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# Role and Correlation of High Resolution Ultrasound and Magnetic Resonance Imaging in Evaluation of Shoulder Pain in the Elderly

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## Abstract

*Background:* Soft tissue lesions are a common cause of pain and disability in elderly people, clinical examination alone has a limited value in deciding on the management options for the underlying etiology. Several studies have been done that evaluated the accuracy of either magnetic resonance imaging or high-resolution ultrasound in detection of shoulder disorders and only few studies compared these two methods.

*Aim of Study:* To evaluate the role of high-resolution ultrasonography and magnetic resonance imaging in elderly patients with shoulder pain.

*Patients and Methods:* In this cross-sectional study, a total of 22 patients (11 females and 11 males). Were presented with acute shoulder joint pain. The patients were aged from 60 to 70 years.

*Results:* Overall, we were able to demonstrate performance values for musculoskeletal ultrasound in diagnosing the abnormalities of rotator cuff, biceps tendon, acromioclavicular joint, and glenohumeral joint compared to MRI to be 100% for sensitivity. Positive predictive value (PPV) was 100% for rotator cuff, biceps tendon, and glenohumeral joint disorders, while it was 96% for the abnormalities developed in the acromioclavicular joint. Finally, the accuracy was 98.4%, 100%, 96%, and 100% respectively for the abnormalities of rotator cuff, biceps tendon, acromioclavicular joint, and glenohumeral joint disorders, respectively.

*Conclusion:* Ultrasound for the shoulder joint presents a high accuracy and sensitivity in diagnosis a wide spectrum of shoulder joint lesions, with a diagnostic performance value near to that of MRI. Furthermore, it is a real time investigation that can afford comparison information of the two joints. A wide availability, lower cost and better tolerability of ultrasonography make it a modality of first choice for evaluation of rotator cuff tears. MRI can be reserved for patients with suspicious ultrasonography results.

***Key Words:*** *Rotator cuff tears – Superior labrum anterior-posterior – Long head of biceps.*

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## Introduction

**THE** preferred imaging modalities for evaluation of shoulder disorders include magnetic resonance imaging and high-resolution ultrasound. Both these modalities have their own merits and demerits **[1]**. Accuracy, availability, cost effectiveness and expertise are some of the important parameters that guide the process of making a decision on the best modality. There have been studies done in the past that evaluated the accuracy of either magnetic resonance imaging or high-resolution ultrasound in detection of shoulder pathologies and only few studies compared these two methods. Of course magnetic resonance imaging is the most powerful diagnostic tool **[2,3]**. But nowadays, high-resolution ultrasound shows accuracy in differentiation between complete- and partial-thickness tears and detection of osteoarthritic changes and there is a good agreement with magnetic resonance imaging **[4-7]**.

Low cost, wide availability and scan dynamics are some of the advantages in favor of shoulder high resolution ultrasound make it a modality of first choice.

*Aim of the work:*

The aim of this work was to evaluate the role of high-resolution ultrasonography and magnetic resonance imaging in elderly patients with shoulder pain.

## Patients and Methods

In this cross-sectional study, A total of 22 patients (11 females and 11 males).

Were presented with acute shoulder joint pain. The patients were aged from 60 to 70 years old, study was conducted at Ain Shams University

Hospital, Radiology Department from Dec. 2020 – June 2021.

*Type of study:* Cross sectional study (Agreement study).

*Study setting:* Ain Shams University Hospital-Radiology Department.

Study Population:

*Inclusion criteria:*

Elderly patients (older than 60 years) who was referred to a radiology department for magnetic resonance imaging and high resolution ultrasonography because of shoulder pain.

*Exclusion criteria:*

Those with contraindications to magnetic resonance imaging (Metallic implants, Claustrophobia and Pacemakers). Patients with known or was diagnosed fracture/dislocation. Patients who was undergo shoulder surgery for any reason.

*Sample size:* 22 cases.

