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ORIGINAL ARTICLE

Role of Dynamic Ultrasound versus Magnetic Resonance Imaging in Diagnosis of Shoulder Impingement Syndrome

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ABSTRACT

Background: The advantage of ultrasound (US) and the capability of dynamic evaluation can improve the accuracy of US diagnoses of shoulder pain, especially when the cause is not immediately apparent during a routine evaluation. The current research aims to evaluate the role of dynamic US as a non-invasive modality in the diagnosis of shoulder impingement syndrome in comparison to magnetic resonance imaging (MRI) findings.

Methods: Thirty-six patients with a clinical diagnosis of subacromial impingement were involved in this cross-sectional study, which was conducted at the Radiodiagnosis Department of Zagazig University Hospital. In addition to conventional MRI examination, static and dynamic ultrasonography was performed on all cases.

Results: Our results revealed that the US had 100% sensitivity and specificity in detecting supraspinatus tears compared to conventional MRI. Also, compared to MRI, the US showed 100% sensitivity and 86.7% specificity in the detection of calcification in the supraspinatus muscle. The US had 100% specificity and 80% sensitivity in the detection of infraspinatus tendinopathy changes. Also, the US had 100% specificity and 87.5% sensitivity in the detection of tendinopathy changes in the subscapularis tendon. US shows 100% sensitivity and specificity in detecting biceps tenosynovitis and acromioclavicular joint osteoarthritis compared to conventional MRI. A statistically significant reduction of the sub-acromial tunnel during active shoulder movement was found with a mean difference of 0.42 ($P < 0.001$).

Conclusions: US was found to be comparable to MRI for evaluating shoulder impingement and rotator cuff disorders. US demonstrated great sensitivity and specificity for reporting rotator cuff pathologies, with the dynamic US adding value in detecting sub-acromion tunnel narrowing in patients with shoulder impingement syndrome.

Key Words: Dynamic US, MRI, Shoulder Impingement, Diagnostic Accuracy.

INTRODUCTION

Shoulder impingement, a condition caused by several mechanisms, is a common cause of shoulder pain. Subacromial impingement syndrome results from irritation of the tendons of the rotator cuff muscles in the subacromial space and may manifest as a range of pathologies. It can be categorized into two major aetiologies: structural factors (which are related to the humerus, rotator cuff, bursa, coracoid process, acromion as well as acromio-clavicular joint) in addition to the functional factors [1].

Despite its widespread acceptance as a diagnostic tool, MRI still has one major drawback: it demonstrates a static assessment only of the painful shoulder joint rather than a dynamic one. Painful shoulder syndrome is one of several musculoskeletal conditions that can be effectively assessed using dynamic ultrasonography [2].

Pathologies affecting the tendons of the shoulder's rotator cuff are extremely common [3]. Clinical decision-making is aided by the information provided by diagnostic radiological methods like ultrasonography, MRI, and magnetic resonance arthrography (MRA). To reduce the number of cases in which unnecessary surgery is performed, the best imaging method should have high true-positive detection and low false-positive findings [4].

Due to its low price, easy availability, and capacity for real-time high-resolution imaging that permits a dynamic assessment, the use of the US in assessing musculoskeletal injuries has recently expanded [5]. We hypothesized that the US is a regularly used diagnostic tool for evaluating rotator-cuff disorders in patients complaining of shoulder pain due to its many benefits, including high diagnostic accuracy, high resolution, low cost, easy accessibility, and the ability to perform dynamic evaluations. Hence, this study explored the significance of high-resolution US in identifying shoulder abnormalities and how dynamic ultrasonography improves the traditional assessment of such cases. This was compared to the gold-standard magnetic resonance imaging in evaluating these cases. The current study aimed to assess the role of static and dynamic US as a non-invasive modality in diagnosing shoulder impingement compared to MRI findings.

METHODS

Thirty-six participants with a clinical diagnosis of subacromial impingement were included in this cross-sectional study, which was conducted at the Radiodiagnosis Department of Zagazig University Hospitals over a six-month period from December 2022 to June 2023.

Written informed consent was obtained from all participants, and the research ethical committee of the Faculty of Medicine, Zagazig University, approved the study. The institution's medical ethics committee, the Faculty of Medicine (with reference number ZU-IRB# 6683), approved the study protocol. The Declaration of Helsinki, issued by the World Medical Association to protect people participating in medical research, was strictly followed during this study.

A comprehensive patient history was collected for each case, covering various aspects, including demographic information such as age and sex. Furthermore, a detailed account of systemic diseases and previous surgical procedures was documented.

