Original Research Article

Diagnostic accuracy of ultrasound in adhesive capsulitis of shoulder joint

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Abstract

Introduction: Adhesive capsulitis or frozen shoulder is an inflammatory process that causes progressive capsular retraction of the shoulder joint. Magnetic resonance imaging (MRI)is currently considered as the modality of choice for imaging shoulder disorders, but for high cost and limited availability. Ultrasound is a potential investigating modality to diagnose the condition. **Methodology:** A single centre observational study was conducted on 180 subjects from the out-patient department of the orthopedic department, KMCT medical college hospital, Kozhikode, with shoulder pain who were referred to the radiology department for MRI examination. Ultrasound findings in these subjects were compared with those of MRI. **Conclusion:** This study concludes that ultrasound is a reliable modality for diagnosing adhesive capsulitis of shoulder joints with a reasonable degree of sensitivity, specificity, negative predictive valurand positive predictive value. A high rate of visualization of coracohumeral ligament further reiterates the reliability of this parameter for diagnosing adhesive capsulitis.

Keywords:ultrasound,shoulder

Introduction

Adhesive capsulitis or frozen shoulder is an inflammatory process that of the shoulder joint which is frequently seen in women compared to men. Approximately 2 to 5% of the general population is affected by this condition[1]. Trauma, immobilization, hemiplegia, diabetes mellitus, and cervical disk disease are the most common predisposing factors. The incidence in diabetes mellitus is about 20%. Clinically, adhesive capsulitis is characterized by shoulder pain at rest, at night, and with motion. These symptoms may mimic impingement and rotator cuff tears. Limitation of movement is seen in this condition, mainly of abduction and external rotation, which is progressive. The process is self-limited and usually lasts 12 to 18 months[1].

Ultrasound has emerged as one of the important diagnostic modalities for musculoskeletal imaging during the past decade. With technological advancement, ultrasound has become easier to use, more portable, and more affordable than ever. Modern ultrasound machines have excellent soft tissue penetration capability and good spatial resolution. The number of musculoskeletal ultrasound investigations has also increased manifold in the last few years. Many conditions which were entirely relied on the clinical expertise of treating doctors in the past are being diagnosed by newer modalities like ultrasound and MRI, adhesive capsulitis of shoulder joint being one of them[1].

Magnetic resonance imaging (MRI); with multiplanar capability, high soft-tissue resolution and, the absence of ionic radiation is currently considered as themodality of choice for imaging shoulder disorders, but for high cost and limited availability.

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Due tothe non-availability of a reliable investigation in many rural parts of the country, adhesive capsulitis remains an underdiagnosed or misdiagnosed condition of the shoulder joint. Ultrasound is a potential modality that can be made use to evaluate pathological changes of adhesive capsulitis in the rotator cuff and coraco-humeral ligament. Ultrasound is inexpensive, fast, and can be used in peripheral setups[2].

Currently, only a few studies are available wherein investigators have used ultrasound to diagnose adhesive capsulitis and to differentiate it from other causes of the painful shoulder. There is no consensus on criteria to diagnose adhesive capsulitis by ultrasound examination. This study will hopefully help to fill the vacuum in differentiating adhesive capsulitis from other causes of a painful shoulder. The accurate and timely diagnosis by ultrasound is bound to reduce the cost and time delay in instituting an appropriate management strategy.

Methodology

The study was conducted by collecting data from 180 patients from the out-patient department of the orthopedic department, KMCT medical college hospital, Kozhikode, with shoulder pain who were referred to the radiology department for MRI examination.Based on MRI findings, the subjects were divided into two groups. Those diagnosed with adhesive capsulitis **(AC group)** and those who did not have features of adhesive capsulitis (**non-AC group).** Each ultrasound parameter (namely coraco-humeral ligament thickness, soft tissue in rotator interval and increased vascularity in rotator interval) was subjected to comparison taking MRI as the reference standard. The sensitivity, specificity, positive predictive value and negative predictive value of each parameter were calculated.

To compare Coracohumeral ligament accessibility, the non-AC group was divided into two groups: patients with imaging findings other than adhesive capsulitis (PS group) and patients with no pathological findings at all (normal subjects).

