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Comparative evaluation of ultrasonography with magnetic resonance imaging in the diagnosis of shoulder ailments

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ABSTRACT

Background: Shoulder pain encompasses a diverse array of pathologies and can affect as many as one quarter of the population depending on age and risk factors. It may be caused by problems with the neck, glenohumeral joint, acromioclavicular joint, rotator cuff, or other soft tissues around the shoulder. **Aims and Objectives:** The main aim of the study is to compare the diagnostic accuracy of ultrasound (US) shoulder and magnetic resonance imaging (MRI) of the shoulder in the diagnosis of shoulder ailments. **Materials and Methods:** This is a comparative study done in Department of Radiology, Aarupadai Veedu Medical College and Hospital, Pondicherry. In total, 54 patients were included for ultrasonography (USG) and MRI examination of shoulder ailments. The statistical analysis was done using Statistical Package for the Social Sciences Version 21.0 statistical analysis software. **Results:** Subacromial-Subdeltoid Bursitis is the most common finding. US detects partial-thickness tears with a sensitivity of 63.3% and a specificity of 70.8% and full-thickness tears with a sensitivity of 80.0% and a specificity of 91.8%. Trauma was the etiology in only a few patients. MRI is more sensitive than USG in identifying labral and capsular pathologies. MRI is the most sensitive and specific modality for the establishment of shoulder pain. MRI is useful in cases in which the diagnosis is uncertain on USG. **Conclusion:** MRI is recommended as a secondary method since it provides more information about the extent of tendons and has a lower artifact risk.

Key words: Shoulder ailments; Magnetic resonance imaging; Ultrasonography

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INTRODUCTION

Shoulder pain encompasses a diverse array of pathologies and can affect as many as one-quarter of the population depending on age and risk factors.[1] It may be caused by problems with the neck, glenohumeral joint, acromioclavicular joint, rotator cuff, or other soft tissues around the shoulder. Approximately two-thirds of shoulder pain cases are caused by problems with the rotator cuff.[2,3] There are several causes of rotator cuff disorders, including musculoskeletal problems in the shoulder joints and muscles, degeneration of the cuff due to aging and ischemia, and overloading the shoulder.[4,5] A person with compromised shoulder movement due to pain, stiffness, or weakness may experience substantial disability and be unable to perform daily activities (eating, dressing, and personal hygiene). Approximately 1% of adults consult a general practitioner with new shoulder pain each year due to self-reported shoulder pain, which is the third most common cause of musculoskeletal consultation in primary care.[6] There is a higher risk of shoulder disorders in occupations as diverse as construction work and hairdressing. Several physical factors can contribute to symptoms and disability, such as lifting heavy loads, repetitive movements in awkward positions, and vibrations. Psychosocial factors can also contribute. Chronicity and recurrence are common, according to recent studies.[7] To differentiate between these conditions, magnetic resonance imaging (MRI) and shoulder arthroscopy have been the most commonly used imaging modalities. It is possible to obtain a variety of imaging tests,

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including plain radiographs and MRI using intraarticular contrast and phased array coils. Due to the development of advanced ultrasound (US) capabilities, musculoskeletal ultrasonography (USG) is now considered a primary diagnostic imaging test.[8,9] It is important to note that every modality has its strengths and weaknesses in evaluating shoulder pathology. Radiologists and surgeons agree that US and MRI are useful for shoulder arthroscopy, but the role of these technologies is still evolving. An understanding of shoulder pathology requires an understanding of the unique anatomy of the shoulder joint.[10] In pre-operative planning, the ability to visualize images in axial, sagittal, and coronal planes can be helpful.[11] When performing and interpreting shoulder imaging, it is essential to use equipment with high-resolution transducers, adhere to a strict examination protocol, understand normal anatomy and pathological processes, and be aware of common pitfalls.[12]

This study was undertaken to compare the diagnostic accuracy of US shoulder with MRI as the gold standard in the diagnosis of shoulder ailments.

Aims and objectives

The main aim of the study is to compare the diagnostic accuracy of ultrasound (US) shoulder and magnetic resonance imaging (MRI) of the shoulder in the diagnosis of shoulder ailments.

MATERIALS AND METHODS

Study design

Ours is a comparative study.

Study population

Data for the study were collected from the patients who present to OPDs with a history of shoulder pain and were referred to the Department of Diagnostic Radiology at Aarupadai Veedu Medical College and Hospital, over 2 years.

