

ROLE OF ULTRASOUND AND MAGNETIC RESONANCE IMAGING IN TRAUMATIC SHOULDER JOINT INJURIES.

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ABSTRACT

Aim: The aim of this study is to evaluate role of magnetic resonance imaging and ultrasound in diagnosis of traumatic shoulder injuries.

Patients and methods: Fifty patients who had one or more of post traumatic shoulder dislocation, pain or limitation of the affected shoulder joint movements were examined by gray scale ultrasound and conventional magnetic resonance imaging.

Results: 18 cases were diagnosed as supraspinatus tears (11 partial tear and 7 complete tear). 8 cases were diagnosed as supraspinatus tendinosis. Four cases were diagnosed as acromioclavicular joint lesions 2 of them were diagnosed as acromioclavicular joint separation and 2 cases were diagnosed as acromioclavicular joint osteoarthritis and all of cases with acromioclavicular joint lesions were associated with impingement syndrome. 11 cases were diagnosed as Hill Sach's fracture; 5 of them were associated with Bankart lesion. Two cases were diagnosed as biceps tendon instability. Four cases were diagnosed as biceps tenosynovitis.

Conclusion: ultrasound should be increasingly used as the first-line imaging modality in the assessment of traumatic shoulder lesions. Further magnetic resonance imaging is needed in order to evaluate the joint in more detailed manner

Keywords: Shoulder joint, trauma, musculoskeletal, ultrasound, magnetic resonance imaging.

INTRODUCTION

The complex anatomy of the glenohumeral joint allows the greatest range of mobility compared with any other joint in the body. This presents a higher risk for dislocation and development of chronic instability⁽¹⁾.

Ultrasonography can examine the shoulder structures during movement and contemporaneously compare the finding of the symptomatic side with those of the asymptomatic side⁽²⁾.

A combination of different osseous and soft tissue restraints such as ligaments, tendons, labrum, and capsule have increasingly received recognition either as stabilizers or as structures that sustain secondary damage in these situations. The main shoulder structures that can be evaluated with US in patients with instability problems are the long head of biceps, the glenohumeral joint, and the acromioclavicular joint. US can be used for documenting the presence, direction, and extent of glenohumeral translation, especially in patients with posterior shoulder dislocation⁽³⁾.

MR imaging provides a global view of the shoulder and is relatively easy to learn and interpret. However, it is expensive and may be time-consuming. MR arthrography provides exquisite information about the labrum and rotator cuff, but is expensive and invasive. Full-thickness tears of the rotator cuff may be accurately identified at MR imaging with little observer variation. Consistent differentiation between the normal cuff, tendinitis, and partial-thickness tears is considerably more difficult because MR criteria for these diagnoses are not universally accepted⁽⁴⁾.

The aim of this work is to evaluate role of MR imaging and ultrasound in diagnosis of traumatic shoulder injuries.

PATIENTS AND METHODS

Fifty patients, with age range from 19 to 67 years (mean age 43 years), were referred to the radiology department from the orthopedics surgery department and out patients clinics, faculty of Medicine Zagazig University.

All patients were complaining of one or more of post traumatic shoulder dislocation, pain or limitation of the affected shoulder joint movements.

All patients were subjected to history taking, clinical provisional diagnosis and radiological investigations that include gray scale ultrasound and conventional MRI.

All ultrasonographic examinations were obtained in real time with use of (GE LOGIC 3 EXPERT US) machine and a variable high frequency linear array 7.5 to 9 Mega Hertz. All patients had standardized bilateral sonography of the shoulder.

Technique of ultrasound examination:

Patient position: Typically, the patient is seated on a backless chair or stool in the static technique and supine in the dynamic technique.

Technique

To visualize the biceps tendon

To begin the patient is asked to place their supinated hands over their knees. The probe is placed over the antero-lateral aspect of the humeral neck in the axial plane, where the biceps tendon can be readily identified lying in the intertubercular groove. Its proximal course through the rotator cuff interval can be demonstrated as it passes between the

supraspinatus and subscapularis, and deep to the coracohumeral ligament. The probe may then be rotated to view the biceps tendon in its long axis.

To visualize the supraspinatus tendon

The patient is then asked to place their hand behind their back over their buttock, allowing the supraspinatus tendon to be better demonstrated. The supraspinatus muscle runs in a coronal oblique plane under the acromion process, and may be visualized in short and long axis planes.

To visualize the infraspinatus and teres minor tendons

First, the patient places their arm across their chest with their shoulder in flexion and internal rotation to reveal the infraspinatus and teres minor tendons.