Sample size was calculated using PASS 11.0; In a test for agreement between two raters using the Kappa statistic, a sample size of 22 subjects achieves 80% power to detect a true Kappa value of 0.90 in a test of H0: Kappa = 0.50 vs. H1: Kappa <> 0.50 when there are 3 categories with frequencies equal to 0.20, 0.30, and 0.50. This power calculation is based on a significance level of 0.05000.

*Ethical considerations:* The study was presented for the approval from The Ethical Committee of the Faculty of Medicine Ain Shams University.

*Study procedure:* All patients were examined clinically, then by radiography of the affected shoulder. All patients were undergo magnetic resonance imaging of the symptomatic shoulder. High-resolution, real-time ultrasound examination of the involved shoulder was done together with an ultrasound examination of the contralateral normal shoulder for comparison in all patients.

*MR technique and protocol:*

MR scan was carried out on a Philips ingenia 1.5 Tesla unit. The standard imaging protocol consists of: Axial (T1 & Gradient), Coronal oblique (T1, T2 & Proton density), Sagittal oblique (T1 and or T2).

*Ultrasonography technique and patient position:*

Machine used: A high-resolution ultrasound unit logic P7.

The patient was asked to sit on a revolving stool with the examiner seated opposite on a similar stool. The height of the patient's stool was adjusted to be ergonomically comfortable for scan performance.

*Long head of biceps tendon:*

Patient's forearm was placed in a slight internal rotation with the palm of hand facing upwards and elbow was flexed at 90 degrees. The bicipital groove was identified. The biceps tendon was seen between the greater and lesser tubersosities. Scanning was done in short and long axes planes and the biceps tendon was followed from its intra articular course down to the muscle belly **[8]**. Normal tendon was seen as a uniform fibrillary structure.

*Subscapularis tendon:*

The arm was rested in a position with the elbow was fixed on the iliac crest on the same side with the palm of hand was faced upwards, the probe was placed in a transverse plane at the bicipital groove and the arm of the patient was externally rotated. This tendon was examined in transverse planes and sagittal planes with passive internal and external rotation. The SSC tendon was visible when entering medially to the groove **[8]**. It was seen as an elongated and slightly convex tendon.

*Supraspinatus tendon:*

The dorsal surface of the hand was placed on the back pocket of the opposite side with elbow opposing to the lateral wall of the chest. This position was make the supraspinatus tendon project anteriorly. Scanning was done in both transverse and longitudinal axes. The subacromial-subdeltoid bursa was seen in-between the deltoid and supraspinatus as a thin hypoechoic structure **[8]**.

*Infraspinatus tendon:*

The palmar surface of the hand was placed on the opposite shoulder with the ultrasound probe will place over the posterior aspect of the glenohumeral joint. Supraspinous and infraspinous fossae will be identified with upward and downward movement of the probe using the scapula spine as a landmark. The infraspinatus muscle will be seen separately from the teres minor muscle within the infraspinous fossa.

*Statistical analysis:*

Data was collected, revised for completeness, coded and then finally analyzed using SPSS version 20. Quantitative data will be presented as number and percentages. Appropriate statistical tests will be applied.

## Results

Table (1): Demographic data of the included 22 patients.

| | |
|---|---|
| Number of patients | 20 |
| Mean Age (years) | 64±1.2 |
| *Gender:* | |
| Male | 11 (50%) |
| Female | 11 (50%) |
| *Age for gender distribution:* | |
| Male | 65±0.87 |
| Female | 63.5±1.5 |

Table (2): Medical history and clinical presentations in patients with acute shoulder joint pain.

| Medical history | Frequency (n) | Percentage (%) |
|---|---|---|
| *Side:* | | |
| Right | 12 | 54.55 |
| Left | 10 | 45.45 |
| Free | 13 | 26.2 |
| For joint instability | 9 | 16.9 |
| *Clinical presentation:* | | |
| Pain/tenderness | 22 | 100 |
| Swelling | 4 | 18.18 |
| Numbness | 2 | 9.09 |
| Joint weakness | 5 | 22.73 |
| Joint stiffness | 7 | 31.82 |
| Bruising/Redness | 1 | 4.55 |
| Clunking sound | 3 | 13.64 |

Table (3): MRI findings.

