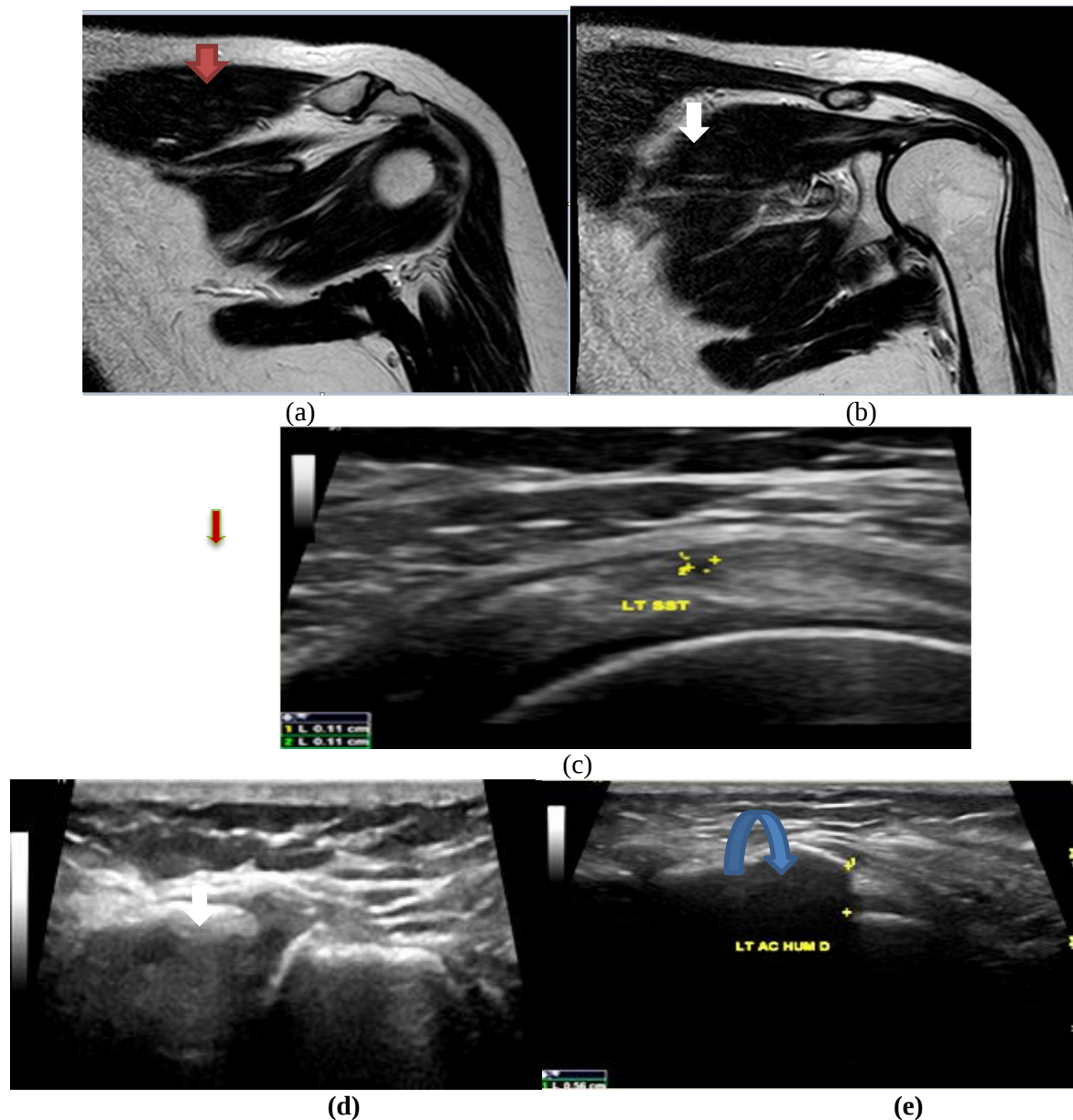


Figure (1): (a, b) MRI coronal T2 images showed ACJ osteoarthritic changes (red arrow) & left Supraspinatus tendon intrasubstance high signals denoting intrasubstance partial thickness tear (white arrow). (c) US image showed left supraspinatus tendon is seen thickened with a heterogenous echo pattern with a bursal surface hypoechoic focus measuring about 1x1 mm denoting partial thickness tear on top of tendinopathy (red arrow). (e) US image showed ACJ osteoarthritic changes. (white arrow). (d) dynamic US image showed evidence of sub-acromial tunnel narrowing to 5.6 mm denoting sub-acromial impingement. (curved arrow).

DISCUSSION

The prognosis for cases exhibiting musculoskeletal shoulder pain differs significantly among cases, with approximately fifty percent continuing to report problems six months following their initial presentation in primary care. Shoulder pain can be related to conditions affecting the rotator cuff, acromioclavicular joint, glenohumeral joint, cervical spine, or adjacent soft tissues. Rotator cuff issues constitute around two-thirds of shoulder pain cases ⁽⁹⁾.

The current study demonstrated that the included 72 patients aged from 18 to 70 years with mean age of 44.3 ± 11 years. 48.6% of the study group were males and 51.4% were females. Regarding the pain side, a majority of patients (56.9%) reported pain on the right side, while 43.1% experienced pain on the left side. Our study is aligning with **Reddy et al.** ⁽⁹⁾ who presented A comparative study of US and MRI in diagnosing shoulder diseases, which indicated that the mean age of cases was 54.62 ± 9.45 years, with thirty-six males (56.25%) and 28 females (43.75%). Additionally, thirty-eight cases (59.37 percent) have been affected on the right side, whereas twenty-two cases (40.63%) were affected on the left side. **Kurnal et al.** ⁽¹⁰⁾ conducted a comparative study of US and MRI in diagnosing shoulder problems. They revealed a mean case age of 53.80 ± 11.49 years, with thirty-one cases (57.40%) being males and 23 cases (42.60%) were females, 32 cases (59%) have been affected on the right and 22 cases (41%) were affected on the left side.

