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Original Article

Correlations between MRI findings and outcome of capsular distension in adhesive capsulitis of the shoulder

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Abstract. [Purpose] The aim of this study was to investigate the association between magnetic resonance imaging (MRI) findings in patients with adhesive shoulder capsulitis and the therapeutic effect of capsular distension. [Subjects and Methods] We retrospectively reviewed the medical records of 57 patients who underwent capsular distension therapy after a diagnosis of adhesive capsulitis with clinical and MRI scans. Axillary joint capsular thickness by MRI was graded as I (≤3.6 mm), II (3.7–4.2 mm), and III (≥4.3 mm). Subcoracoid fat obliteration of the rotator interval was graded subjectively as absent, partial, and complete. [Results] Capsular thickness and fat replacement were correlated with passive range of motion (PROM) and pain score on a visual analog scale (VAS) by analysis of variance with a Bonferroni correction before treatment and by analysis of covariance with a Bonferroni correction after treatment. Visual analog scale (VAS) for patients with all grades decreased significantly after treatment and passive range of motion (PROM) for patients with all grades improved. No difference was detected between grades. [Conclusion] Although MRI is useful to evaluate adhesive capsulitis, MRI findings of shoulder did not predict the prognosis after capsular distension treatment.

Key words: Adhesive capsulitis, Magnetic resonance imaging, Capsular distension

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INTRODUCTION

Adhesive capsulitis is a common painful shoulder disorder that limits active and passive glenohumeral movement[1)]. If treatment is not performed properly at an early stage, more recovery time is needed, and work performance and daily activities are negatively affected. The diagnosis of adhesive capsulitis can usually be made based on symptoms, history, and physical findings. However, it is important to establish the diagnosis to rule out concomitant conditions that may influence treatment of an individual patient. Magnetic resonance imaging (MRI) is generally regarded as the gold standard for shoulder imaging because it has excellent contrast resolution, soft tissue visualization, multi-planar scanning capability, and is non-invasive. Moreover, MRI can be used to distinguish other causes of shoulder pain, such as rotator cuff tear, arthritis, effusion, latent fracture, and labral tears from adhesive capsulitis[2)].

Several studies have reported that specific MRI findings of the shoulder, such as axillary joint capsule thickness, contrast enhancement of the axillary joint capsule, and subcoracoid fat obliteration of the rotator interval, suggest adhesive capsulitis pathology and could be correlated with the clinical condition[3–9)].

Many treatments are available for adhesive capsulitis, including patient education, physical therapy, oral anti-inflammatory

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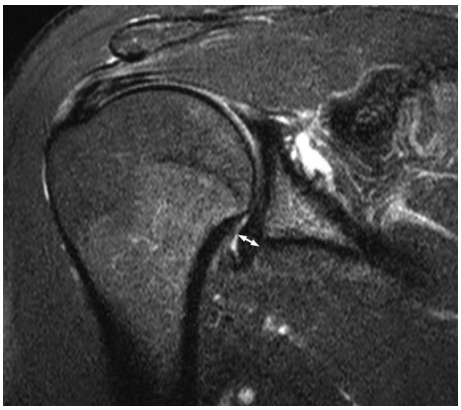

Fig. 1. Joint capsule thickness measurement on T2-weighted fat-suppressed oblique coronal imaging
Capsular and synovial thickness of axillary recess was measured by distance between the high signal fluid and the outer border of the capsule in perpendicular direction to the capsular configuration (arrow).

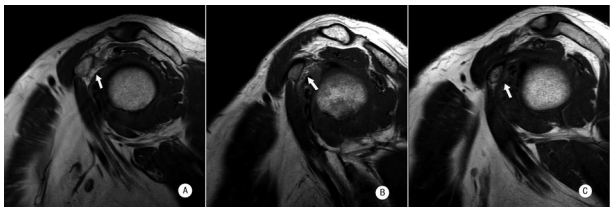

Fig. 2. Subcoracoid fat obliteration of the rotator interval
Replacement of the fat in the rotator interval was graded on a sagittal T1-weighted image as (A) absent, (B) partial, (C) complete (arrow).

drugs, intra-articular injections without capsular distension, capsular distension, suprascapular nerve block, manipulation under anesthesia, capsular release, and stugery[10–13]. Among these treatments, capsular distension has improved pain and shoulder range of motion (ROM) in several studies[14–19].