To visualize the subscapularis tendon

Lastly, subscapularis is shown to best advantage by asking the patient to bring their arm by their side and turn their shoulder into external rotation.

To visualize the anterior glenoid labrum

The elbow is flexed to a 90° angle, and holding the patient's forearm, the examiner rotates the shoulder from internal to maximally tolerable external rotation. This procedure used to document detachment of the anterior labrum from the glenoid rim or capsular shearing as well as optimizes visualization of the labral ligamentous complex.

Imaging of the contra-lateral shoulder provides a means for comparative evaluation of any observed or suspected abnormality.

The transducer is put on the top of shoulder joint to visualize the acromioclavicular joint and finally intact hyperechoic line of humeral cortical bone is examined to exclude fractures.

Technique of Magnetic Resonance Imaging

First, we ask the patient to take off all clothes and wear a special gown. We re-assured the patient to avoid claustrophobia, asked to avoid any movement of examined shoulder & limb to avoid motion artifacts, also we asked patients about metallic cardiac pacemaker or metallic fixation.

We applied the Shoulder Surface Coil with its center over the humeral head while the patient was sitting, then we asked the patient to lie supine, and patient arms placed at side of the abdomen in extension and external rotation position.

All the MR images were performed on 1.5 tesla (Achieva, PHILIPS Medical Systems).

The pulse sequences include:

1. Axial T1 (localizer) (TR 400, TE 20).
2. Oblique coronal T1 (TR 400, TE 20), in which cuts are taken parallel to long axis of

supraspinatus muscle, which is demonstrated in previous axial cuts.

(Field of view, 100 mm ; 4mm-thick slice with 0.4-mm intersection gap and 354x512 matrix; 4 excitations)

3. Axial T2 FSE (TR 4000, TE 20).
4. Oblique coronal T2 FSE (TR 4000, TE 100)
5. Oblique sagittal T2 FSE (TR 4000, TE 100)
6. Oblique coronal T2 with STIR (TR 4000, TE 60).
7. Oblique sagittal T2 with STIR (TR 4000, TE 60).

(Field of view, 120 mm; 4-mm thick slice with 0.4-mm gap and 320x512 matrix; 4 excitations)

The total scanning time was about 7min.

RESULTS

Ultrasound and magnetic resonance imaging were obtained for the 50 patients included in this study. On the basis of that imaging finding, the study population was classified into five groups. Group one rotator cuff tears (18 patients), Group two rotator cuff tendinosis (8 patients), Group three acromioclavicular joint lesions (4 patients), group four Hill Sach's fracture (11 patients) and Group five long head of biceps tendon lesions (9 patients).

Rotator cuff tears group, according to our U/S diagnosis, 5 cases were diagnosed as complete (full thickness) rotator cuff tears, 9 cases were diagnosed as partial rotator cuff tear, while 4 cases were diagnosed as normal cuff, and according to our MRI diagnosis 5 cases were diagnosed as complete (full thickness) rotator cuff tear, 11 cases were diagnosed as partial rotator cuff tear, while 2 cases were diagnosed as normal supraspinatus tendon with no abnormal signal intensity changes could be detected

Rotator cuff tendinosis group, according to US criteria for rotator cuff tendinosis 5 cases were diagnosed as tendinosis, while 3 cases were diagnosed as normal cuff, and according to MRI criteria for rotator cuff tendinosis 6 cases were diagnosed as tendinosis, while two cases were over diagnosed as partial tear.

Acromioclavicular joint lesions group, according to our U/S diagnosis, 2 cases were diagnosed as osteoarthritis, while 2 cases were diagnosed as joint separation, and according to our MRI diagnosis, 2 cases were diagnosed as joint separation, 2 cases were diagnosed as osteoarthritis.

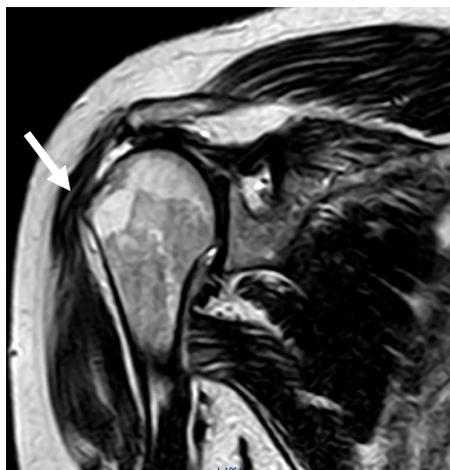
Hill Sach's fracture group, according to our U/S diagnosis, 7 cases were diagnosed as Hill Sach's fracture, of them 5 cases were associated with Bankart lesion, while 4 cases was diagnosed as normal, and according to our MRI diagnosis, 11

cases were diagnosed as Hill sach`s fracture, 7 of them were associated with Bankart lesion. Long head of biceps tendon lesions group, according to our US criteria, 4 cases were diagnosed as biceps tenosynovitis, 2 cases were diagnosed as biceps tendon instability, while 3