Period of study

The period of the study was October 2020–October 2022.

Place of study

The study was conducted by Department of Radiology, AarupadaiVeedu Medical College and Hospital, Puducherry.

Inclusion criteria for cases

The following criteria were included in the study:

1. History of shoulder pain
2. History of restricted movement of the shoulder
3. Clinically suspected to have internal derangements like rotator cuff injury, biceps tendon injury, and calcific tendinitis
4. Either gender
5. Age group between 18 and 80 years.

Exclusion criteria

The following criteria were excluded from the study:

1. Previous history of a prosthesis
2. Patients with any electrically, magnetically, or mechanically activated implants (pacemaker, bio stimulators, neurostimulators, and cochlear implants)
3. Patients having claustrophobia
4. Patients who are unwilling to imaging
5. Subjects are unable to cooperate due to pain
6. Patients were not willing to give written informed consent.

Study procedure

Patient selection

The patients were included in the study irrespective of sex and socioeconomic status using the inclusion criteria. We will exclude the patients who have a history of claustrophobia and Patients with metallic prosthetic implants from our study. Patients with previous surgical histories were also excluded from the study. A detailed clinical history was taken followed by USG and MRI evaluation. Each patient was first taken up for USG followed by MRI evaluation thus making the radiologist blind to MRI results. Both USG and MRI were conducted by the same senior radiologist with 8 years of experience in musculoskeletal radiology.

US examination of the shoulder

The examination of the affected shoulder was carried out by Mindray DC-70 high-frequency linear transducer with a frequency range of 3.5–16 MHz. The patient was in a seated position on a revolving chair. Both shoulders are exposed for comparison in both axial and sagittal planes.

Following structures are routinely evaluated

1. Biceps tendon
2. Subscapularis
3. Supraspinatus
4. Infraspinatus
5. Posterosuperior labrum, spinoglenoid notch
6. Fluid collection in glenohumeral joint,
7. Acromioclavicular joint
8. Dynamic maneuvers for biceps tendon to rule out subluxation/dislocation; subscapularis for subcoracoid impingement; supraspinatus for subacromial impingement.

MRI of the affected shoulder

A plain MRI was performed using a 1.5T Philips Achieva machine with a shoulder coil. The patient is placed in a supine position and asked to hold the shoulder in a neutral position. A sponge was placed at the elbow and another

one supporting the hand and the arm will be strapped in place to prevent movement.

Statistical analysis

The statistical analysis was done using Statistical Package for the Social Sciences Version 21.0 statistical analysis software.

RESULTS

Fifty-four patients with a history of shoulder pain were evaluated using USG and then by MRI. Thirty-two patients (59%) were affected on the right and 22 patients were affected on the left side. The parameters are shown in Table 1.

In our study, the age incidence ranged from 18 years to 80 years. The mean age of patients was 53.80±11.49 years. Most patients were between 40 and 80 years of age. Maximum patients were between 40 and 49 years (68.52 %), followed by 50–59 years (22.22%) and >60 years (9.26%). The analysis revealed that the number of male patients was comparatively higher than the number of female patients. In the total 54 patients, the gender difference was recorded at around 14% with males at 57.40% (31 patients) and females at 42.60% (23 patients).

The data about the duration of symptoms were analyzed. The evaluation showed that around 50% (27 patients) of the patients suffered from the symptoms for up to 1 month and 42.6% (23 patients) of the patients were found to suffer from the symptoms for 1–6 months. Around 7.4% (4 patients) of the patients were suffering from the symptoms for 6 months–12 months.

Correlation of USG findings with MRI findings

In the subscapularis evaluation comparison, the sensitivity was only 50% with a specificity of 94%. The positive predictive value (PPV) was recorded as 40% and negative prediction value (NPV) was recorded as 95.9% with an accuracy of 91%. The P-value obtained was 0.003 which confirms the significance of the correlation. Contrastingly, in supraspinatus evaluation, sensitivity was higher (84.8%) compared to specificity (50%) and PPV was higher (90.7%) compared to NPV (36.4%) with an accuracy rate of 80%. The P-value was recorded as 0.024 which depicts the significance of correlation. No correlation data was obtained for another tendon (Infraspinatus, Teres Minor, and Biceps tendon) findings. In the case of Bursal PBT (Biceps tendon) data correlation, sensitivity was recorded as 46.5% with a specificity range of 81.8%. The PPV was recorded as 90.9% and the NPV was recorded as 28.1% with an accuracy range of 54%. The P-value was found as 0.088 which is <0.05 confirming the significance of the correlation. Similarly, the Subacromial Subdeltiod Bursitis data correlation also showed 31.7% sensitivity with 84.6% specificity. The PPV was also recorded as 86.7% and the NPV value was noted as 28.2% with an accuracy of 44%. The P-value obtained was >0.05 which shows that the correlation was not statistically significant. In the case of Bursal SCA (Subcoracoid Bursitis), no sensitivity was observed but the specificity was noted as 92%. Similarly, no PPV value was observed whereas, the NPV value was obtained as 44.2% with an accuracy range of 43%. P=0.013 which is >0.05 confirms the insignificance of the correlation. The correlation of USG findings with MRI findings was shown in Table 2.

