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Comparative study of Ultrasound and MRI in diagnosis and assessment of shoulder impingement syndrome

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ABSTRACT

Background: When the arm sometimes lifted, the rotator cuff, subacromial bursa, and biceps tendon pressed on the underside of the acromion and coracoacromial ligament, causing shoulder impingement. There are two sorts of impingements: intrinsic and extrinsic. As a result of the degenerative process brought on by excessive strain, intrinsic impingement produces a partial or full rupture of the rotator cuff tendons. Extrinsic impingement occurs when outside causes apply mechanical pressure on the tendons, causing irritation or degeneration.

Aim of The Work: Using MR imaging as a gold standard, assess and compare the effectiveness of high-resolution ultrasonography and magnetic resonance imaging in identifying subacromial impingement disorders.

Patients and Methods: The study has been carried out on 50 patients, based on age range 20-60 years, having pain at the shoulder for three months and more with a clinically confirmed diagnosis of subacromial impingement, excluding cases having a history of shoulder dislocation, fractures, surgical intervention, or neoplastic lesions. All patients had ultrasonography and conventional MR exams.

Results: Intrinsic impingement reasons were more common in patients under the age of 40. Those above the age of 40, on the other hand, showed a greater incidence of extrinsic factors, particularly hypertrophic osteoarthritic changes of the acromioclavicular joint, with full-thickness rotator cuff tendon tears.

Conclusion: Ultrasonography was proven to be a fairly sensitive diagnostic technique for subacromial impingement in this study.

Keywords: *Comparative Ultrasound, MRI, Impingement Syndrome.*

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INTRODUCTION

The third most prevalent source of musculoskeletal discomfort is the shoulder joint, which affects 7–26% of the general population.[1]

Adults had a 2.4 percent annual prevalence and 1.5 percent annual incidence of shoulder disorders, respectively.[2]

Shoulder discomfort is frequently caused by rotator cuff disease.[3]

Repetitive action at or above the shoulder level, such as work or leisure activities, causes shoulder impingement syndrome.[4]

Shoulder impingement syndrome is more common in those over the age of 40, thus age is another aspect to consider.[5]

Inflammation or degeneration of the tendons or bursae, dysfunctional glenohumeral and scapulothoracic mechanics, debilitated rotator cuff or scapular musculature, joint capsule abnormalities, positional disorders of the neck or shoulder, and structural deformities of the pertinent skeletal components.[6]

A multitude of factors can lead to shoulder impingement syndrome. They are split into two categories: structural variables and functional factors.[7]

The distance between the coracohumeral curve above and the humeral head and tuberosities below is the cause of shoulder impingement syndrome. The rotator cuff tendons travel via this area.[8]

Subacromial impingement, subcoracoid impingement, and internal impingement are the three different types of impingement in the shoulder.[9]

In the general population, the most prevalent reason of shoulder discomfort is subacromial impingement, which accounts for 44–65 percent among all shoulder disorders.[10]

Shoulder impingement syndrome is frequently accompanied by a partial or total tear of the rotator cuff tendon, necessitating examination of rotator cuff integrity in these individuals.[11]

Non-contrast MRI is the best imaging modality for individuals with suspected shoulder impingement.[12]

Although MRI was thought to be a reliable tool for evaluating tendons of rotator cuff muscles, it just evaluates the shoulder joint in a static state. Because most signs are nonspecific, it can only imply a diagnosis of subacromial impingement indirectly.[13]

The limited availability of open MR and the fact that MR imaging can only image single-plane shoulder movements sequentially that do not fully mimic physiologic movements of the shoulder are the two primary limitations of dynamic MRI.[13]

Being a widely available, non-invasive, and fast tool for musculoskeletal issues, particularly those involving the shoulder joint. The use of high-resolution ultrasonography as a diagnostic tool for musculoskeletal assessment is becoming more common.[13]

PATIENTS AND METHODS

Our study was carried out on 50 patients diagnosed clinically with a subacromial impingement in the radiology department of El Hussein and Sayed Galal hospitals From March 2021 to September 2021.

The patients were selected using a set of criteria for inclusion and exclusion.

The study included patients with age range (20 – 60 years), pain at the shoulder for more than 3 months, and positive clinical tests.

We exclude patients with a history of surgical procedure on the shoulder, previous shoulder dislocation, history of fracture of the shoulder girdle and neoplastic lesions, and congenital anomalies.

The following was done to all of the patients:

Obtaining a medical history and making a clinical preliminary diagnosis.