In this study, we evaluated MRI findings of shoulder in patients with adhesive capsulitis to determine whether they influenced the outcome of capsular distension by comparison with the visual analog scale (VAS) for pain and passive range of motion (PROM) before and after treatment.

SUBJECTS AND METHODS

This study retrospectively analyzed the medical records of 137 patients who underwent capsular distension therapy after the diagnosis of adhesive capsulitis at the physical medicine rehabilitation clinic of a hospital between 2011 and 2014. Informed consent was waived and the Institutional Review Board of the hospital approved this study (2015-SCMC-015-00). A total of 57 patients met the following inclusion criteria: symptom duration >1 month, PROM limitation, normal simple X-ray, no previous shoulder surgery, no neurological deficits affecting shoulder function, and no associated medical conditions, such as rheumatoid arthritis. The inclusion criteria MRI were: a musculoskeletal radiologist reported adhesive capsulitis shoulder MRI findings based on axillary joint capsule thickness, contrast enhancement of the axillary joint capsule, and subcoracoid fat obliteration of the rotator interval.

The capsular distension protocol was composed of ultrasonography-guided capsular distension and physical therapy. Ultrasonography-guided capsular distension was performed using a posterolateral approach with a 23-gauge needle under LOGIQ P5 ultrasound guidance (GE Ultrasound Korea, Seongnam, Korea) with 2% lidocaine (5 ml), triamcinolone (40 mg), and normal saline (14 ml) for a total 20 ml fluid volume. After capsular distension, all patients received physical therapy four times during the first week and then twice weekly for 8 consecutive weeks.

Capsular and synovial thicknesses of the axillary pouch were measured as the distance between the high signal fluid in the axillary recess and the outer border of the capsule in a perpendicular direction to the capsular configuration on T2-weighted fat-suppressed coronal images taken with a 3.0-Telsa MRI scanner (Ingenia, Philips DA, Best, The Netherlands) (Fig. 1). Axillary joint capsular thickness of the shoulder was graded as I (≤3.6 mm), II (3.7–4.2 mm), and III (≥4.3 mm).Replacement of fat in the rotator interval was graded as absent for high signal intensity fat, partial for high signal intensity fat partially replaced by intermediate or low signal intensity, and complete for high signal intensity fat completely replaced by intermediate or low signal intensity. These conditions were observed clearly in the subcoracoid triangle on an oblique sagittal T1-weighted image and were not identified as water on an oblique sagittal T2-weighted image (Fig. 2).

Treatment effects were assessed using the VAS and PROM of the shoulder (flexion, abduction, external rotation, and internal rotation) at baseline and 9 weeks after injection. VAS was scored from 0 (no pain) to 10 (worst pain imaginable) with 1-cm intervals. Shoulder PROM checked by the ability to move the shoulder passively was measured with a conventional goniometer. The measurement included abduction in the frontal plane and forward flexion and external rotation with the arm at 0° abduction. Internal rotation was measured by noting the highest segment of spinal anatomy reached with the thumb. This was scored as 0 (below the buttocks), 1 (below L5), 2 (L1–L5), and 3 (above T12) for the statistical analysis as proposed by Ahn et al[9].

Table 1. Characteristics of the patients depending on fat replacement grades of the rotator interval and capsular thickness of the axillary joint

Fat replacement	Absent	Partial	Complete
Number of patients	19	27	11
Gender (female/male)	12/7	14/13	8/3
Age (years)	50.5 ± 7.0	54.6 ± 10.3	57.6 ± 8.5
Duration (months)	5.2 ± 2.7*	6.9 ± 5.1*	12.5 ± 9.3*
Capsular thickness	I	II	III
Number of patients	18	22	17
Gender (female/male)	9/9	17/5	8/9
Age (years)	53.2 ± 10.6	54.7 ± 8.5	53.2 ± 8.9
Duration (months)	6.8 ± 7.3	7.3 ± 5.7	5.7 ± 3.1