Table 1: Demographic parameters

Parameters	
Age (range)	53.820±11.49 (18–75)
Age distribution (%)	
40–49 years	37 (68.52)
50–59 years	12 (22.22)
>60 years	5 (9.26)
Sex distribution (%)	
Male	31 (57.40)
Female	23 (42.60)
Duration of symptoms (%)	
<1 month	27 (50)
1–6 months	23 (42.6)
6–12 months	4 (7.4)

Table 3 was showing the Correlation of USG findings with MRI findings regarding thickness. The correlation results showed that the partial thickness data have a sensitivity of 63.3% with a specificity of 70.8%. The PPV value obtained was 73.1% and the NPV value was noted as 60.7% with an accuracy of 67%. The P-value obtained was <0.05 confirming the significance of the correlation. A similar trend was observed in full-thickness data correlation. The sensitivity was observed as 80% with a specificity range of 91.8%. The PPV value was a little lower (50%) when compared to the NPV value (97.8%) but the accuracy range was recorded as 91%. P=0.0001 which is <0.05 confirms the significance of the correlation.

USG showing a partial thickness tear on the bursal aspect. USG of supraspinatus tendon showing tendinopathy (Figure 1). Secondary signs of full-thickness rotator cuff tears include fluid in the SASD bursa and muscle atrophy (Figures 2 and 3) shows MRI images in coronal (a and b), axial (c), and sagittal (d) planes showing full thickness tear of the supraspinatus.

DISCUSSION

When a patient is experiencing shoulder pain, a variety of methods are used to evaluate their pathologies, such

Table 2: Correlation of USG findings with MRI findings

Findings	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	P-value
Subscapularis	50.00	94.00	40.00	95.90	91.00	0.003
Supraspinatus	84.80	50.00	90.70	36.40	80.00	0.024
Infraspinatus	0	0	0	0	0	NA
Teres Minor	0	0	0	0	0	NA
BicepsTendon	0	0	0	0	0	NA
Bursal PBT	46.50	81.80	90.90	28.10	54.00	0.088
Bursal SA-SD	31.70	84.60	86.70	28.20	44	0.252
Bursal SCA	0.0	92.00	0.0	44.20	43	0.121

PPV: Positive predictive values, NPV: Negative prediction value

Table 3: Correlation of USG findings with MRI findings regarding thickness

Findings	Sensitivity	Specificity	PPV	NPV	Accuracy	P-value
Partial thickness	63.3	70.8	73.1	60.7	67.0	0.013
Full thickness	80.0	91.8	50.0	97.8	91.0	0.0001

PPV: Positive predictive values, NPV: Negative prediction value

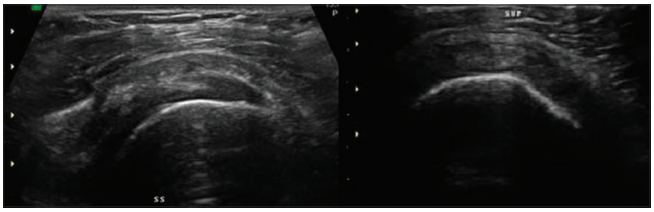

Figure 1: USG of supraspinatus (SS) tendon showing signs of partial thickness tear in the bursal aspect. USG of supraspinatus tendon showing tendinopathy