| Shoulder joint MRI finding | Frequency | Percentage (%) |
|---|---|---|
| *Biceps tendon abnormalities:* | | |
| Tendinosis | (2) | 9.09 |
| Full-thickness tear | (1) | 4.55 |
| *Subscapularis tendon abnormalities:* | | |
| Tendinosis | (5) | 22.73 |
| Partial thickness tear | (2) | 9.09 |
| Full thickness tear | (1) | 4.55 |
| *Supraspinatus tendon abnormalities:* | | |
| Tendinosis | (5) | 22.73 |
| Partial thickness tear | (1) | 4.55 |
| Full thickness tear | (3) | 13.64 |
| *Infraspinatus tendon abnormalities:* | | |
| Tendinosis | (7) | 31.82 |
| Partial thickness tear | (1) | 4.55 |
| *Teres minor muscle-tendon abnormalities:* | | |
| Tendinosis | (3) | 13.64 |
| Atrophy | (1) | 4.55 |
| *Acromioclavicular joint abnormalities:* | | |
| Osteoarthritis | (7) | 31.82 |
| Sub acromion and sub deltoid bursitis | (5) | 22.73 |
| Sub coracoid bursitis | (3) | 13.64 |
| *Glenohumeral joint/bony margins abnormalities:* | | |
| Osteoarthritis | (7) | 31.82 |
| Sub acromion and sub deltoid bursitis | (4) | 18.18 |

Table (4): Ultrasound findings in acute shoulder joint pain.

| Shoulder joint MRI finding | Frequency | Percentage (%) |
|---|---|---|
| *Biceps tendon abnormalities:* | | |
| Tendinosis | (2) | 9.09 |
| Full-thickness tear | (1) | 4.55 |
| *Subscapularis tendon abnormalities:* | | |
| Tendinosis | (4) | 18.18 |
| Partial thickness tear | (3) | 13.64 |
| Full thickness tear | (1) | 4.55 |
| *Supraspinatus tendon abnormalities:* | | |
| Tendinosis | (5) | 22.73 |
| Partial thickness tear | (1) | 4.55 |
| Full thickness tear | (3) | 13.64 |
| *Infraspinatus tendon abnormalities:* | | |
| Tendinosis | (7) | 31.82 |
| Partial thickness tear | (1) | 4.55 |
| *Teres minor tendon abnormalities:* | | |
| Tendinosis | (3) | 13.64 |
| Atrophy | (1) | 4.55 |
| *Acromioclavicular joint abnormalities:* | | |
| Osteoarthritis | (7) | 31.82 |
| Sub acromion and sub deltoid bursitis | (5) | 22.73 |
| Sub coracoid bursitis | (3) | 13.64 |
| *Glenohumeral joint abnormalities:* | | |
| Osteoarthritis | (7) | 31.82 |
| Sub acromion and sub deltoid bursitis | (4) | 18.18 |

Table (5): Performance of musculoskeletal ultrasound in diagnosing abnormalities of rotator cuff, biceps tendon, acromioclavicular joint, and glenohumeral joint.

| Disorders location | MRI | US | Sensitivity, % | Accuracy, % | *PPV, % |
|---|---|---|---|---|---|
| *Rotator cuff:* | | | | | |
| Tendinosis | 20 | 19 | 100% | 98.4% | 100% |
| Partial thickness tear | 4 | 5 | | | |
| Full thickness tear | 4 | 4 | | | |
| Atrophy | 1 | 1 | | | |
| *Biceps tendon:* | | | | | |
| Tendinosis | 2 | 2 | 100% | 100% | 100% |
| Full thickness tear | 1 | 1 | | | |
| *Acromio-clavicular joint:* | | | | | |
| Osteoarthritis | 7 | 7 | 100% | 96% | 96% |
| Sub acromion and sub deltoid bursitis | 5 | 5 | | | |
| Sub coracoid bursitis | 3 | 3 | | | |
| *Gleno-Humeral joint:* | | | | | |
| Osteoarthritis | 7 | 7 | 100% | 100% | 100% |
| Sub acromion and sub deltoid bursitis | 4 | 4 | | | |

*PPV: Positive predictive value.