Among the bicep's tendons, tendinosis was observed in 69.4% of patients (50 out of 72), while 16.7% (12 patients) had a full-thickness tear. The supraspinatus tendon abnormalities showed tendinosis in 44.4% (32 cases), a partial thickness tear in 13.9% (10 patients), and a full-thickness tear in 26.4% (19 patients). For the subscapularis tendon, tendinosis was seen in 40.3% (29 patients), while 30.6% (22 cases) had a partial thickness tear, and 16.7% (12 cases) presented with a full-thickness tear. Tendinosis in the infraspinatus tendon was the most prevalent, affecting 76.4% (55 patients), with 9.7% (7 patients) showing a partial thickness tear. The teres minor muscle-tendon abnormalities were characterized by tendinosis in 56.9% (41 patients) and atrophy in 27.8% (20 patients). Regarding joint abnormalities, osteoarthritis was found in 44.4% (32 patients) of the acromioclavicular joints, with subacromion and subdeltoid bursitis affecting 27.8% (20 patients) and subcoracoid bursitis observed in 11.1% (8 patients). Osteoarthritis in the glenohumeral joint or bony margins was present in 50% (36 patients), and subacromion and subdeltoid bursitis was noted in 34.7% (25 patients). The present research agrees with **Shrestha et al.** ⁽¹¹⁾ who concluded that high resolution US being a dynamic investigation could be utilized as the 1st-

line assessment for rotator cuff tear and full-thickness rotator cuff tears could be recognized utilizing US and MRI with similar accuracy, as they reported that 9 patients (18%) had partial thickness tear of supraspinatus, 5 patients (10%) calcific supraspinatus tendinitis, 14 patients (28%) had full thickness tear at supraspinatus and Subscapularis as regards MRI findings.