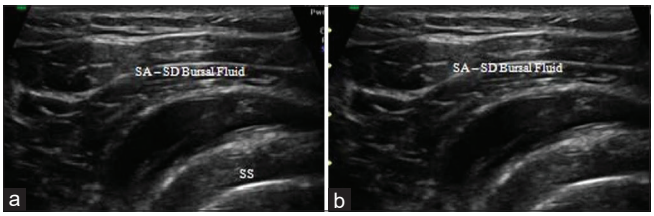

Figure 2: (a and b) USG showing SA-SD bursal fluid

Figure 3: MRI images in coronal (a and b), axial (c), and sagittal (d), show a full-thickness tear of the supraspinatus

as clinical examination, X-rays, arthrography, USG, CT, and MRI. In terms of accuracy, MRI is one of the most accurate methods. The limited availability cost associated with MRI machines means that they cannot be used as the first line of investigation to find out if a condition exists. USG, on the other hand, is a method that can be used cheaply and non-invasively to diagnose a variety of pathological conditions.[13]

An investigation was conducted on 54 patients who were suffering from shoulder pain.[14] First, we performed a comprehensive clinical examination and history to get a good understanding of each of the shoulder's problems, followed by an examination by USG to compare the affected shoulder to the opposite shoulder. The results of the MRI were corroborated by the results of a CT scan.[15] As a result of decreasing prevalence estimates in the general population over the age of 60–65 and continuing growth of rotator cuff pathology, the shoulder pain prevalence estimates effectively decline in the general population over the age of 60–65.[16]

In this age bracket, researchers hypothesized that this might be related to people retiring, changing occupations, or not exposing themselves to as many shoulder-demanding activities as in the younger age bracket.

USG criteria for partial thickness tears were focal discontinuities of the tendon either at the Bursal or Articular surface. The absence of a complete tendon is the USG criteria for identifying full-thickness tears. Associated features can be in the form of free fluid in the Subacromial Subdeltoid Bursa and fluid tracking through the AC joint to the subcutaneous location (Geyser phenomenon). The USG revealed tendinosis as thickening (more than 6 mm

craniocaudal dimension) of the tendon and heterogeneous echotexture.[17]

In MRI, partial thickness tears were detected by focal fiber discontinuities that are filled with fluid in acute tears, a subtle increased signal at the site of tear on fluid sensitive sequences. A focal tendon defect was also observed, along with surface fraying or changes in the caliber of the tendon. In MRI, tendon discontinuity is characterized by full-thickness tears associated with tendon retraction and atrophy of residual muscle. Another indirect indicator of a full-thickness tear is fluid in the subacromial-subdeltoid bursa.[18,19]

The correlation data between USG findings and MRI findings showed that the partial thickness data have a sensitivity of 63.3% with a specificity of 70.8%. The PPV value obtained was 73.1% and the NPV value was noted as 60.7% with an accuracy of 67%. The P-value obtained was <0.05 confirming the significance of the correlation. A similar trend was observed in full-thickness data correlation. The sensitivity was observed as 80% with a specificity range of 91.8%. The PPV value was a little lower (50%) when compared to the NPV value (97.8%) but the accuracy range was recorded as 91%. P=0.0001 which is <0.05 confirms the significance of the correlation. Rotator cuffs reflect the US beam maximally when they are insonated 90° to the long axis of the tendon fibers.[20] Consequently, the transducer will detect fewer reflected sound waves as the angle deviates. Tendons become isoechoic to the muscle between 2° and 7° and hypoechoic at greater angles. Because of their curved course, tendon insertions are most susceptible to anisotropic artifacts. In the absence of this artifact, less experienced radiologists may mistake this for tendinosis or partial thickness rotator cuff tears. Anatomical abnormalities of the humeral head, such as fractures, distort the rotator cuff anatomy. For evaluation of Denervation injuries, USG cannot be used as a first-line modality. For radiologists, USG has a high learning curve and a high inter-observer variation.[21,22]

Limitations of the study

The shoulder pain can be diagnosed most accurately and precisely with MRI.

CONCLUSION

Pathology accounting for shoulder pain can be diagnosed most accurately and precisely with MRI. When USG is inconclusive, MRI can help. Rotator cuff injuries can be evaluated by experienced radiologists with USG as a first-line imaging modality with results comparable to MRI. It is possible to screen all painful shoulder joints with a well-performed USG regardless of the operator's dependence, as it is a fast and inexpensive primary diagnostic method.

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Authors' Contributions:
KKNK- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, and submission of article; **PCP-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **PCP-** Design of study, statistical analysis, and interpretation; KKNK- Review manuscript; **PCP-** Review manuscript; **KKNK-** Literature survey and preparation of figures; and **PCP-** Coordination and manuscript revision.

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