Radiological investigations: Static & dynamic ultrasound and Conventional MRI.

Complete standard sonographic assessment of shoulder joint was performed to characterize the etiology & sequel of subacromial impingement as well as any associated abnormality. All of the cases were also subjected to a dynamic sonographic examination.

The patients were instructed to do the active movement once more for a few occasions during the examination. The results obtained by Sonographic examination were correlated to the results obtained by MR examination.

The patients were examined using a Toshiba ultrasound device (Aplio 500) electric that has been fitted with a linear array probe with a frequency band of 5–12 MHz for musculoskeletal applications to identify the causes of painful shoulder and/or shoulder movement limitations, as well as any other abnormalities that may be present.

The technique of examination: A little patient's medical history should be gathered before beginning the examination, as this can be highly crucial in assessing if the referrer's request and subsequent imaging findings correspond to a definitive diagnosis of the underlying condition.

While the patient is resting, an ultrasound examination is performed. The operator may sit in front of or behind the patient. The scan should be carried out in a position that is both technically and physically suitable. The operator's shoulder should be raised above the shoulder level of the patient.

The biceps tendon's long head is assessed first, with the forearm of the patient on or above the ipsilateral thigh. The palm is pointing upward and the elbow is bent at a 90-degree angle. The probe is moved craniocaudally from the sulcus bicipitalis to the myotendinous junction to determine the length of the tendon.

After that, by 90-degree rotation of the probe to observe the tendon's length, the tendon's long-axis view is obtained. The tendon's continuity, tendinopathy, tendon sheath effusion, and synovitis are all evaluated.

Biceps Tendon Long Head and Subscapularis Tendon dynamic Examination: The probe placed in the axial direction over the anterior shoulder in the same place as the bicipital sulcus to see the tendon from a long-axis perspective. The patient's forearm is to be twisted laterally whilst maintaining the elbow close to the wall of the chest, since the tendon will be pulled out from beneath the coracoid process as a result of this, allowing inspection. By rotating the probe 90 degrees, a short-axis image is acquired, revealing its multipennate appearance, which includes hypoechoic fibers of the muscle, appears sandwiched between its hyperechoic fibers.

Rotator Interval and Supraspinatus tendon:

Starting over the rotator interval is the optimum option. The probe was placed with the long axis of the long head of the biceps tendon. The supraspinatus tendon runs in parallel to the long head of the biceps tendon and may be easily assessed by sliding the probe posteriorly across the greater tuberosity in the same plane as the longitudinal plane of the biceps tendon.

For assessment tendon of the supraspinatus muscle, the Crass and modified crass postures have been outlined. The dorsal side of the hand is positioned over the lumbar area on the ipsilateral side in the Crass position.

Place the probe on the shoulder's anterior side in a transverse plane. While retaining the upper arm in the modified crass posture to show the supraspinatus tendon in a short-axis perspective.

After that, with the upper limb in the same posture, the probe is rotated 90 degrees along the supraspinatus tendon's long axis to acquire a long axis image of the tendon. Tears, tendinopathy, and calcification are all looked for in the tendon.

Subacromial Bursa: It is a thin sac that lies in between deltoid muscle and the rotator cuff tendons, and it takes the form of a hypoechoic thin layer covering the rotator cuff. At the same time that the supraspinatus tendon is evaluated. It is checked for synovitis, thickening of the bursa, and effusion.

Tendons of the Infraspinatus and Teres Minor; and recess of the Glenohumeral Joint: With the palm facing up, return the hand to the thigh. The transducer is situated underneath and coplanar to the scapula's spine, giving a longitudinal view of the infraspinatus and teres minor tendons from their origin on the posterior greater tuberosity to their insertion. The glenohumeral joint's posterior recess can be assessed for effusion by moving the transducer medially on the same level. The infraspinatus muscle belly is well exhibited in its short axis in the infraspinatus area. It has central echogenicity in its tendon. Its echogenicity and size can be compared to the teres minor muscle to see if it has fatty degeneration or atrophy.

Acromioclavicular (AC) Joint: The probe is aligned in the coronal plane to evaluate it across the upper shoulder and distal clavicle. The clavicle and acromion's superior bony outlines are apparent since the joint capsule embraces the joint space and housing the fibrocartilage disc. The joint is examined for signs of swelling or constriction, uneven boundaries, capsular bulging, and synovitis.

The technique of Magnetic Resonance Imaging:

Devices: high field (1.5 Tesla) closed magnet unit (PHILIPS).

