Background & objectives: Adhesive capsulitis of the shoulder is a condition of unknown aetiology that results in the development of restricted active and passive glenohumeral motion. It has been reported that magnetic resonance (MR) imaging is useful in diagnosing adhesive capsulitis. We carried out this study to assess how pain and/or resistance during contrast material injection affects the diagnosis of adhesive capsulitis on magnetic resonance (MR) arthrography.

Methods: The study included MR arthrography examinations of 21 patients with a diagnosis of adhesive capsulitis. The control group consisted of 20 patients who presented clinically with rotator cuff tear. The pain (visual analog scale, VAS), resistance to injection and the amount of contrast material that could be injected during injection phase of MR arthrography was assessed and compared between groups.

Results: The patients in adhesive capsulitis group (mean VAS score 66.5±25.5) experienced more pain when compared with the control group (mean VAS score 34.9±27.7, \( P<0.001 \)). A statistically significant difference \( (P<0.001) \) in terms of the amount of the injected fluid (4.3±2.6 ml for adhesive capsulitis group, and 10.9±4.1 ml for control group) was seen into the joint cavity. Resistance to injection was significantly more \( (P<0.001) \) in patients with adhesive capsulitis when compared to control group.

Interpretation & conclusion: Experience of pain during injection, a decreased amount of contrast material injected and resistance to injection in patients during injection phase of MR arthrography may suggest adhesive capsulitis.

Key words Adhesive capsulitis - magnetic resonance (MR) arthrography - shoulder
Adhesive capsulitis also known as frozen shoulder, is a common inflammatory condition of the shoulder joint that may be associated with trauma, osteoarthritis, or rheumatic disorders. Idiopathic cases have also been reported. The disease manifests itself as inflammation of the synovial surface of the joint capsule, the capsular ligaments, the periarticular tendons and bursa. Histologically the capsule and synovium are thickened. The condition is clinically characterized by painful restriction of motion of the shoulder joint. This condition should accurately be diagnosed to be effectively treated; however, its correct diagnosis might be difficult because many shoulder conditions have similar clinical symptoms.

Various imaging modalities are used to identify adhesive capsulitis. Especially magnetic resonance (MR) arthrography has gained popularity in recent years. Although there are many studies in the literature dealing with the MR arthographic findings of adhesive capsulitis, the results are a little confusing. Some report decreased joint volume, obliteration of the axillary recess and variable filling of the biceps tendon sheath on MR arthrography studies. The coracohumeral ligament thickening was demonstrated in some studies, while others have not confirmed this finding on MR arthrography studies. Mengiardi and coworkers defined the specific MR arthrographic criteria that may be used in the diagnosis of adhesive capsulitis.

The aim of this study was to evaluate whether clinical signs, such as pain and/or resistance to injection, and the amount of injected contrast material have an effect on the diagnosis of adhesive capsulitis on MR arthrography studies.

**Material & Methods**

A total of 33 consecutive patients with clinical suspicion of adhesive capsulitis were prospectively examined and MR arthrography examinations of the shoulder were performed between January 2004 and November 2005 in the department of Radiology at Cerrahpasa Hospital, Istanbul, Turkey. The strict MR arthrography criteria described by Mengiardi and coworkers for the diagnosis of adhesive capsulitis were used. Twelve patients were excluded from the study since they did not fulfill the MR arthrographic criteria. The adhesive capsulitis group (group 1) consisted of 21 patients (9 women and 12 men). The control group consisted of 20 consecutive patients (10 women and 10 men) presented clinically with rotator cuff tear (group 2) without MR diagnosis of adhesive capsulitis. The mean age of the patients in group I was 41±10.2 yr (range 23 to 55 yr), and those in group II was 40±11.4 yr (range 21 to 57 yr).

The patients underwent standard shoulder MR imaging with a 1.5-T Symphony scanner (Siemens Medical Solutions, Erlangen, Germany) prior to contrast material injection. Coronal oblique T1-weighted (TR/TE, 375/10) and T2-weighted (TR/TE, 3500/111), sagittal oblique T2–weighted (TR/TE, 3500/111), and axial gradient echo (TR/TE, 600/19) images were acquired. A shoulder array coil was used for the MRI examinations. All sequences were performed with a 20 cm field of view, a 4 mm slice thickness, and the matrix was 192x156.

After the pre-contrast MR examination under fluoroscopy guidance intra-articular injection of contrast solution was performed. The physician who performed the injection was blinded both to the patient’s clinic and pre-contrast MR examinations. A 15 milliliter of diluted gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany) syringe was prepared with a concentration of 2 mmol/l. Under fluoroscopic guidance a 20-gauge needle was advanced into the joint by using an anterior approach. After removing the inner stylet, the syringe then was connected to the needle to perform the intra-articular dilute contrast injection. The injection process was terminated whenever there was a resistance to injection that did not allow dilute contrast passage, or it was terminated whenever the patient experienced severe pain in the shoulder.
After the intra-articular injection the patient was asked to grade the pain during injection. They were especially warned not to grade the initial needle passage but the pain that occurred during injection. The shoulder pain was graded based on the visual analog scale (VAS), with 0 corresponding to no pain to 100 corresponding unbreakable pain. The mark placed on the scale by the patient was then measured by a ruler. The measurements were performed and recorded by a physician who was blinded to the clinical and MR arthrographic findings of the patient. The physician who performed the dilute contrast material injection noted the presence of resistance to injection and the amount of dilute contrast solution that was injected. Resistance to injection was not present when 15 ml of dilute contrast medium could be injected without any force. Resistance was experienced when the amount of dilute contrast material injection was less than 5 ml due to presence of force.