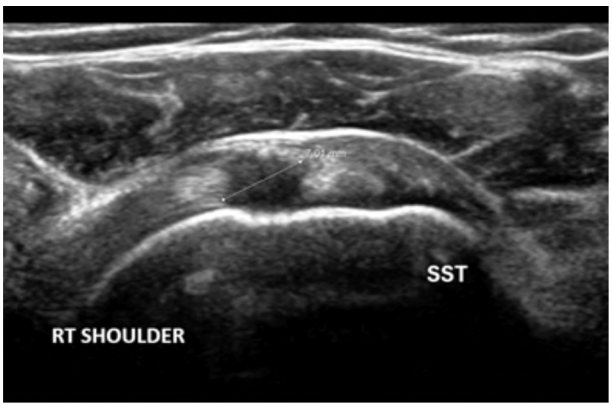


Fig. (1): US LS of the right supraspinatus tendon showing a hypoechoic area within involving its whole thickness denoting full thickness tear with a gap measuring 7mm.

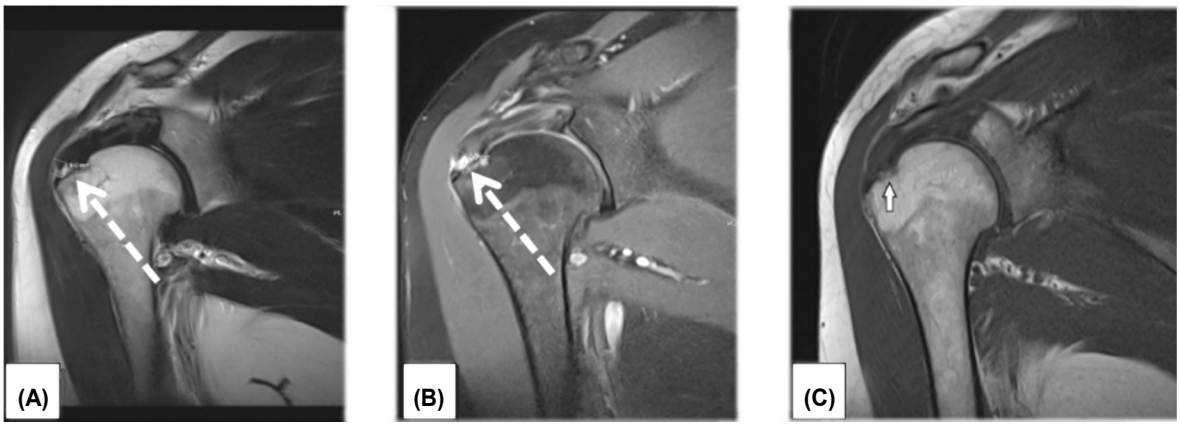


Fig. (2): MRI coronal T2 (A), PD with fat suppression (B) and T1 (C) WI revealed a full thickness tear of the supraspinatus tendon near its humeral attachment with fluid signal seen in the gapping area which measures about 6mm (comparable to the US).


Fig. (3): US of the left subscapularis tendon showing relative increase in its girth with normal echogenicity diagnosed as normal (white arrow).

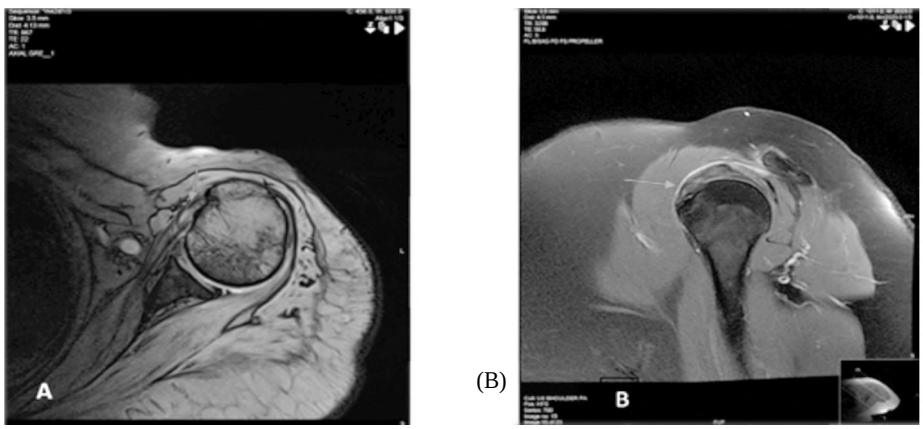


Fig. (4): MRI axial GR WI (A) and sagittal PD fat suppression (B) Showing abnormal intermediate signal of the subscapularis tendon with relative increase of its girth (red arrows) denoting tendinopathy.