In this study, specific eligibility criteria were applied to the participants. Inclusion criteria comprised individuals of any age from both sexes experiencing shoulder pain for more than three months, showing suspicion of shoulder impingement clinically, and those who had positive clinical tests (the Neer, Hawkins-Kennedy, coracoid impingement, and cross-arm impingement tests). Conversely, exclusion criteria were used to exclude patients with metallic ocular implants, pacemakers, or other implanted cardiology devices incompatible with MRI. Additionally, individuals with instability disorders, shoulder girdle fractures, previous shoulder surgery, neoplastic lesions, infectious shoulder arthritis, and congenital anomalies were not included in the study.

Ultrasonography examination of patients was done by a linear array transducer of 6-12 MHz (a high-resolution US) model GE LOGIQ P6. The patient was positioned on a chair without back support. Rotator-cuff tendons (Supraspinatus, infraspinatus, and subscapularis), long head of biceps, as well as acromio-clavicular joint and sub-acromial space were evaluated. For dynamic US evaluation, the patient was asked to raise the affected arm halfway between flexion and abduction with the hand in pronation and the elbow extended. Between the acromion and the larger tuberosity of the humerus, in the coronal plane, along the long axis of the supraspinatus tendon, the ultrasonic probe was positioned.

Normally, during this maneuver, the supraspinatus tendon and overlying subacromial bursa should pass smoothly under the acromion process and out of view. Subacromial impingement is implied to present when fluid pools in the subacromial bursa at the lateral edge of the acromion or snapping of the bursal tissue with associated symptoms. Other findings of impingement include interposition of the supraspinatus tendon between the greater tuberosity and the acromion and direct contact between the greater tuberosity and the acromion. The subacromial tunnel was measured before and after abduction movement to clarify the significant narrowing of the tunnel during the dynamic study.

MRI examination of patients was done using a magnet unit (MagnetomAvanto, SiemensHealthcare, Erlangen, Germany), a closed high field strength system (power of 1.5 Tesla). The patient was rested in a supine position, thumb pointing up, and arm at side in neutral or mild external rotation. We used shoulder coils. Preliminary scout localizers in sagittal, axial, and coronal planes were attained, multiple weighted images in different parameters were attained (MRI parameters are summarized in table no 1) then image interpretation was done.

STATISTICAL ANALYSIS

SPSS (Statistical Package for the Social Sciences) software version 23 was used to analyze the collected data. Numbers and frequencies were used to characterize qualitative variables. Mean and standard deviation (SD), median and range (minimum value – maximum value) were used in representing continuous data. Independent sample t-test or Mann-Whitney test were used in comparing to continuous data after assumptions of normality. Diagnostic accuracy of US representing specificity, sensitivity, positive predictive values (PPV), and negative predictive values (NPV) were detected compared to MRI as a gold standard test.

RESULTS

Thirty-six patients with shoulder pain and/or limited joint movement participated in this study. Twelve male patients (33.3%) and twenty-four female patients (66.7%) made up the study population. Patients' ages ranged from 28 to 68 (median = 44.5); 55.6% of the studied participants had problems with their right shoulder joints, while 44.4% had issues with their left shoulder joints, 30 patients (83.3%) had limitation of movement, and 14 patients (38.9%) had positive impingement tests (Table 2).

From 24 patients having tendinopathy changes in supraspinatus muscle detected by MRI, the US detected these changes in 20 patients only with 83.3% sensitivity and 95% confidence interval (62.6%-95.3%) while it was specific 100%. US showed 100% sensitivity and specificity in detecting supraspinatus tears compared to conventional MRI. Also, the US showed 100% sensitivity and 86.7% specificity with a 95% confidence interval (69.3%-96.2%) in detecting calcification in supraspinatus muscle compared to MRI. The US had 100% specificity and 80% sensitivity with (79.4%- 100%) and (56.3%-94.3%) 95% confidence intervals, respectively, in the detection of infraspinatus tendinopathy changes. Also, the US had 100% specificity and 87.5% sensitivity in detecting tendenopathic changes in the subscapularis tendon (Table 3).

US revealed 100% sensitivity and specificity in detecting biceps tenosynovitis and acromioclavicular joint osteoarthritis (Table 4). The overall sensitivity and specificity of US in detecting rotator cuff tendinopathies were 82.2% and 100%, respectively (Table 5). A statistically significant reduction of the sub-acromial tunnel during active shoulder movement from adduction to abduction was found with a mean difference of 0.42 and a 95% confidence interval (0.36-0.47) ($P < 0.001$). Also, males and females showed a statistically significant difference in the measurements of the sub-acromion tunnel at abduction and internal rotation position, whereas females had a narrower tunnel ($p = 0.003$) (Table 6).