The images were reviewed by two experienced musculoskeletal radiologists (KK, MHY) who were blinded to the clinical manifestations and to the degree of pain and resistance during dilute contrast injection of the patients. Quantitative and qualitative inclusion criteria for the diagnosis of adhesive capsulitis were as follows. Quantitative criteria: (i) a coracohumeral ligament thickness of 4 mm or more, (ii) thickness of capsule at the rotator cuff interval of 7 mm or more; qualitative criteria: (i) an abnormal coracohumeral ligament, (ii) obliteration of the subcoracoid fat triangle, and (iii) synovitis-like abnormality at superior border of subscapularis tendon. The diagnosis of adhesive capsulitis was established by the presence of both quantitative criteria and at least two of the three qualitative criteria. Analysis of the MR images was performed by measuring quantitatively the coracohumeral ligament (CHL) and joint capsule thickness at the rotator cuff interval. The thickest portion of the CHL was measured on sagittal oblique images. The thickest portion of the capsule was determined in the rotator cuff interval. For measurement in the rotator cuff interval, the sagittal oblique image 1.5 cm lateral to the base of the coracoid process was used. Qualitative measurements for subcoracoid fat triangle obliteration, synovitis like abnormalities at superior border of subscapularis tendon and CHL assessment were performed on sagittal oblique views. The study protocol was approved from the institutional review board.

Statistical analysis: VAS pain measurements and the amount of injected contrast material in to the joint cavity between patients with and without adhesive capsulitis were compared statistically by Mann-Whitney U test. \( P<0.05 \) was considered significant. The presence of resistance to injection between two groups was compared by Pearson chi square test or Fisher’s exact test. Statistical significance was defined at \( P<0.001 \).

Results

The mean VAS value was 66.5±25.5 (range 23 to 93) for patients with the diagnosis of adhesive capsulitis and it was 34.9±27.7 (range 5 to 80) for patients in the control group, the difference was statistically significant \( (P<0.001, Z = -3.419) \) between the two groups indicating that the patients in the adhesive capsulitis group experienced more pain than those in the control group. The mean amount of fluid that could be injected into the joint cavity was significantly lower \( (P<0.001) \) (4.3±2.6 ml) for the adhesive capsulitis group compared to the control group (10.9±4.1 ml) (Figs 1 and 2).

Resistance to injection was recorded in all 21 patients in adhesive capsulitis group, and 8 patients in control group.

Discussion

The term “frozen shoulder” was first introduced by Neviaser and described it as the chronic inflammatory process of the capsule that subsequently results in capsular thickening, contracture and
adhesion of the humeral head. Histologically, the disease demonstrates inflammation of joint capsule, capsular ligaments of the rotator interval, periarticular bursa, and tendons. These pathological changes in the joint cause the painful restriction of motion associated with adhesive capsulitis.

MR imaging is the most common method for evaluating the shoulder for various disease processes that may present with clinical findings similar to adhesive capsulitis. The MR imaging findings mirror the findings of arthroscopy for the diagnosis of adhesive capsulitis. Contraction of the CHL and thickening of the joint capsule in the rotator cuff interval has been demonstrated in most of the arthroscopic studies. A thickened CHL and joint capsule, decreased axillary recess volume and obliteration of the subcoracoid fat triangle was used for presumptive MR arthrographic diagnosis of adhesive capsulitis. Jung et al. showed that in absence of a full-thickness rotator cuff tear, thickness of capsule and synovium greater than 3 mm at the level of the axillary recess is a practical MR criterion for diagnosing adhesive capsulitis. However, there are discordant results in the literature. None of our patients in adhesive capsulitis group underwent arthroscopy; therefore, we used the most specific MR arthrographic criteria in the diagnosis of adhesive capsulitis.

Based on the histological findings in patients with adhesive capsulitis, such as capsular thickening, contracture and adhesion, we hypothesized that, if these changes create restriction of motion due to pain caused by stretching they should also produce pain when the joint capsule is distended artificially. In our study we observed a statistically significant difference of pain experienced during the injection of dilute contrast material in patients with adhesive capsulitis compared to those with control subjects. Further, not only the experience of pain but also the amount of dilute contrast injected was significantly low in these patients, which could be explained by the inadequate and painful distention of the chronically inflamed joint capsule.
In conclusion, the injected volume of dilute contrast material into the joint in patients with adhesive capsulitis was low when compared to patients without adhesive capsulitis. This may be due to fibrosis of the joint capsule and experience of severe pain during injection. Patient’s experience of pain, resistance to injection and a decreased amount of injected contrast material during injection phase of MR arthrography may suggest adhesive capsulitis.

References