Patient position: The patient has to be flat with the head facing the scanner aperture. The preferred arm posture of the patient is to be neutral and turned slightly to the outside.

Surface coil (Flexible coil): wrap around the anatomical area of interest and conform to it.

Pulse sequences and imaging planes: Preliminary Scout Localizer in three planes: axial, sagittal, and coronal.

Coronal T1 (TSE, TR 664, TE 18, FOV 14, SL 4, MTARIX 205x512, NSA 3),

Coronal T2 (TSE, TR 2411, TE 100, FOV 14, SL 4, MTARIX 201x512, NSA 2),

Coronal STIR (TSE, TR 2411, TE 15, FOV 14, SL 4, MTARIX 201x512, NSA 2)

Axial GR (TSE, TR 551, TE 18, FOV 17, SL 4, MTARIX 179x512, NSA 3)

Sagittal T2 (TSE, TR 3342, TE 100, FOV 16, SL 4, MTARIX 205x512, NSA 3)

Selected cases

Case (1) Male patient 51 years old, complaining of right shoulder pain markedly limiting the shoulder movement, for 6 months duration. History of old trauma yet with no dislocation. No history of operation.

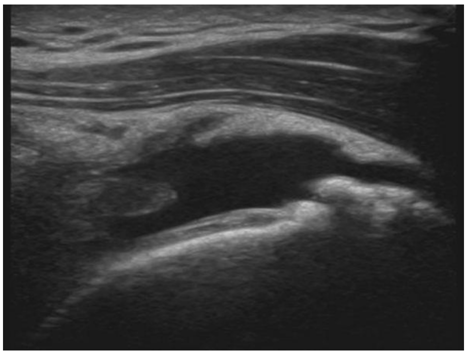

Fig. 1: ultrasonography shows full thickness tear of supraspinatus tendon, with muscle retraction & excessive effusion filling the gap.

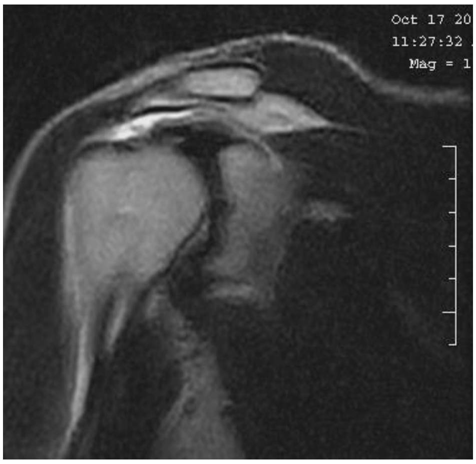

Fig. 2: Conventional MRI coronal T2 WIs (Figure 2) of the same case shows discontinuity of the supraspinatus tendon with muscle belly retraction & gapping filled with fluid.

Case (2):- Male patient 56y presented with right shoulder pain of 4 months duration with limitation of arm elevation. No history of trauma, dislocation, or operation.

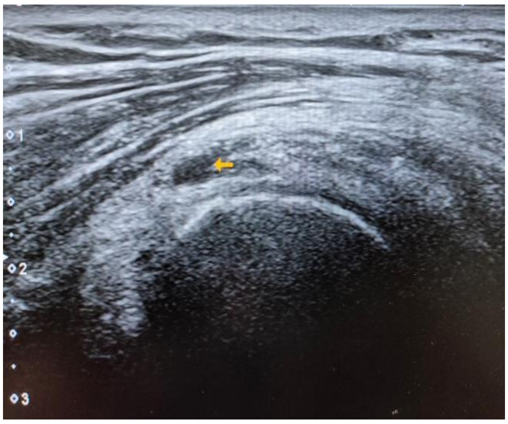

Fig. 3: Ultrasonography shows a focal hypoechoic area within the supraspinatus tendon not involving the whole thickness of tendon, representing partial interstitial tear.