Table 1: MRI parameters

Sequence	TR	TE	Slices	FOV	NEX
Proton density axial oblique with fat sat	2000-4000	30-40	4mm	160-170	2
proton density coronal oblique with fat saturation	2000-4000	30-40	3mm	160-170	2
T2-weighted coronal oblique with fat saturation	3000-4000	90-110	3mm	160-170	2
T1-weighted sequences in the sagittal plane	400-600	15-25	3mm	160-170	2
Proton density with fat saturation the sagittal plane	2000-4000	30-40	3mm	160-170	2

Table 2: Demographic and clinical data among the studied patients

Variable	Patients (N=36)
Age: median (range)	44.5 (28-68)
Sex:	
Male	12 (33.3%)
Female	24 (66.7%)
Variable	**Frequency (N %) (N=36)**
Laterality	
Right	20 (55.6%)
Left	16 (44.4%)
Shoulder pain	36 (100%)
Limitation of movement	30 (83.3%)
Positive impingement tests	14 (38.9%)

Table 3: Validity data of US compared to conventional MRI in the detection of rotator cuff pathology

	MRI (Gold standard)				
	Tendenopathic changes in supraspinatus muscle				**Validity data**
US		Positive	Negative	Total	Sensitivity: 83.3% Specificity: 100% PPV: 100% NPV:75%
	Positive	20	0	20	
	Negative	4	12	16	
	Total	24	12	36	
	Supraspinatus muscle partial tear				**Validity data**
US		Positive	Negative	Total	Sensitivity: 100% Specificity: 100% PPV: 100% NPV:100%
	Positive	4	0	**4**	
	Negative	0	32	**32**	
	Total	**4**	**32**	**36**	
	Supraspinatus muscle calcification				**Validity data**
US		Positive	Negative	Total	Sensitivity: 100% Specificity: 86.7% PPV: 60% NPV:100%
	Positive	6	4	**10**	
	Negative	0	26	**26**	
	Total	**6**	**30**	**36**	
	Infraspinatus muscle tendenopathic changes				**Validity data**
US		Positive	Negative	Total	Sensitivity: 80% Specificity: 100% PPV: 100% NPV:80%
	Positive	16	0	**16**	
	Negative	4	16	**20**	
	Total	**20**	**16**	**36**	
	Subscapularis muscle tendenopathic changes				**Validity data**
US		Positive	Negative	Total	Sensitivity: 87.5% Specificity: 100% PPV: 100% NPV:90.9%
	Positive	14	0	**14**	
	Negative	2	20	**22**	
	Total	**16**	**20**	**36**	

Table 4: Validity data of US compared to conventional MRI in the detection of non-rotator cuff pathology

	MRI (Gold standard)				
	Biceps tendenopathic changes				**Validity data**
US		Positive	Negative	Total	Sensitivity: 100% Specificity: 100% PPV: 100% NPV:100%
	Positive	4	0	**4**	
	Negative	0	32	**32**	
	Total	**4**	**32**	**36**	
	Acromio-clavicular joint osteoarthritis				**Validity data**
US		Positive	Negative	Total	Sensitivity: 100% Specificity: 100% PPV: 100% NPV:100%
	Positive	24	0	**24**	
	Negative	0	12	**12**	
	Total	**24**	**12**	**36**	

Table 5: Overall validity data of US compared to conventional MRI

	MRI (Gold standard)				Validity data
	Tendenopathies				
US		Positive	Negative	Total	Sensitivity: 82.2% Specificity: 100% PPV: 100% NPV:33.3%
	Positive	30	0	**30**	
	Negative	4	2	**6**	
	Total	**34**	**2**	**36**	

Table 6: The dynamic measurements of sub-acromion tunnel by ultrasound

Variable	All patients (N=36)	P-value*
Sub-acromion tunnel at adduction *Mean±SD* *Median (range)*	 1.04±0.18 0.99 (0.93-1.5)	**<0.001**
Sub-acromion tunnel at abduction *Mean±SD* *Median (range)*	 0.63±0.17 0.59 (0.32-1)	
	Sub-acromion tunnel at adduction & internal rotation	**P-value**
Sex: **Female** **Male**	 0.97 (0.8-1.4) 1.1 (0.9-1.5)	0.1
	Sub-acromion tunnel at abduction & internal rotation	**P-value**
Sex: **Female** **Male**	 0.6 (0.3-1) 0.8 (0.6-0.9)	**0.003**