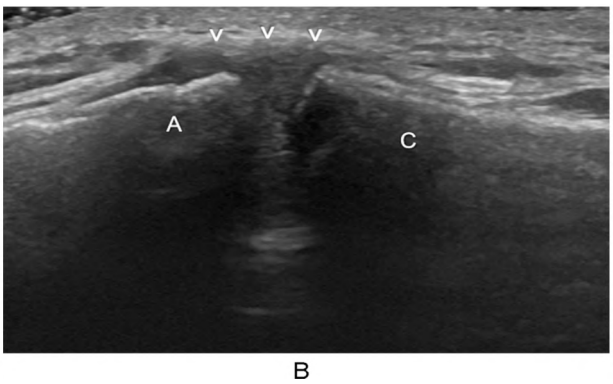


Fig. (5): Acromioclavicular joint. Corresponding US image; A, Acromion; C, Clavicular bone; Arrowheads, acromioclavicular joint capsule.

## Discussion

Role of diagnostic imaging in the evaluation of shoulder pain is to guide clinical management. Non-invasive imaging modalities such as ultrasonography and MRI are used for evaluating rotator cuff pathologies. Ultrasonography can be used as a primary modality because its accuracy in detecting partial- and full-thickness rotator cuff tears is comparable to MRI **[9]**. Thus help the clinician decide between operative or nonoperative treatment **[10]**.

If surgical treatment is decided, imaging can be used further to plan the surgical approach whether it be open or arthroscopic. US has been shows to be a powerful and reasonably accurate method for diagnosis of rotator cuff tears and other rotator cuff abnormalities, provided the examiner with a detailed knowledge of shoulder anatomy, using a standardized examination technique, and thorough understanding of the potential pitfalls, limitations, and artifacts.

In our study, the most common abnormality that leads to the onset of the acute pain in the shoulder joint was rotator cuff tendinosis, in 20 (91% of cases) on MRI and 19 (86.36% of cases) on ultrasound examination rotator cuff tendinosis was seen showed rotator cuff tendinosis. Similar results were reported by as Millar et al., and McKendry et al., **[11,12]**.

Regarding Biceps tendon pathologies, the MRI results demonstrated in 3 out of 22 patients presence of biceps tendon abnormalities; of whom 2 patients had tendinosis and one patient had full thickness biceps tendon tear, while the US showed the same results with ultrasound sensitivity of 100%, specificity of 100% and accuracy of 100%, Thus ultrasonography and MRI showed a high agreement for detection of bicep tendon abnormalities. Similar results were reported by Alasaarela et al., **[13]** who reported bicep tendon abnormalities in 24 shoulders on MRI and in 20 patients on ultrasound. They found a good agreement between ultrasound and MRI for detection of biceps tendon abnormalities.

In our study, we were able to demonstrate an ultrasound accuracy of 98.4% and a sensitivity of 100% for detection of rotator cuff tears compared to MRI, where ultrasound was able to correctly identify partial thickness tears in 5 out of 22 cases with a sonographic detection rate of 22.72% and for full thickness tears in 4 out of 22 cases with a sonographic detection rate of 18.18%, while MRI examination revealed rotator cuff partial-thickness tears in 4 out 22 cases with a rate of 18.18% and rotator cuff full thickness tear was diagnosed in 4 out 22 cases with a rate of 18.18%. This rate was slightly higher than the rate reported by Moosmaymer et al., **[14]** that ultrasonography revealed a sensitivity and accuracy of 94% and 81 %, respectively compared to MRI **[15]**.