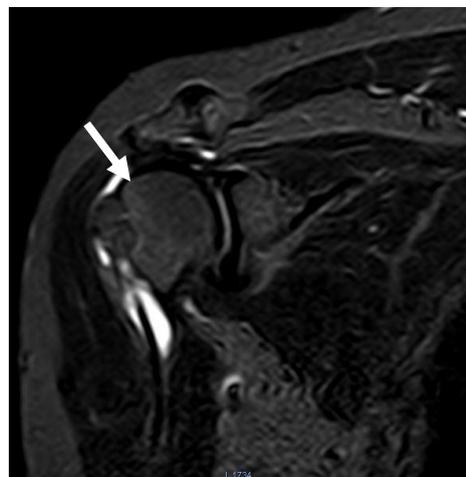
cases were diagnosed as normal, and according to our MRI diagnosis, 4 cases were diagnosed as biceps tenosynovitis and 2 case as tendon instability while 3 cases were diagnosed as normal.

Table 1: Comparison between the radiological diagnosis and pathological diagnosis in 50 cases with shoulder trauma

Final pathological Diagnosis	No. of cases	Final radiological Diagnosis by MRI	No. of cases	Final radiological Diagnosis by ultrasound	No. of cases
Partial rotator cuff tear	11	Partial rotator cuff tear	11	Partial rotator cuff tear	9
Complete rotator cuff tear	7	Complete rotator cuff tear	5	Complete rotator cuff tear	5
Rotator cuff tendinosis	8	Rotator cuff tendinosis	6	Rotator cuff tendinosis	5
Acromioclavicular OA	2	Acromioclavicular OA	2	Acromioclavicular OA	2
Acromioclavicular separation	2	Acromioclavicular separation	2	Acromioclavicular separation	2
Hill Sach`s fracture	11	Hill Sach`s fracture	11	Hill Sach`s fracture	7
Biceps instability	2	Biceps instability	2	Biceps instability	2
Biceps tenosynovitis	7	Biceps tenosynovitis	4	Biceps tenosynovitis	4



(A)



(B)



(C)

Fig (1):

A female patient 35 years old age with long history of right shoulder pain with limited movement

- (A) **MRI coronal oblique T2WI:** shows a gap filled with fluid high signal intensity replacing the whole thickness of supraspinatus tendon extending between articular and bursal surfaces (white arrow)
- (B): **MRI coronal oblique STIR:** confirm the exaggerated high signal intensity area which involves the whole thickness of the supraspinatus tendon (white arrow).
- (C) : **Transverse ultrasound image of supraspinatus tendon** reveals a hypoechoic defect involving the whole thickness of the supraspinatus tendon (white arrow).