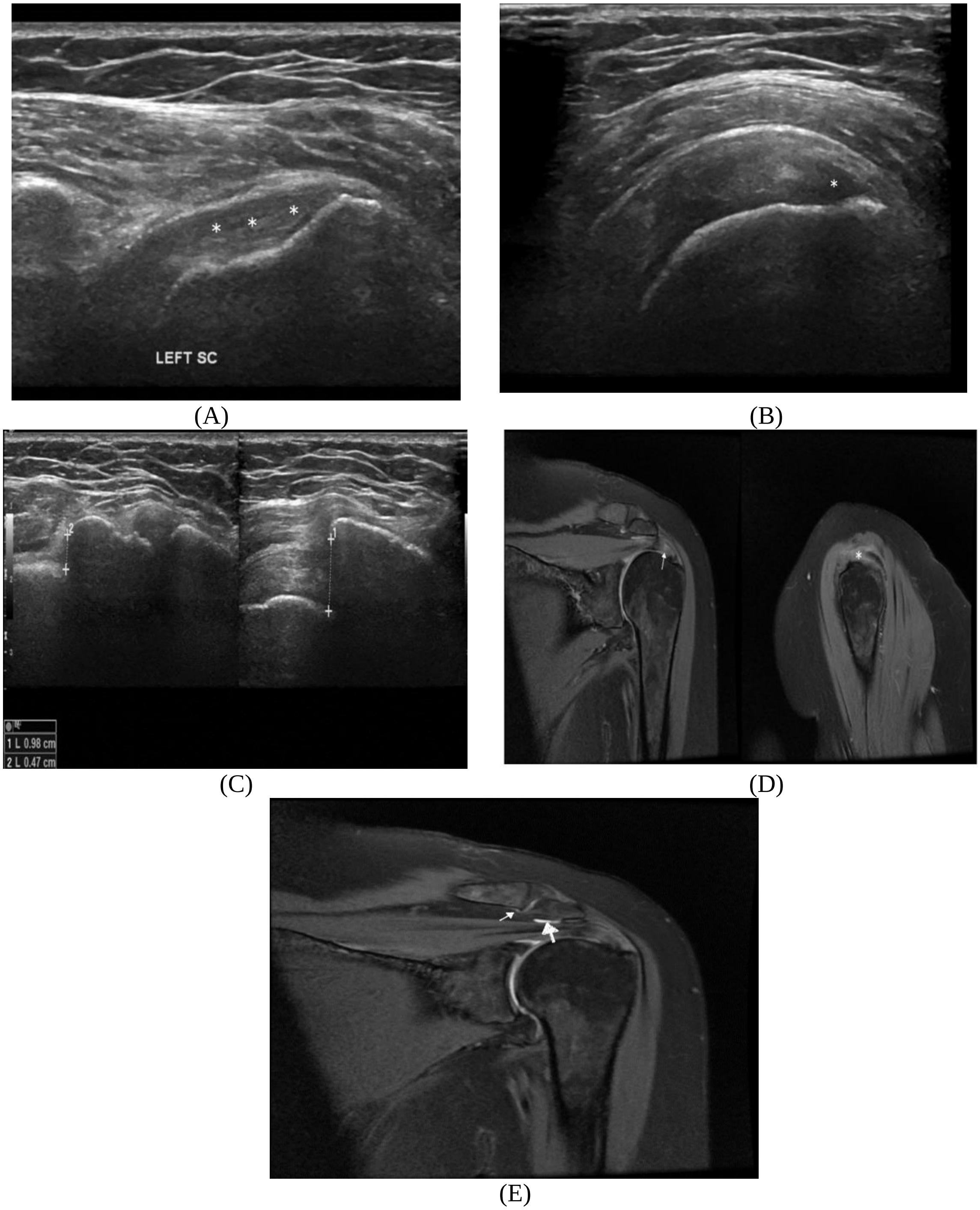
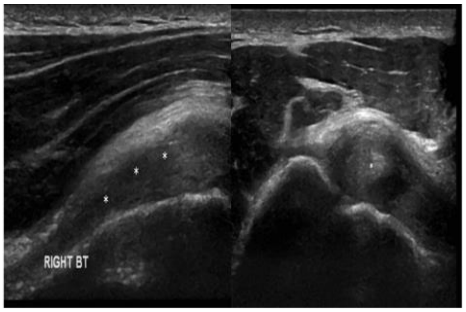
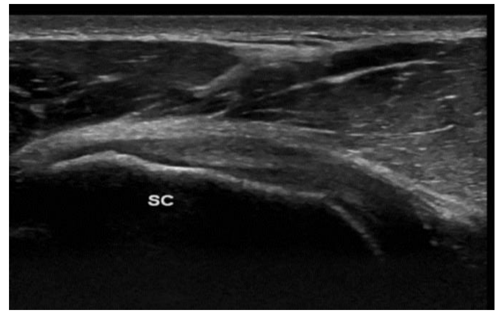