While Girish et al., **[16]** determined rates higher than the rate obtained in our study from 51 included patients, the US managed to detect 12% of patients having full thickness rotator cuff muscles tear and 13% for partial thickness tear.

Sonographic results in the detection of rotator cuff tears varied, probably due to the use of low frequency (and low resolution) 5 MHz transducers and limited experience with the examination procedure. Subsequently technical improvements such as 7.5-14 MHz linear array broad-bandwidth transducers and better penetration of the ultrasound beam, as well as increased experience and detailed knowledge of shoulder anatomy and pathology significantly improved sonographic results and reliability.

Waldt et al., **[17]** showed that the diagnosis of small partial thickness tears by ultrasound (31 patients of 49 patients) is restricted (sensitivity 80%) because of difficulties in the differentiation among fiber tearing, tendinitis, synovitic changes and superficial fraying at tendon margins. Moreover, Rutten et al., **[18]** evaluated 68 patients and concluded that the diagnostic performances of high-resolution US and MR imaging in the detection of partial and full thickness tears of the rotator cuff is comparable, demonstrating an accuracy of 87% and sensitivities and specificities of over 90% respectively.

Lenza et al., **[19]** in a systematic review mentioned that thirteen studies assessed the accuracy

of US to detect any rotator cuff tears in comparison to MRI. The studies included a total of 854 shoulders from 848 patients with a median study size of 50 (range 24 to 190). The prevalence of any rotator cuff tears in the US studies was 80% (range 34% to 92%), and the sensitivities ranged from 33% to 100%, specificities from 45% to 100%. The summary sensitivity and specificity of US were 91% (95% CI 83% to 95%) and 85% (95% CI 74% to 92%) respectively. The positive and negative likelihood ratios were 6 (95% CI 3 to 12) and 0.11 (95% CI 0.05 to 0.22) respectively, with there was no statistically significant difference between the two tests ($p$=0.13).

Ottenheijm et al., **[20]** reported a sensitivity of 95% for detecting full thickness tears compared to 92% (95% CI 82% to 96%). The difference between the studies was due to the accuracy and type of US machine and the experience of the radiologist in using US.

In our study US revealed teres minor muscle atrophy in one patient (4.55% of cases) and tendinosis in 3 patients (13.36% of cases), with the same detection rate by MRI, with sonographic detection rate of 18.18% and accuracy of 89.4% Thus, ultrasonography and MRI showed a good agreement. Schibany et al., **[21]** reported similar results when compared to our results (3% of cases) had teres minor muscle atrophy and (10.42% of cases) had teres minor tendinosis by MRI and the detection rate by ultrasonography was the same in total number 61 patients.

In our study, we were able to succeed in evaluating shoulder arthropathy as ultrasound showed that there was a high prevalence of osteoarthritis. Osteoarthritis affects both glenohumeral and acromioclavicular joints in a same 31.82% percentage. The same results were obtained by MRI.

Overall, we were able to demonstrate performance values for musculoskeletal ultrasound in diagnosing the abnormalities of rotator cuff, biceps tendon, acromioclavicular joint, and glenohumeral joint compared to MRI to be 100% for sensitivity. Positive predictive value (PPV) was 100% for rotator cuff, biceps tendon, and glenohumeral joint disorders, while it was 96% for the abnormalities developed in the acromioclavicular joint. Finally, the accuracy was 98.4%, 100%, 96%, and 100% respectively for the abnormalities of rotator cuff, biceps tendon, acromioclavicular joint, and glenohumeral joint disorders, respectively.

*Limitations of ultrasound:*

The first limitation of this study was its small sample size that was limited. Secondly, clinical follow-up was unavailable for patients; thus, there were no results concerning the achievement of shoulder ultrasound in this group of patients in need for follow-up. However, this study managed to determine accurately the causes of acute shoulder joint pain, as proved by using MRI modality.