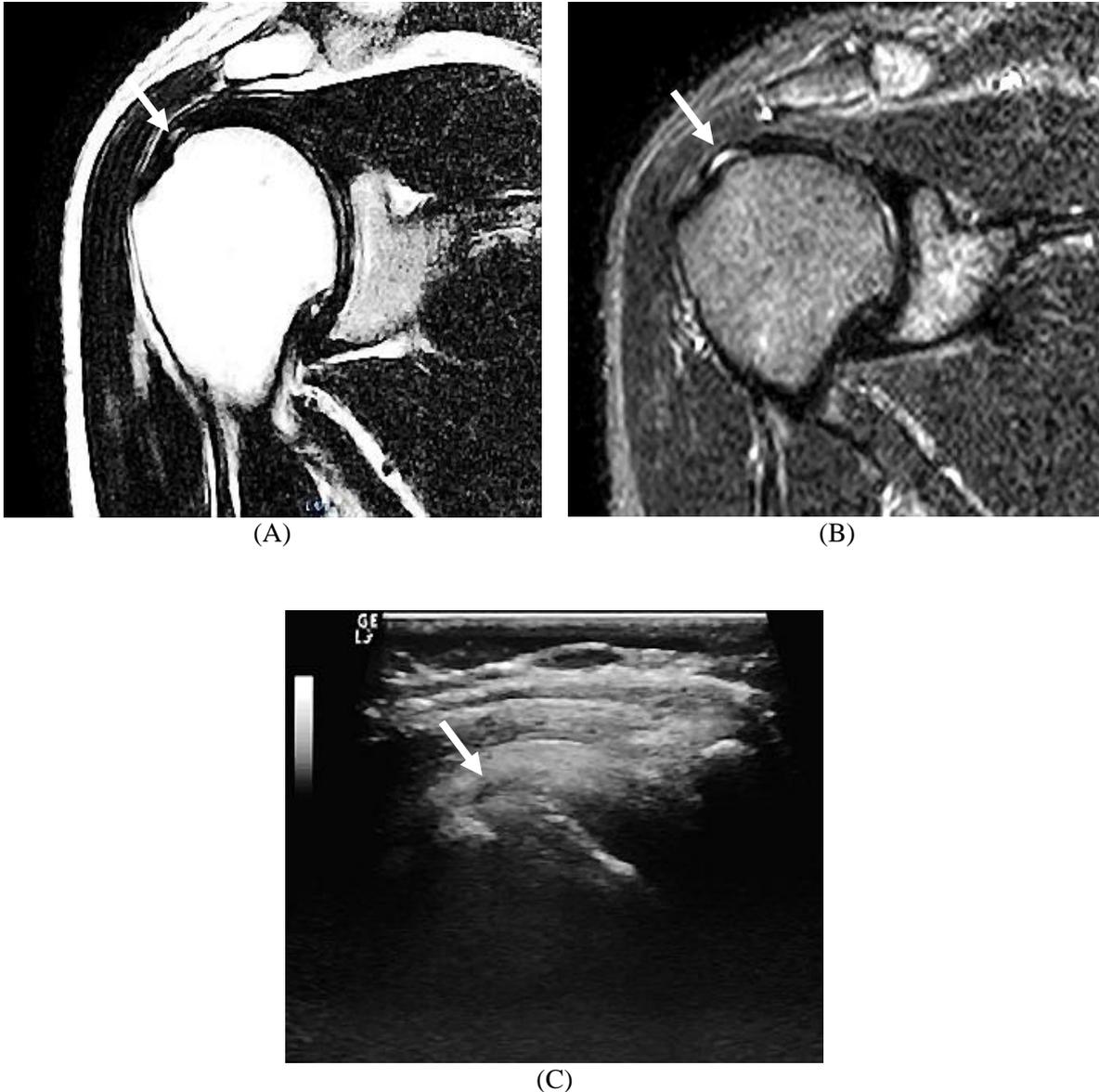


Fig (2):

A male patient 50 years old age with long history of shoulder pain and limited movement of his right shoulder.

(A) **MRI Coronal oblique T2WI:** shows abnormal high signal involving articular surface of supraspinatus tendon (white arrow).

B) **MRI Coronal oblique STIR:** showing high signal intensity area at articular surface of supraspinatus tendon (white arrow).

D) **Transverse ultrasound image** show a hypoechoic defect at articular surface of supraspinatus tendon (white arrows).