Figure 1: (A): Subscapularis tendinosis: Longitudinal ultrasound shows thickened and hypoechoic subscapularis tendon, (B): Supraspinatus partial tear: longitudinal ultrasound shows thickened supraspinatus tendon. Hypoechoic area is noted at the supraspinatus tendon (artistic), (C): Dynamic ultrasound view in adduction and abduction with internal rotation shows the sub-acromion tunnel measuring 0.98 and 0.47cm at the adduction and abduction with internal rotation position respectively, (D): Supraspinatus partial tear: Coronal (left image) and sagittal (right image) PD fat sat MRI shows intrasubstance high T2 signal intensity extending to its synovial surface with evolving extension to its bursal surface (arrow in left and artistic in right), (E): Acromioclavicular osteoarthritis and sub acromion bursitis: coronal PD fat sat MRI shows marginal osteophytes (small arrow). Small amount of high fluid signal is noted at the sub acromion space (large arrow).



(A)



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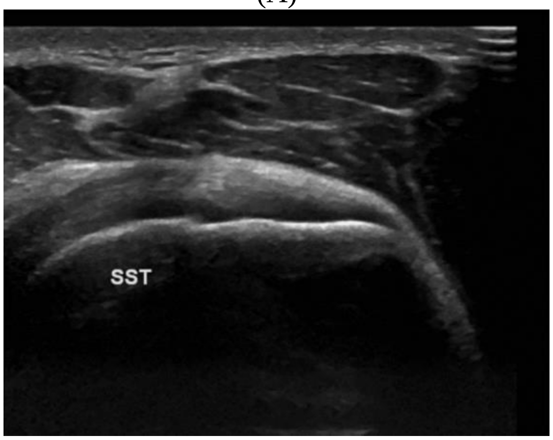

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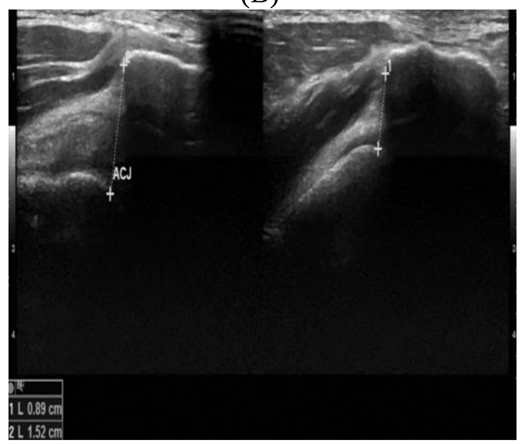
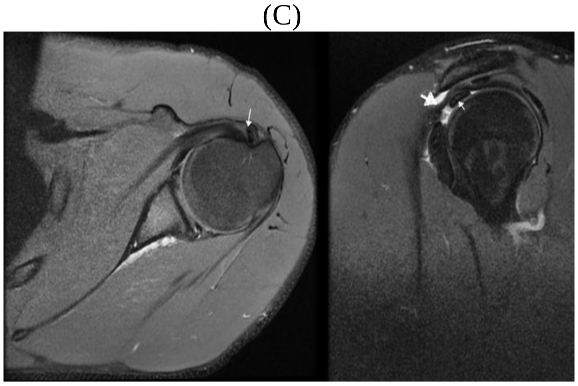
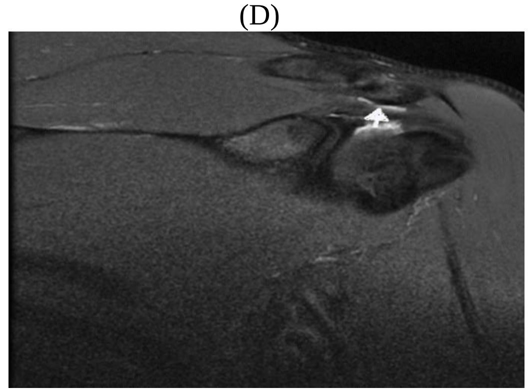
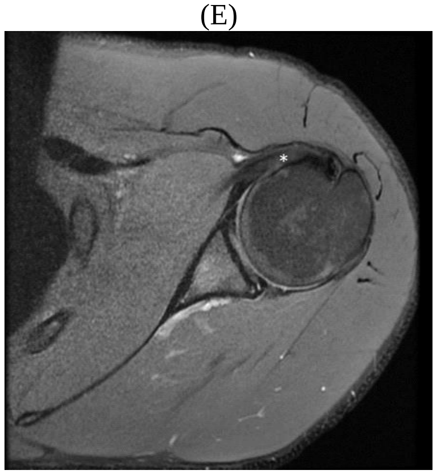