Figure : I llustration of probe positioning in the oblique axial plane to assess CHL thickness

Inclusion criteria

After obtaining approval from the institutional ethic and Research committees and written informed consent from all the participants, an observational study was conducted on a total of 180 patients. All the participants were orthopaedic outpatients with shoulder pain referred to the Radiodiagnosis Department, K M C T Medical college for MRI examination of the shoulder.

Exclusion criteria

- Non-consenting patients
- Patient unwilling for an ultrasound examination.
- Patients with a history of acute trauma.
- History of surgery to the shoulder.
- Patients having contraindications for MR imaging like metallic implants, cochlear implants etc.
- Claustrophobia

Results

Out of 180 patients with shoulder pain who underwent MRI examination, 55 were diagnosed with adhesive capsulitis and 125 were grouped into non-adhesive capsulitis group. Another experienced independent radiologist blinded to the MRI findings then assessed three ultrasound parameters, namely coracohumeral ligament thickness, abnormal soft tissue in the rotator interval, and increased vascularity in the rotator interval assessed by Doppler evaluation

1. CHL thickness

Coracohumeral ligament (CHL) was found significantly thickened in the adhesive capsulitis group (AC group) compared to the non-adhesive capsulitis group (non-AC group) (P value 0.001). The mean thickness of CHL in the AC group was 2.6 mm, and in the non-AC group, it was 1.29 mm.

Table:Mean thickness of CHL in AC group vs non-AC group.

	CHL thickness in mm				P value
MRI diagnosis		Mean	SD	Standard error of mean	
	AC	2.60	0.50	0.06	0.001
	Non-AC group	1.29	0.15	0.01	

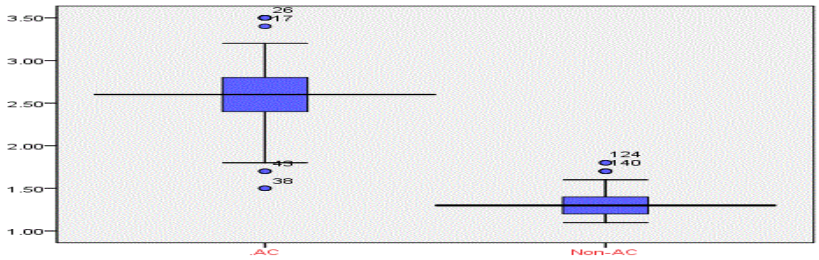

Figure: Box plot demonstrating comparison of CHL thickness (in mm) in the two groups.

The ROC analysis was performed to estimate thediagnostic cut off value of CHL thickness. Using 1.8 mm as an optimal cut-off value, we achieved a high sensitivity of 92.72 % and a high specificity of 98.4 %. At 1.8 mm, the area under the curve is 0.995 which shows our diagnostic parameter (CHL) is excellent (p-value 0.001).

	MRI			sensitivity	specificity	NPV	PPV
CHL thickness in mm		AC	Non-AC	92.72%	98.40%	96.85%	96.22%
	>1.80	51(TP)	2(FP)				
	<1.80	4(FN)	123(TN)				

2. Abnormal soft tissue in rotator interval

The increased soft tissue in rotator interval was found in 35 out of 55 subjects in the AC group and 3 out of 125 subjects in the non-AC group. This parameter had a sensitivity of 69.09 % and a high specificity of 91.2 % in diagnosing adhesive capsulitis.Postive predictive value and negative predictive value were 77.55% and 87.02% respectively.

3. Increased vascularity in rotator interval

Increased vascularity in RI was found in only 11 out of 55 subjects in the AC group. However, it was significantly higher when compared to the subjects with positive findings in the non-AC group (3 out of 125). This parameter had a sensitivity of 20 % and a high specificity of 97.6 % in diagnosing adhesive capsulitis. Positive predictive value and negative predictive value were 78.57% and 73.49% respectively.