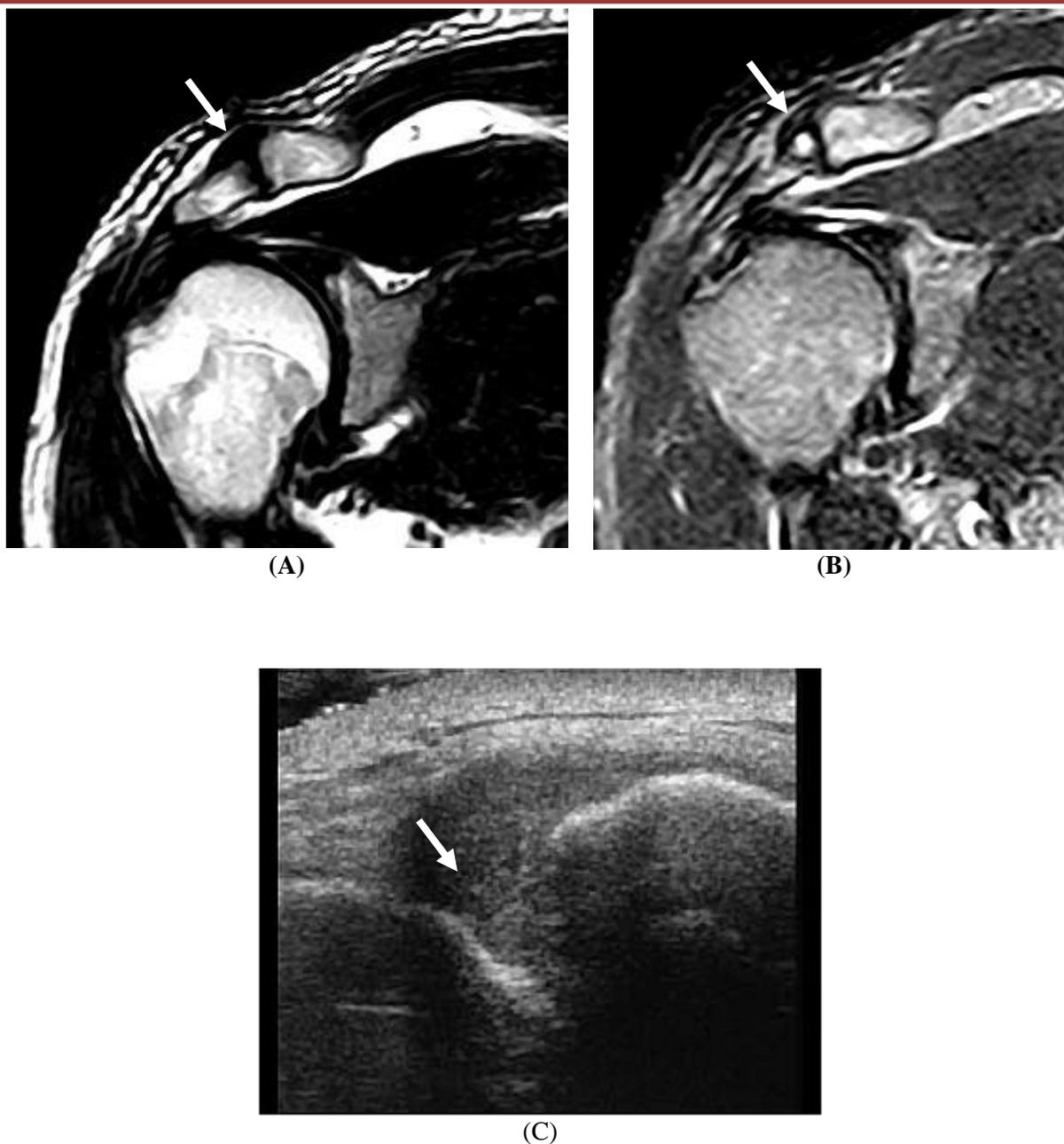
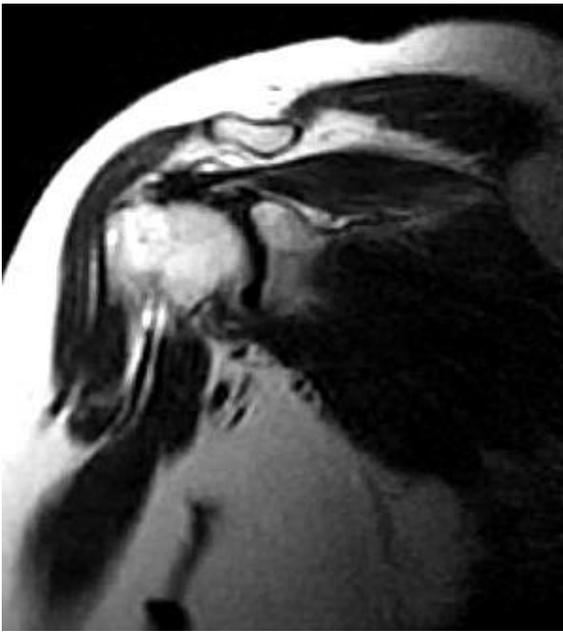


Fig (3):

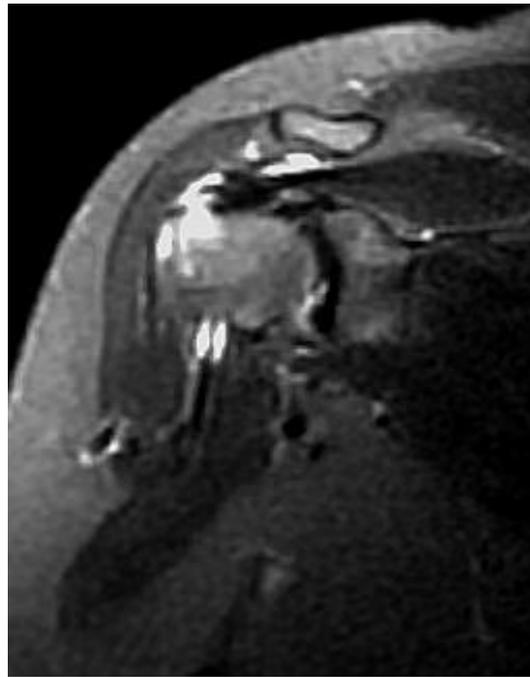
A male patient 45 years old complaining of pain localized over acromioclavicular joint, associated with limited movement of his shoulder joint.