(D)


(E)


(F)


(G)

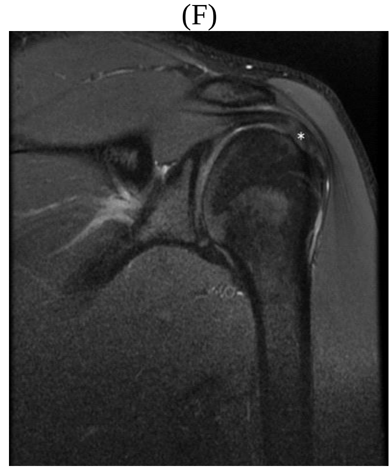

(H)

Figure 2: (A) Biceps tendon tenosynovitis: Longitudinal and axial ultrasound show the biceps tendon is seen markedly thickened with surrounded synovial thickness, (B) Subscapularis tendinosis: Longitudinal ultrasound shows subscapularis tendon thickened, (C) Supraspinatus tendinosis: Longitudinal ultrasound shows supraspinatus tendon mildly thickened comparing to the other side(not shown) with and loss of normal fibrous architecture of the tendon, (D) Dynamic ultrasound view in adduction and abduction with internal rotation shows the sub-acromion tunnel measuring 1.5 and 0.89 cm at the adduction and abduction with internal rotation position respectively, (E) Biceps tendon tenosynovitis: Axial and sagittal PD fat sat MRI show the biceps tendon thickened with high signal (small arrow), Sub- acromion bursitis: Small amount of high fluid signal is noted at the sub-acromion space (large arrow), (F) Sub deltoid bursitis: Coronal PD fat sat MRI shows fluid signal is noted at the sub deltoid space (arrows), (G) Subscapularis tendinosis: Axial PD fat sat MRI shows high signal intensity of the subscapularis tendon, (H) Supraspinatus tendinosis: Coronal PD fat sat MRI shows high signal is noted at the supraspinatus tendon (artistic).

DISCUSSION

Shoulder impingement syndrome develops when the supraspinatus tendon becomes inflamed regularly as it travels through the subacromial gap, the tunnel created by the ACJ and the coracoacromial ligament underneath the anterior one-third of the acromion [6].

The most frequent pathology affecting the shoulder is a disease of the surrounding tendons that stabilize the shoulder joint. US, conventional MRI, and MR arthrography are all examples of radiological methods that can assist doctors in determining the best course of treatment for their patients. Diagnostic imaging is used to decide treatment, whether surgical or non-surgical. [3].

The study found that 33.3 % of patients were male, while 66.7% were female. This differs from previous research, which found a 67% higher male incidence of rotator cuff injuries [8]. Most patients had problems with their right shoulder joints, while 44.4% had problems with their left, which was concordance with El-Shewi et al. [7], who reported right shoulder joint involvement in approximately two-thirds of their studied patients.

El-Shewi et al. [7] revealed that dynamic examination of subacromial impingement and visible increased synovial vascularity by additional color are two areas where US outperforms above MRI.

In the current research, MRI was used as the gold-standard diagnostic test. All cases displayed pathology of the supraspinatus tendon, either tendinosis, partial-thickness tear, or calcification.

From 24 patients with tendinopathy changes in supraspinatus muscle detected by MRI, the US detected these changes in 20 patients only with 83.3% sensitivity, which was specific 100%. US

shows 100% sensitivity and specificity in detecting supraspinatus tears compared to conventional MRI. Also, compared to MRI, the US showed 100% sensitivity and 86.7% specificity in the detection of calcification in the supraspinatus muscle. The US had 100% specificity and 80% sensitivity in the detection of infraspinatus tendinopathy changes. Also, the US had 100% specificity and 87.5% sensitivity in detecting tendinopathy changes in the subscapularis tendon.