4. Diagnostic accuracy of ultrasound combining all three parameters.

Combining all three parameters, sonography showed an overall high sensitivity of 98.18 % and high specificity of 91.2 % for the diagnosis of adhesive capsulitis, taking MRI as the reference standard. It had a high PPV (83.07 %) and NPV (99.13%) as well.

5. Secondary objective: Ultrasound accessibility of coracohumeral ligament.

Coracohumeral ligament was well visualized in 167 out of 180 patients. The rate of non-visualization was 5.45 % in the AC group

and 8% in the non-AC group. Among the non-AC group, the rate of non-visualization was highest in patients with normal MRI study findings (normal subjects) than subjects with findings other than adhesive capsulitis (painful shoulder).

Discussion

The present study on imaging features of adhesive capsulitis showed that ultrasound features had a high diagnostic accuracy for adhesive capsulitis when three parameters were combined.

Coracohumeral thickness

The coracohumeral ligament (CHL) was found to be significantly thicker in the adhesive capsulitis group (AC group) when compared to the non-adhesive capsulitis group (non-AC group). The mean thickness of CHL in the AC group was 2.6 mm which was significantly higher when compared to that ofthe non-AC group (1.29 mm). Taking 1.8 mm as the optimal cut-off value for CHL thickness we could attain high sensitivity (92.72 %) and specificity (98.4 %) for the diagnosis of adhesive capsulitis. CHL thickness had a positive predictive value (PPV) of 96.22 % and a negative predictive value of 96.85%.

Abnormal soft tissue in the rotator interval

The abnormal soft tissue in rotator interval was the second ultrasound parameter evaluated in this study. It had a sensitivity of 69.9% in diagnosing the condition. Notably, this parameter had a high specificity of 91.2 %. Also, all patients with abnormal soft tissue in rotator interval had thickened coracohumeral ligament.

Increased vascularity in rotator interval

The third parameter evaluated was vascularity of rotator interval using color Doppler ultrasound technique. It had a sensitivity of 20 % which is low compared to the other two parameters and had a high specificity of 97.6 % in diagnosing adhesive capsulitis.

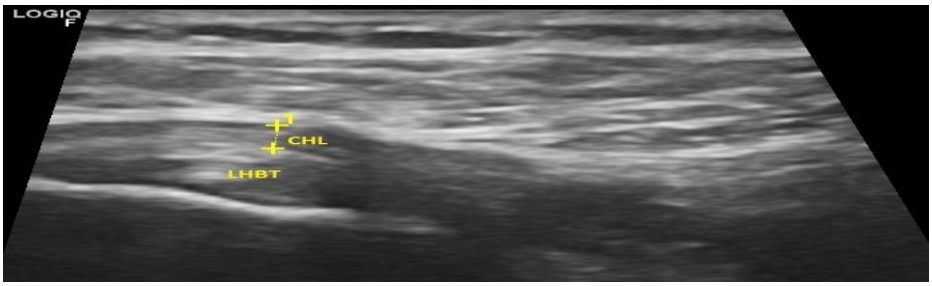

Figure: Oblique axial ultrasound image of rotator interval in a patient with adhesive capsulitis showing thickened CHL (coracohumeral ligament) measuring 2 mm. LHBT: Long head of bices tendon.

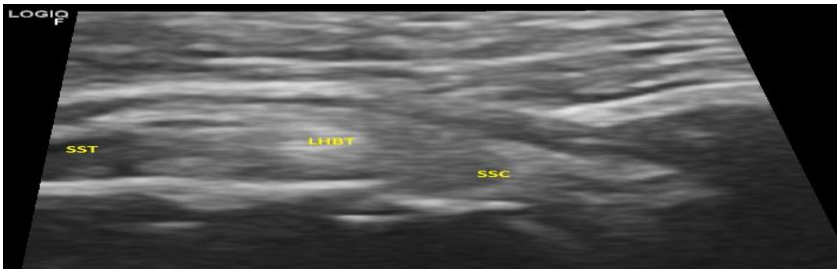

Figure. Ultrasound image of patient with adhesive capsulitisshowing abnormalsoft tissue in rotator interval.SST: Supraspinatus, LHBT: Long head of biceps tendon, SSC: Subscapularis.