The False-positive sonographic findings of rotator cuff tears can be caused by the technique (anisotropy, transducer positioning, acoustic shadowing by the deltoid septum), by the anatomy (rotator cuff interval, supraspinatus infraspinatus interface, musculotendinous junction, fibrocartilaginous insertion), or by disease (criteria for diagnosis of rotator cuff tears, tendon inhomogeneity, acoustic shadowing by scar tissue or calcification, rotator cuff thinning) **[22]**. False-negative sonographic findings of rotator cuff tears can be caused by the technique (transducer frequency, suboptimal focusing, imaging protocol, transducer handling), by the anatomy (non-diastasis of the ruptured tendon fibers), by disease (tendinosis, calcifications, synovial proliferation, granulation or scar tissue, bursal thickening, massive rotator cuff tears), or by patient factors (obesity, muscularity, limited shoulder motion) **[22]**.

*Conclusion:*

Ultrasoundfor the shoulder joint presents a high accuracy and sensitivity in diagnosis a wide spectrum of shoulder joint lesions, with a diagnostic performance value near to that of MRI. Furthermore, it is a real time investigation that can afford comparison information of the two joints. A wide availability, lower cost and better tolerability of ultrasonography make it a modality of first choice for evaluation of rotator cuff tears. MRI can be reserved for patients with suspicious ultrasonography results.

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# دور وترابط الموجات فوق الصوتية عالية الدقة والتصوير بالرنين المغناطيسى فى تقييم آلام الكتف لدى كبار السن

الخلفية : آفات الأنسجة الرخوة هى سبب شائع للألم والعجز لدى كبار السن، والفحص السريرى وحده له قيمة محدودة فى تقرير خيارات الإدارة للمسببات الأساسية. تم إجراء العديد من الدراسات التى قيمت د قة التصوير بالرنين المغناطيسى أو الموجات فوق الصوتية عالية الدقة فى الكشف عن اضطرابات الكتف وقليل من الدراسات فقط قارنت هاتين الطريقتين.

الهدف من العمل : لتقييم دور التصوير بالموجات فوق الصوتية عالى الدقة والتصوير بالرنين المغناطيسى فى المرضى كبار السن الذين يعانون من آلام الكتف.

المرضى والطرق : فى هذه الدراسة المقطعية، ما مجموعة ٢٢ مريضاً (١١ إناث و ١١ ذكور). كانوا يعانون من آلام حادة فى مفصل الكتف. تراوحت أعمار المرضى بين ٦٠ و ٧٠ عاماً.

النتائج : تمكنا من إثبات دور الموجات فوق الصوتية فى تشخيص آفات أوتار الكفة المدورة، ووتر العضلة ذات الرأسين، والمفصل الأخرمى الترقوى، والمفصل الحقانى العضدى مقارنة بالرنين المغناطيسى لتكون ١٠٠٪ للحساسية. كانت القيمة التنبؤية الإيجابية ١٠٠٪ للكفة المدورة، وتر العضلة ذات الرأسين، واضطرابات المفصل الحقانى العضدى، بينما كانت ٩٦٪ للأفات التى حدثت فى المفصل الأخرمى الترقوى. أخيراً، كانت الدقة ٩٨.٤٪ و ١٠٠٪ و ٩٦٪ و ١٠٠٪ على التوالى لتشوهات الكفة المدورة، وتر العضلة ذات الرأسين، والمفصل الأخرمى الترقوى، واضطرابات المفاصل الحقانية العضدية، على التوالى.

الخلاصة : تقدم الموجات فوق الصوتية لمفصل الكتف دقة وحساسية عاليتين فى تشخيص مجموعة واسعة من آفات مفصل الكتف، مع قيمة أداء تشخيصية قريبة من قيمة التصوير بالرنين المغناطيسى. علاوة على ذلك، إنه تحقيق فى الو قت الفعلى يمكنه توفير معلو مات مقارنة للمفاصل. إن التوافر الواسع والتكلفة المنخفضة والتحمل الأفضل للتصوير بالموجات فوق الصوتية يجعلها طريقة الاختيار الأول لتقييم آفات الكفة المدورة. يمكن حجز التصوير بالرنين المغناطيسى للمرضى الذين يعانون من نتائج التصوير بالموجات فوق الصوتية المشبوهة.