Regarding biceps tendon abnormalities, tendinosis was observed in 65.3% of patients (47 out of 72), while 19.4% (14 patients) had a full-thickness tear. For the supraspinatus tendon, tendinosis occurred in 43.1% (31 patients), a partial thickness tear in 12.5% (9 patients), and a full-thickness tear in 26.4% (19 cases). Subscapularis tendon abnormalities included tendinosis in 41.7% (30 patients), a partial thickness tear in 27.8% (20 patients), and a full-thickness tear in 11.1% (8 patients). Tendinosis in the infraspinatus tendon was the most common, affecting 69.4% (50 patients), with 9.7% (7 patients) presenting with a partial thickness tear. For the teres minor muscle-tendon abnormalities, tendinosis was absent, with only 1.38% (1 patient) showing atrophy. Joint abnormalities included osteoarthritis in the acromioclavicular joint in 44.4% (32 patients), subacromion and subdeltoid bursitis in 25% (18 patients) and subcoracoid bursitis in 11.1% (8 patients). In the glenohumeral joint, osteoarthritis was observed in 43.1% (31 patients), and subacromion and subdeltoid bursitis was noted in 33.3% (24 patients). As well, the current findings are supported by **Shrestha et al.** ⁽¹¹⁾ whose investigation has been performed to compare the outcomes collected following the assessment of rotator cuff injuries of shoulder joint by high resolution Ultrasonography and Magnetic Resonance Imaging, as they demonstrated that 7 patients (14%) had partial thickness tear of supraspinatus, 4 patients (8%) calcific supraspinatus tendinitis, 8 patients (16%) had full thickness tear at supraspinatus and Subscapularis as regards US findings. Our findings showed that there was substantial agreement between US and MRI and highly significance in detection of Biceps tendon abnormalities with sensitivity of 90.3% and specificity of 80%. The current investigation demonstrated that there was fair agreement among US and MRI in detection of subscapularis tendon abnormalities with sensitivity 82.5% and specificity of 66.7%. This is in agreement with **Reddy et al.** ⁽⁹⁾ who concluded that MRI was suggested as a 2^{ry} technique since it provided more information about the extent of tendons and has a lower artifact possibility as they revealed that there was agreement between USG and MRI in diagnosing subscapularis tendon abnormalities with sensitivity 52.00% and specificity of 92.00% as MRI had a higher sensitivity and might detect more cases, while USG was more effective in correctly ruling out normal cases.

The current study showed that there was moderate contract among ultrasound and magnetic resonance imaging in detection of infraspinatus tendon abnormalities with sensitivity of 80.6% and specificity of 70%. The current findings agree with **Elshenawy *et al.***⁽¹²⁾ who concluded magnetic resonance imaging is superior to ultrasound in assessing the exact position and amount of rotator cuff muscle tears, as well as in evaluating bony and labral lesions, demonstrating a strong concordance among magnetic resonance imaging outcomes in detection of infraspinatus tendon abnormalities with sensitivity of 95.45% and specificity of 75, 0%.

The current study found out that there was substantial agreement among US and MRI and high significance in detection of acromioclavicular joint abnormalities with sensitivity of 93.3% and specificity of 91.6%. Also, there was fair consistence among US and MRI and significance in detection of glenohumeral joint/bony margins abnormalities with sensitivity of 78.7% and specificity of 72.7%. The current investigation disagrees with **Kurnal *et al.***⁽¹⁰⁾ as they found out that subacromial-subdeltoid bursitis had sensitivity of (31.70%) and specificity of (84.60%) and subcoracoid bursitis had no sensitivity but specificity of (92.00%), which showed poor agreement among magnetic resonance imaging and ultrasound in detection of acromioclavicular joint abnormalities and glenohumeral joint/bony margins abnormalities as there was no significant difference. In contrast, **Narra *et al.***⁽¹³⁾ whose study was conducted on fifty cases presenting with shoulder joint pain and suspected rotator cuff diseases underwent US evaluation, then followed by magnetic resonance imaging, with data compared and analyzed for significance. The sensitivity and specificity values for subacromial and subdeltoid bursitis were twenty-five percent and 86.36 percent respectively, indicating moderate agreement among magnetic resonance imaging in identification of Acromioclavicular joint abnormalities and glenohumeral joint/bony margins abnormalities as there was no significant difference.