Combining all three parameters, ultrasound had a high overall diagnostic accuracy for adhesive capsulitis. It had a sensitivity, specificity, positive predictive value, and negative predictive value of 98.18%, 91.2%, 99.13%, and 83.07% respectively, taking MRI as a reference standard.

Accessibility of coracohumeral ligament

Out of 180 pateints, CHL was visualized in 167 patients. The rate of sonographic visualization of CHL was better in the adhesive capsulitis group (94.5%) when compared to the non-adhesive capsulitis group (92%). The non-visualization of CHL was highest in subjects with normal MRI study. In these patients, the non-visualization was attributable to obesity. Non-visualization in patients with other shoulder pathologies was predominantly due to limited range of motion which restricted ultrasound visibility of CHL.

This result is comparable with a study conducted by C Homsi et al in 306 individuals[4] to assess the diagnostic accuracy of coracohumeral ligament thickness in adhesive capsulitis. The average thickness of CHL in this study (3 mm) is comparable with that of what we could obtain (2.6 mm). While we assessed three parameters and evaluated the overall accuracy of ultrasound, they assessed only theaccuracy of CHL thickness. Both oblique axial and sagittal views of CHL were assessed by Homsi et al. But in the present study sagittal view was difficult to demonstrate in patients with significant soft tissue in rotator interval. Hence, the thickness of CHL is evaluated in oblique axial view only.

A similar study conducted by Jong Geol et al[9] found coracohumeral ligament thickness and rotator interval involvement to have a significant correlation with clinical findings such as limited range of motion. In addition to the three parameters of present study, Jong Deol et al conducted study on two additional parameters such as effusion of the long head of biceps tendon sheath and axillary recess thickness. All these parameters had a significant correlation with clinical findings except altered vascularity in the rotator interval. In comparison, we could achieve a sensitivity of 20 % and a high specificity of 97.6 % for this parameter. The difference could be due to the stages of adhesive capsulitis at which the studies were conducted. The mean thickness of CHL in this study (2.7 mm) was comparable to what we could achieve (2.6 mm). Diagnostic cut-off of 2.2 mm for CHL thickness achieved the highest sensitivity and sensitivity in this study, while we achieved the highest sensitivity and specificity with a cut-off value of 1.8 mm. The slight difference could be explained by the difference in reference standards used.

The role of ultrasound in diagnosis of adhesive capsulitis was also assessed by A. Tandon et al[10]. who evaluated a total of 90 subjects. The mean thickness of coracohumeral ligament calculated in this

study was 0.7 mm among patients with adhesive capsulitis, which is lower than what we could obtain. This difference is attributable to the difference in position of the arm while assessing the ligament. Tandon et al. evaluated CHL with arm in external rotation which stretches the ligament and reduces average thickness. While we assessed the CHL with the arm in a neutral position. In addition to three static parameters in our study, they included two dynamic parameters ofrestricted abduction and restricted external rotation in their study. Both these parameters had high sensitivity and specificity in diagnosing adhesive capsulitis.A comparison of the present study with other research studies and literature on the subject agrees that ultrasound is a reliable modality for diagnosing adhesive capsulitis of shoulder joints with a reasonable degree of sensitivity, specificity, NPV, and PPV. A high rate of visualization of coracohumeral ligament further reiterates the reliability of this parameter for diagnosing adhesive capsulitis. Further research on ultrasound evaluation of adhesive capsulitis of shoulder joint can be done to find out association of axillary recess thickening, dynamic ultrasound parameters and to evaluate imaging features in various stages of the illness.

Conclusions

Ultrasound has high accuracyin diagnosing adhesive capsulitis when three parameters(ie.coracohumeral ligament thickness, abnormal soft tissue in the rotator interval, and increased vascularity in the rotator interval assessed by Doppler evaluation) are combined. The sensitivity, specificity, positive and negative predictive value of ultrasound for diagnosing adhesive capsulitis was 98.18%, 91.2%, 99.13% ,and 83.07% respectively, taking MRI as the reference standard.

Conflict of Interest

Nil

Source of support

Nil

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