(A) MRI coronal oblique T2WI & B) MRI Coronal oblique STIR: of acromioclavicular joint show bone surface irregularity (white arrows).

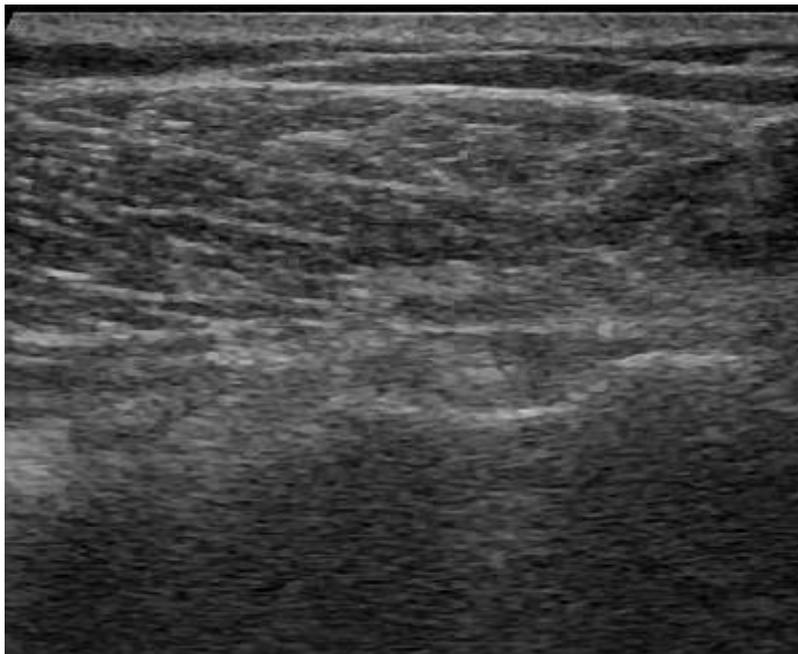
(C): Ultrasound image of acromioclavicular joint shows bone surface irregularities (white arrow).



(A)



(B)



(C)

Fig (4):

A female patient 47 years old with history of pain over bicipital groove radiating to the elbow increases with shoulder flexion and forearm supination especially at night.

A) MRI Coronal oblique T2WI show abnormal high signal fluid collection surrounding the biceps tendon (white arrow).

B) MRI Axial oblique gradient weighted image show abnormal high signal fluid collection (white arrow) surrounding the biceps tendon.

C) Transverse ultrasound scan of biceps tendon (white arrow) of the same patient reveal abnormal hypoechoic fluid collection within the tendon sheath.

DISCUSSION

The shoulder is a joint capable of great freedom and motion. It is therefore both inherently unstable and subject to injury. Shoulder pain is thus a common clinical problem⁽⁵⁾.

Imaging plays an important role in the assessment of post traumatic shoulder disorders includes ultrasono-graphy and conventional magnetic resonance⁽⁶⁾.

The present study included 50 patients presented with shoulder pain and limited movement. The final diagnosis was achieved by radiological examination using US and MRI in all patients. Our results were correlated with surgical or arthroscopic results, as well as clinical evaluation and follow up of patients with conservative management including physiotherapy and medical treatment and surgical results.

In this study we divided patients into 5 groups:

Group 1: Rotator cuff tears, **Group 2:** Rotator cuff tendinosis, **Group 3:** acromioclavicular joint lesions, **Group 4:** Hill Sach`s fracture and **Group 5:** Biceps tendon lesions

In rotator cuff tears group five cases were diagnosed as rotator cuff complete tear by both MRI and Us and nine cases were diagnosed rotator cuff partial tear by US and eleven cases by MRI this is in agree with⁽⁷⁾ who stated that partial or incomplete tears are thought to be twice as common as complete or full thickness tears of the rotator cuff.

In our study among 11 patients diagnosed by MRI as partial thickness tear, the commonest type was articular surface type (5 cases), followed by intrasubstance type (4 case) followed by bursal surface type (2 cases), this agree with⁽⁸⁾ who stated that articular surface partial-thickness tears are the commonest type.

MRI missed one case of partial thickness tear this may be attributed to absence of joint effusion or presence of granulation tissue or scaring this is in agree with⁽⁹⁾ who stated that in the absence of joint effusion, articular surface partial-thickness tears may be difficult to be identified, particularly in the setting of granulation tissue or scarring.

In our study both ultrasound and MRI were equally able to detect full thickness rotator cuff tear this is in agree with⁽⁸⁾ and⁽¹⁰⁾ who stated that either MRI or sonography could be used for equal detection of full thickness rotator cuff tears.