CONCLUSION

MRI is the preferred imaging modality for non-traumatic pain of shoulder due to its detailed visualization of soft tissues and bones. However, ultrasound is a cost-effective, accessible first-line tool for superficial soft tissue conditions. The choice between US and MRI should be based on clinical indications, with ultrasound ideal for routine assessments and MRI reserved for complex or suspected internal joint problems. Combining both techniques can provide a comprehensive diagnostic approach.

DECLARATIONS

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Competing interests: None.

REFERENCES

1. **Tekavec E, Joud A, Rittner R *et al.* (2012):** Population-based consultation patterns in patients with shoulder pain diagnoses. *BMC Musculoskelet Disord.*, 13: 238. doi: 10.1186/1471-2474-13-238.
2. **Borchgrevink P, Glette M, Woodhouse A *et al.* (2022):** A Clinical Description of Chronic Pain in a General Population Using ICD-10 and ICD-11 (The HUNT Pain Examination Study). *The journal of pain*, 23 (2): 337–348.
3. **Mitchell C, Adebajo A, Hay E, Carr A (2005):** Shoulder pain: diagnosis and management in primary care. *BMJ (Clinical research ed.)*, 331 (7525): 1124–1128.
4. **Dinnes J, Loveman E, McIntyre L, Waugh N (2003):** The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health technology assessment (Winchester, England)*, 7 (29): iii–166. <https://doi.org/10.3310/hta7290>
5. **Bongers P (2001):** The cost of shoulder pain at work. *BMJ (Clinical research ed.)*, 322 (7278): 64–65. <https://doi.org/10.1136/bmj.322.7278.64>
6. **Macfarlane G, Hunt I, Silman A (1998):** Predictors of chronic shoulder pain: a population based prospective study. *The Journal of rheumatology*, 25 (8): 1612–1615.
7. **Essam M, Ahmed M, Saleh A (2022):** Role and Correlation of High Resolution Ultrasound and Magnetic Resonance Imaging in Evaluation of Shoulder Pain in the Elderly. *The Medical Journal of Cairo University*, 90 (6): 1119-1126.
8. **Lucas J, van Doorn P, Hegedus E *et al.* (2022):** A systematic review of the global prevalence and incidence of shoulder pain. *BMC musculoskeletal disorders*, 23 (1): 1073. <https://doi.org/10.1186/s12891-022-05973-8>
9. **Reddy O, Raju R, Jyothi T (2024):** Comparative study of ultrasonography with magnetic resonance imaging in the diagnosis of shoulder ailments. *Int J Acad Med Pharm.*, 6 (2): 836-840. DOI: 10.1097/00124743-199908000-00002
10. **Kurnal K, Paladugu P (2023):** Comparative evaluation of ultrasonography with magnetic resonance imaging in the diagnosis of shoulder ailments. *Asian Journal of Medical Sciences*, 14 (5): 186-191. DOI: 10.3126/ajms.v14i5.51590
11. **Shrestha M, Alam A (2011):** A comparative evaluation of rotator cuff injuries of the shoulder joint using high resolution ultrasound and magnetic resonance imaging. *Medical Journal of Shree Birendra Hospital*, 10 (1): 9-14.
12. **Elshenawy E, Nassar I, Elkhoully R, Dabees N (2021):** MRI and ultrasonography in the evaluation of causes of shoulder pain. *Tanta Medical Journal*, 49 (4): 268-273. DOI: 10.1155/2022/1315446
13. **Narra R, Jehendren V, Bollipo J, Putcha A (2017):** Sonographic evaluation of shoulder joint pain with MRI correlation. *J Evol Med Dent Sci.*, 6: 3007-14. DOI: 10.14260/Jemds/2017/649.