Fig. 4: Ultrasonography shows thickened long head of biceps tendon with fluid around it (tenosynovitis of the long head of biceps tendon)

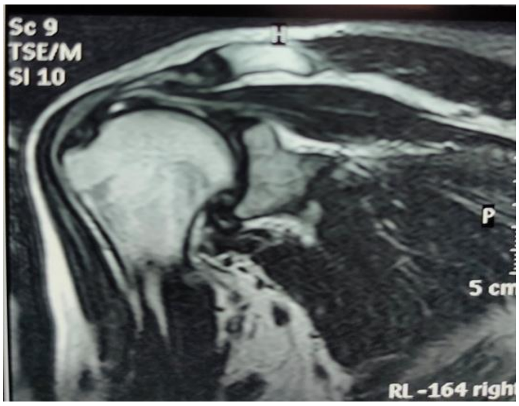

Fig.5 : Conventional MRI, coronal T2 WI of the same case shows a focal small area of bright T2 signal intensity at the supraspinatus tendon, not reaching the articular or bursal surface, representing partial interstitial tear

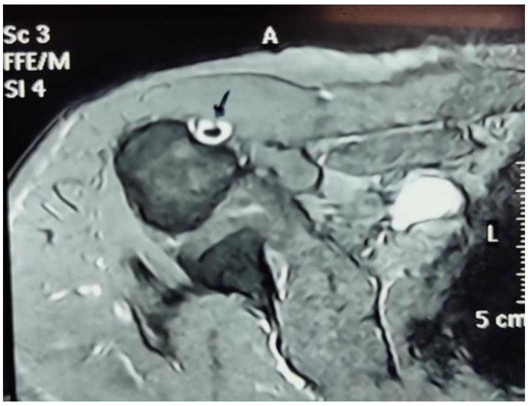

Fig. 6: Conventional MRI, coronal & axial T2 WIs of the same case shows a focal small area of bright T2 signal intensity (Figure 5) at the supraspinatus tendon, not reaching the articular or bursal surface, representing partial interstitial tear as well as fluid signal encircling the long head of biceps tendon (Figure 6) representing tenosynovitis.

RESULTS

SEX	Frequency	Percentage
Male	30	60
Female	20	40
Total	50	100

Table1: The percentage and frequency in accordance with sex

Lesions	<40Y	>40Y
Acromioclavicular osteoarthritis	6	25
Subacromial bursitis	17	22
Partial-thickness tear	15	13
Full-thickness tear	2	5

Table 2: The incidence of various pathological injuries based on the average age (40 years)

Side	Frequency	Percentage
Right	35	70%
Left	15	30%
Total	50	100%

Table 3: The frequency of shoulder side affection, as well as the percentage of people that have it.

Prevalence Lesions	Frequency	percentage (among the cases of the study)
Acromioclavicular osteoarthritis	31	62%
Subacromial bursitis	35	70%
Tendinosis at Rotator cuff	4	8%
Calcific tendinitis	2	4%
Partial-thickness tear	24	48%
Full-thickness tear	7	14%
Joint effusion	35	70%
Biceps tenosynovitis	17	34%

Table (4): The frequency and percentage of different pathological findings detected by ultrasonography

Prevalence Lesions	Frequency	Percentage (among the cases of the study)
Acromioclavicular osteoarthritis	33	66%
Subacromial bursitis	39	78%
Tendinosis at Rotator cuff	5	10%
Calcific tendinitis	2	4%
Partial-thickness tear	28	56%
Full-thickness tear	7	14%
Joint effusion	37	74%
Biceps tenosynovitis	17	34%

Table 5: The frequency and percentage of different pathological findings detected by conventional MRI

Lesion	U/S		MRI	
Acromioclavicular osteoarthritis	31	62%	33	66%
Subacromial bursitis	35	70%	39	78%
Rotator cuff tendinosis	4	8%	5	10%
Calcific tendinitis	2	4%	2	4%
Partial-thickness tear	24	48%	28	56%
Full-thickness tear	7	14%	7	14%
Joint effusion	35	70%	37	74%
Biceps tenosynovitis	17	34%	17	34%

Table 6: Comparing the capability of dynamic ultrasonography in detection of different pathological lesions compared to conventional MRI

Lesion	Sensitivity	Specificity	PPV	NPV
Acromioclavicular osteoarthritis	94%	100%	100%	89%
Subacromial bursitis	90%	100%	100%	73%
Rotator cuff tendinosis	80%	100%	100%	98%
Calcific tendinitis	100%	100%	100%	100%
Partial-thickness tear	86%	100%	100%	85%
Full-thickness tear	100%	100%	100%	100%
Joint effusion	95%	100%	100%	87%
Biceps tenosynovitis	100%	100%	100%	100%

Table 7: Sensitivity, Specificity, PPV, and NPV of dynamic ultrasonography compared to conventional MRI in the detection of different pathological lesions encountered in shoulder impingement

DISCUSSION

This study was conducted to find out that 7 patients were diagnosed with a full-thickness supraspinatus tendon tear by MRI, and all of them were detected by ultrasound with 100% sensitivity and specificity.