In our study US and MRI was similarly accurate in detection of complete rotator cuff tear, however for partial tear the US appear less accurate than MRI this is in agree with⁽¹⁰⁾ who showed that ultrasonography was accurate as MRI for predicting the full thickness tears but less for moderate and small tears.

In rotator cuff tendinosis group 5 cases were diagnosed by US and 8 cases by MRI this is in agree with⁽⁹⁾ who mentioned that MRI is probably more sensitive than US in the detection of degeneration.

In acromioclavicular joint lesions group, 2 cases were diagnosed as osteoarthritis and 2 cases as joint separation by both ultrasound and MRI.

In our study both MRI and ultrasound equally detected acromioclavicular joint lesions this is in agree with⁽¹¹⁾ who stated that ultrasound can detect ACJ changes as reliable as MRI; however,⁽¹²⁾ stated that the main disadvantage of ultrasound that it can examine anterior superior surface of the acromioclavicular joint but the potentially more inferior surface cannot be inspected.

In Hill sach`s fracture group 7 cases were diagnosed by ultrasound 5 of them were associated with Bankart`s lesion and 11 cases were diagnosed by MRI 7 of them were associated with Bankart`s lesion.

In the current study US misdiagnosed 3 cases of Hill sach`s lesion as normal. This may be due to complex anatomic shape of humeral head so US percentage of error increases this is in agree with⁽¹³⁾ who stated that percentage of US error in diagnosis of fractures increases in consideration to joints as general due to their complex anatomic structure.

Among 7 cases diagnosed by US as Hill Sach`s defect 5 cases were associated with Bankart`s lesion and 3 cases were associated with joint effusion.

In this study MRI diagnosed all cases of Hill Sach`s fracture correctly this is in agree with⁽¹⁴⁾ who stated that MRI has high sensitivity and even superior to arthroscopy in detection of Hill Sach`s lesions.

In our study, diagnosis of tenosynovitis by both ultrasound and MRI was based on presence of large amount of fluid around biceps tendon that is disproportionate with amount of joint effusion this is in agree with⁽¹²⁾ who stated that large quantities of fluid within the biceps tendon sheath could be seen in a number of abnormalities as biceps tenosynovitis and⁽¹⁵⁾ who stated that the volume of fluid around tendon should not greatly exceed that within the joint otherwise abnormality should be suspected such as tenosynovitis.

In this group of patients both ultrasound and MRI equally detected biceps tendon instability however ultrasound allowed dynamic evaluation of the lesion this is in agree with⁽¹²⁾ who stated that the dynamic demonstration of instability of the biceps tendon represent a relative advantage of ultrasound over more or less static Imaging methods as MRI.

In conclusion, our results recommend that US should be increasingly used as the first-line imaging modality in the assessment of traumatic shoulder lesions. Further MRI is needed in order to evaluate the joint in more detailed manner; this will eventually assist in choice of the best line of treatment for the patient as well as taking the final surgical decision.

REFERENCES

1. Javier Beltran and Agustinus Suhardja: Imaging of orthopedic sports injuries F.M Vanhoenacker(eds). Springer, pp 121,2007.
2. Marian V ,Hammar, Goran B, Wintzell, K. Gunnar O and Astrom: Role of ultrasound in the preoperative evaluation of patients with anterior shoulder instability. *Radiology* 2001; 219; 29-34.
3. Martinoli C, Bianchi S, Prato N, et al.,: US of the shoulder, non-rotator cuff disorders. *RadioGraphics* 2003;23:381-401.
4. Quinn SF. Accuracy of fat suppressed MR imaging of the shoulder for detection of partial thickness rotator cuff tears (letter). *Radiology* 1996; 198:293.
5. M Zlatkin MB, Hoffman CJ, Needell S et al., (2003): MRI of the shoulder 2nd edition lippincott Williams&Wilkians.
6. Lecouvet E., Paolo Simoni, Sophi Koutaïssoff, et al.,: Multidetector Spiral CT arthrography of the shoulder. Clinical applications and limits with MR arthrography and arthroscopic correlations. *European Journal of Radiology* 2008; 68: 120-36.
7. Borges AV, Chung CB, Resnick D: MR Imaging and MR Arthrography of the Postoperative Shoulder: Spectrum of Normal and Abnormal Findings. *Radiographics*; 2004;24:69-85.
8. Teefey S Middleton WD, Payne WT., : Sonography and MRI of the shoulder : comparison of patient satisfaction. *AJR* 2004 ;183:1449-52.
9. Kassarian A, Bencardino JT, Palmer WE: MR imaging of the rotator cuff. *Magn Reson Imaging Clin N Am.* 2004;12:39-60.
10. Dinnes J, Loveman E, McIntyre L: The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders :a systemic review .*Health Technol assess* 2003;7:1-166.
11. Alaseerela E ,Tervonen O,Takalo R: Ultrasound evaluation of the acromioclavicular joint, *J Rheumatology Oct.* 1997;24(10): 1954-63.
12. Zanetti M. and Hodler J.: imaging of degenerative and posttraumatic disease in the shoulder joint with ultrasound. *European Journal of Radiology* 2000;35:119-25.
13. Baltrame V,Robert Stramare ,Nicola Rebellato , Federico Angelini, Anna Chiara , Leopoldo Rubaltelli : sonographic evaluation of bone fractures :a reliable alternative in clinical practice .*Clinical Imaging* .2012;36:203-208.
14. Lynne S. Steinbach: Review; MRI of shoulder instability. *European Journal of Radiology* 2008;68: 57-71.
15. Bruce B.Forster and Karim M. Khan. A practical approach to magnetic resonance imaging of normal and injured tendons: pictorial essay, *Can Assoc Radiol J* 2003; 54(4):211-20.