El-Shewi et al. [7] reported US sensitivity, specificity, and accuracy in diagnosing supraspinatus tendinopathy to be 83.3%, 100%, and 90.9%, respectively. In addition, Roy et al. [10] compared the diagnostic efficacy of US, MRI, and MR arthrography in characterizing rotator cuff pathologies and found that the US had a mean sensitivity and specificity of 79% (range: 63%-91%; mean: 79%) and 94% (range: 86%-99%; mean: 94%) for detecting supraspinatus tendinopathy.

Naganna et al. [12] investigated the correlation between US and MRI findings in thirty cases with clinical diagnoses of rotator cuff problems. The method was 100% accurate, with a sensitivity of 100%, a specificity of 96.4%, and a sensitivity of 96.4% for detecting rotator-cuff tendon tears.

Another study by Chen et al. [13] reported that the US's sensitivity and accuracy in detecting full-thickness tears were 92.9% and 89.1%, respectively.

Lenza et al. [3] found that very small partial-thickness tears can be missed. In conclusion, it is important to assess the size of the partial tear to confirm that partial-thickness tears are often undetected because of their low detectability rates.

When compared to conventional MRI, the US's sensitivity and specificity for detecting osteoarthritis in the acromioclavicular joint were both shown to be 100%. This corroborated the findings of Melanie et al. [15], who found that ultrasonography was useful for detecting acromioclavicular joint degeneration's direct effect on the rotator cuff tendon.

Similarly, El-Shewi et al. [7] demonstrated that the US is as accurate as MRI for detecting osteoarthritic changes in the acromioclavicular joint.

In a study comparing US and MRI for shoulder injuries, Rao [14] examined 60 patients and found that ultrasonography was 80 percent sensitive and 95 percent specific for detecting rotator-cuff tendon injuries caused by acromioclavicular joint degenerative alterations.

The US showed 100% sensitivity and specificity in the detection of biceps tenosynovitis among studied participants. This was also in agreement with the study conducted by El-Shewi et al. [7], who demonstrated that the US has a 100% sensitivity, specificity, and accuracy rate in the diagnosis of biceps tenosynovitis. Rao [14] found a sensitivity of 100% in his investigation of biceps tenosynovitis, which is consistent with our findings. Both static and dynamic ultrasonography are of great diagnostic value in patients with bicep tenosynovitis, as concluded by Bureau et al. [9].

In the current study, the overall sensitivity and specificity of the US in diagnosing rotator cuff tendinopathies were 82.2% and 100%, respectively. In a study comparing ultrasonography with MRI to identify rotator cuff diseases and tears, Bashir et al. [11] found that ultrasonography was 78.04% sensitive and 89.47% specific.

In our study, rotator cuff tendinosis, which was visible on ultrasonography as a localized or diffuse area of decreased reflectivity without disruption of the fiber continuity, was detected with a lower likelihood by MRI. This was by the research conducted by Beggs et al. [16], which stated the generally accepted accuracy of ultrasonography in detecting rotator cuff tendinosis, particularly among patients with ensuing diffuse or local tendon thickening that was easily compared to the neighboring normal part of the tendon or the contralateral normal one.

In addition, our study showed a highly statistically significant reduction of the sub-acromial tunnel during active shoulder movement with a mean difference of 0.42 and a 95% confidence interval (0.36-0.47). Also, there were statistically significant disparities between males and females in the measurements of the sub-acromion tunnel at abduction and internal rotation position, where females had a narrower tunnel ($p < 0.05$).

Bureau et al. [9] assessed the use of dynamic US imaging; they revealed a marked narrowing of the subacromial tunnel in the painfully overused, stress position of the shoulder; consequently, the rotator cuff tendon is more vulnerable to compression.

El-Shewi et al. [7] have demonstrated that static US, in conjunction with dynamic examination, can be useful for identifying various abnormalities that contribute to uncomfortable shoulders, notably impingement syndrome, and its underlying causes.

Our current research confirms that magnetic resonance imaging (MRI) is an invaluable diagnostic modality in cases of subacromial impingement. It allows for the precise delineation of anatomic details such as acromial shape, subacromial bursa abnormalities, and rotator cuff abnormalities such as tendinosis, partial-thickness tears, and full-thickness tears. However, MRI has many drawbacks, including being a static scan that cannot disclose the exact relationship between the acromion, humeral head, and intervening soft tissues during dynamic shoulder movement. It is also expensive, time-consuming, and unsettling for patients; this availability issue further complicates the debate around MRIs in general. On the other hand, US provides for dynamic scanning of the shoulder in motion, providing a direct real-time view of the interaction between the acromion, subacromial bursa, supraspinatus tendon, and larger tuberosity of the humeral head. Our study's main limitation was the small number of cases, so we recommend further studies on a larger population to ensure the validity of our result.