This was supported by a research of [14] in which four patients were identified with full-thickness supraspinatus tendon injuries by MRI, and all of them were detected in the ultrasound with 100 percent sensitivity and specificity.

This was in contrast to a research [15] in which the supraspinatus tendon was discovered to be completely torn in ten of the patients using MRI, and nine of them were detected in ultrasonography with 90 percent sensitivity and 100 percent specificity.

In terms of partial-thickness tears, MRI identified 28 patients, whereas ultrasonography identified 24 of them as deteriorated tendons with 86 percent sensitivity and 100 percent specificity.

Other authors have also reported on this agreement in the assessment of partial-thickness rips. According to [16], a tiny partial-thickness rip can be overlooked.

The agreement between ultrasonography and MRI for assessment of supraspinatus tendon was 100 percent for complete-thickness tears and 86 percent for partial-thickness tears in this study, indicating that ultrasonography can be used to exclude the possibility of complete tears at supraspinatus tendon, particularly in people who aren't appropriate to have MRI.

In the study of [15], the sensitivity of US in the detection of supraspinatus tendon partial-thickness tear was 85.71% with 100% specificity.

In comparison to [14] studies which revealed 80% sensitivity and 95% specificity for partial thickness tear.

This contradicts the findings of [17], which found that dynamic ultrasonography had a high sensitivity (about 100%) for detecting various kinds of partial-thickness rotator cuff injuries.

In comparison to [18] studies found that ultrasound and magnetic resonance imaging were equally effective in identifying full-thickness rotator cuff injuries. Conversely, ultrasonography may be more accurate than MRI in identifying partial thickness tear, according to [18].

The sensitivity for revealing full-thickness tears was found to be 95 percent by [19], compared to the sensitivity of 100 percent in our study.

However, [19] claimed a sensitivity of 72 percent for detecting partial-thickness rips, whereas we found a sensitivity of 93 percent.

For identifying full-thickness tears, in comparison to our finding of 100 percent sensitivity, [12] reported a sensitivity of 91 percent.

For detecting partial-thickness rips, [12] claimed a sensitivity of 80 percent, but we found a sensitivity of 86 percent.

Ultrasonography was shown to be less sensitive (80 percent sensitivity) than MRI in identifying rotator cuff tendinosis, which manifests as an area of decreased reflectivity that is either localized or diffuse with no interruption in fiber continuity. Ultrasonography in our study was able to detect four of the five patients identified by MRI as having rotator cuff tendinosis, with ultrasonography reporting normal rotator cuff tendon in one of the missing cases.

This is supported by [15] that found that ultrasonography had a high sensitivity (approximately 83 percent) in detecting rotator cuff tendinosis.

In comparison, [14] found that ultrasonography had 78.6 percent sensitivity and 87.4 percent specificity for detecting rotator cuff tendinosis.

Both ultrasonography and MRI revealed calcific tendinitis in two patients in this study.

This is in line with the findings of [15], who found that ultrasonography had a high degree of accuracy in detecting calcific tendinitis.

When compared to magnetic resonance imaging (MRI), the results revealed that dynamic ultrasonography had acceptable accuracy (approximately 94 percent sensitivity) in detecting acromioclavicular joint osteoarthritic alterations.

This is consistent with the findings of [15], who discovered that dynamic ultrasonography was effective in detecting acromioclavicular joint osteoarthropathy with a sensitivity of 94 percent and a specificity of 100 percent.

Ultrasonography revealed 35 cases of subacromial bursitis with fluid distending the bursa, whereas MRI revealed 39 cases (about 90 percent sensitivity). The instances missed by U/S had extremely little bursal effusions, suggesting that ultrasonography had a disadvantage in detecting small quantities of fluid.

In studies of [14; 15] they reported slightly higher sensitivity (about 93.33 percent) and (92.3 percent) respectively of dynamic ultrasonography in detection of subacromial bursitis.

There were 37 instances of joint effusion in this research, two of which were missed by ultrasonography.

This is supported by nearly all peer-reviewed research in the same subject, such as those conducted by [14; 15].

The 17 instances of biceps tenosynovitis discovered by MRI were also detected by ultrasonography in our study, demonstrating that ultrasonography is effective in identifying synovial abnormalities.

This is supported by studies conducted by [14; 15], which found that static and dynamic ultrasonography had a high diagnostic value in instances with biceps tenosynovitis.

CONCLUSION

Ultrasonography is a very accurate and highly sensitive diagnostic technique for cases with a subacromial impingement in this research.

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