المخلص العربي

تم إجراء هذه الدراسة بقسم الأشعة التشخيصية بمستشفيات جامعة الزقازيق وقد اشتملت هذه الدراسة على خمسين مريضاً تراوحت أعمارهم بين تسعة عشر وسبع وستون عاماً ومتوسط أعمارهم ثلاثة وأربعون عاماً. إنقسم المرضى إلى ثمانية وعشرين من الذكور واثنان وعشرون من الإناث.

تم فحص جميع المرضى باستخدام الموجات فوق الصوتية السطحية والفحص بالرنين المغناطيسي.

تم تقسيم المرضى الي خمس مجموعات تشتمل علي:

- ١- مجموعة قطع العضلات الدوارة .
- ٢- مجموعة اعتلال أوتار العضلات الدوارة .
- ٣- مجموعة أصابات المفصل الأخرمي الترقوي.
- ٤- مجموعة أصابة الهيل ساكس.
- ٥- مجموعة اعتلال وتر العضلة ثنائية الرأس.

في مجموعة قصع العضلات الدوارة كان التشخيص بالرنين المغناطيسي أكثر دقة؛ حيث شخصت به ست عشر حالة في حين استطاعت الأشعة فوق صوتية في تسخيص اربعة عشر حالة من اجمالي ثمانية عشرحاله.

وفي مجموعة اعتلال أوتار العضلات الدوارة كان التشخيص بالرنين المغناطيسي اكثر دقة من الموجات فوق صوتيه؛ حيث شخصت به ست حالات بواسطة الرنين المغناطيسي بينما شخصت خمس حالات بواسطة الموجات فوق صوتية من إجمالي ثماني حالات.

وفي مجموعة أصابات المفصل الأخرمي الترقوي كانت الموجات فوق صوتية في نفس دقة الرنين المغناطيسي. فكلاهما شخص حالتين لأنفصال المفصل الأخرمي الترقوي ، وحالتين بهما التهابات مفصليه عظمية بالمفصل ذاته.

وفي مجموعة أصابة الهيل ساكس كان التشخيص بالرنين المغناطيسي أكثر دقة من الموجات فوق صوتية، حيث تمكن الرنين المغناطيسي من تشخيص احد عشر حالة؛ سبعة منها مصحوبة بأصابة بانكرت بينما تمكنت الموجات فوق صوتيه من تشخيص سبعة حالات ؛ خمس منها بها اصابة بانكرت من اجمالي احد عشرحاله.

أما في حالات اعتلال وتر العضلة ثنائية الرأس كانت الموجات فوق الصوتية في نفس دقة الرنين المغناطيسي ؛ فكلاهما شخص اربعة حالات التهابات غمدالوتر وحالة حالتان لعدم أتران وتر العضلة ثنائية الرأس من اجمالي تسعة حالات لاصابات وتر العضلة ثنائية الرأس.

وعلى ذلك:

توصي نتائج هذه الدراسة باستخدام الموجات فوق الصوتية بصورة متزايدة كوسيلة خط أول في تقييم اصابات الكتف، وان هناك حاجة ضرورية للتشخيص بالرنين المغناطيسي لتقييم أصابات مفصل الكتف بصورة أكثر تفصيلا، حيث سيساهم ذلك في اختيار الطريقة المثلى للعلاج وفي اتخاذ القرار الجراحي.