CONCLUSION

US was comparable to MRI for evaluating shoulder impingement and rotator cuff disorders for evaluating shoulder impingement and rotator cuff disorders. US demonstrated great sensitivity and specificity for reporting rotator cuff pathologies, with the dynamic US adding value in detecting sub-acromion tunnel narrowing in patients with shoulder impingement syndrome.

To screen for shoulder impingement syndrome and rotator cuff problems, ultrasonography may be the most cost-effective imaging modality because it is non-invasive, non-ionizing, widely available, and has the advantage of dynamic real-time assessment. Patients complaining of shoulder pain can benefit from this imaging technique right away. An MRI may be performed when a US scan yields an inconclusive diagnosis.

Conflict of interest: None
Financial Disclosure: None

REFERENCES

1. Smith C, Vassiliou CE, Pack JR, & Borstel D.V. Shoulder Impingement and Associated MRI Findings, J Am Osteopath Coll Radiol;2018, 7, 3 :5-6.
2. Gimarc DC, Lee KS. Shoulder MR Imaging Versus Ultrasound: How to Choose. *Magn Reson Imaging Clin N Am*. 2020;28(2):317-30.
3. Lenza M, Buchbinder R, Takwoingi Y, Johnston RV, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane Database Syst Rev*.;2013(9): CD009020.
4. Jacobson JA. Musculoskeletal ultrasound: focused impact on MRI. *AJR Am J Roentgenol*. 2009;193(3):619-27.
5. Greis AC, Derrington SM, McAuliffe M. Evaluation and non-surgical management of rotator cuff calcific tendinopathy. *Orthop Clin North Am*. 2015;46(2):293-302.
6. Manzoor, I., Bacha, R., Gilani, S., and Liaqat, M.: The Role of Ultrasound in Shoulder Impingement Syndrome and Rotator Cuff Tear. Ann. Orthop. Trauma Rehabilitation;2019, 2(1): 126.
7. El-Shewi IEA, El Azizy HM and Gadalla AAH: Role of dynamic ultrasound versus MRI in diagnosis and assessment of shoulder impingement syndrome. Egyptian Radiol. Nucl. Med.;2019, 50: 100.
8. Chauhan NS, Ahluwalia A, Sharma YP, Thakur L. A Prospective Comparative Study of High Resolution Ultrasound and MRI in the Diagnosis of Rotator Cuff Tears in a Tertiary Hospital of North India. *Pol J Radiol*. 2016; 81: 491-7.
9. Bureau NJ, Beauchamp M, Cardinal E, Brassard P. Dynamic sonography evaluation of shoulder impingement syndrome. *AJR Am J Roentgenol*. 2006;187(1):216-20.
10. Roy JS, Braën C, Leblond J, Desmeules F, Dionne CE, MacDermid JC, et al. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. *Br J Sports Med*. 2015;49(20):1316-28.
11. Bashir S, Firdose S. R, Kamal Y, Khan H. A, Arora M, Gul S, et al.: Correlation between high resolution ultrasonography and MRI in rotator cuff tear diagnosis. Int J Health Sci Res;2014, 4(4): 103–12.
12. Naganna H. P, Rangaswamy S. M, and Puttaraju N. C: Study of Rotator Cuff Disorders by Ultrasound with Magnetic Resonance Imaging Correlation. IJCMSR;2018, 3(1): 70–5.
13. Chen D.Y, Lan H. H, Lai K, Chen H, Chen Y., and Chen, C: Diagnostic utility of US for detecting rotator cuff tears in rheumatoid arthritis patients: comparison with magnetic resonance imaging. J. Med. Ultrasound;2014, 22(4): 200–6.
14. Rao, A.: Role of Ultrasound in Evaluation of Shoulder Injuries: A Comparative Study of Ultrasound and MRI Abhinav Pratap Singh, Anuradha Rao, Siddalinga Devaru,2017.
15. Melanie F, Karen F, Grey S: Sonography of suprapinatus tears. AJR;2005 184: 180–4.
16. Beggs I. Shoulder ultrasound. Semin Ultrasound CT MR. 2011;32(2):101-113.

Citation

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