Values are mean ± standard deviation, *p<0.05

Table 2. Comparison of visual analog scale (VAS) and passive range of motion (PROM) at baseline and post treatment according to fat replacement grades of the rotator interval and capsular thickness of the axillary joint

		Fat replacement			Capsular thickness		
		Absent	Partial	Complete	I	II	III
VAS	pre	7.1 ± 1.8	6.6 ± 1.8	7.7 ± 1.1	6.8 ± 1.7	7.4 ± 1.5	6.7 ± 2.0
	post	2.6 ± 1.7*	3.1 ± 1.7*	3.4 ± 2.1*	2.6 ± 1.9*	3.6 ± 1.7*	2.7 ± 1.6*
Fl°	pre	129.5 ± 24.1	119.3 ± 25.3	111.4 ± 31.3	130.0 ± 23.3	115.7 ± 22.9	118 ± 32.6
	post	153.7 ± 27.3*	145.4 ± 24.1*	138.2 ± 32.5*	156.7 ± 22.5*	143.4 ± 27.2*	140.6 ± 29.7*
Abd°	pre	102.4 ± 26.4	102.2 ± 28.7	90.0 ± 23.7	113.3 ± 22.5	92.5 ± 25.5	95.29 ± 29.4
	post	129.0 ± 34.1*	127.8 ± 28.8*	120.0 ± 26.5*	137.5 ± 27.5*	121.8 ± 28.6*	121.5 ± 32.6*
IRscores	pre	1.2 ± 0.7	1.19 ± 0.9	1.3 ± 1.1	1.6 ± 0.7	1.1 ± 1.0	0.94 ± 0.7
	post	2.0 ± 0.9*	2.4 ± 0.8*	2.1 ± 0.9*	2.4 ± 0.5*	2.1 ± 1.0*	2.1 ± 1.0*
ER°	pre	45.5 ± 17.2	44.1 ± 21.7	45.9 ± 28.6	50.8 ± 20.2	41.4 ± 20.8	43.2 ± 23.5
	post	64.5 ± 19.6*	62.6 ± 20.8*	58.2 ± 19.1*	70.8 ± 16.8*	58.4 ± 15.5*	58.5 ± 25.5*

Mean ± SD, *p<0.05.
VAS: visual analogue scale; Fl: flexion; Abd: abduction; IR scores: internal rotation scores; ER: external rotation

Statistical data were analyzed SPSS ver. 18 software (SPSS Inc., Chicago, IL, USA). Differences in gender, age, and symptom duration between the fat replacement and capsular thickness grades were analyzed using the Kruskal-Wallis and Mann-Whitney U-tests. We investigated the differences in improvement on the VAS and PROM based on the fat replacement and capsular thickness grades using analysis of variance with Bonferroni's correction as the post-hoc test at baseline and by analysis of covariance with Bonferroni's correction as the post-hoc test after treatment. A p-value <0.05 was considered significant.

RESULTS

Among the 57 patients in this study, there were 34 females, 23 males. Mean age and symptom duration were 53.81 ± 9.17 years and 6.65 ± 5.64 months respectively. There were 33 dominant and 24 non-dominant shoulders. The clinical characteristics of the patients are shown in Table 1. Symptom duration was significantly different between the grades of fat replacement of the rotator interval, but the other variables were not different between grades.

Mean baseline and post-treatment VAS scores of patients with grades I, II, and III capsular thickness and those of patients with the absent, partial, and complete fat replacement grades were like Table 2. The pain scores of patients in all capsular thickness and fat replacement grades improved significantly after capsular distension treatment, but no difference was detected between the grades. Mean baseline and post-treatment forward flexion, abduction, external rotation angles, internal rotation scores in patients with capsular thickness grades I, II, and III were like Table 2. Mean baseline abduction angles were significantly different between capsular thickness grades I and III (p<0.05). PROM of all patents in all capsular thickness grades improved significantly (p<0.05), but no difference was detected between grades. Mean baseline and post-treatment forward flexion, abduction, external rotation angles, internal rotational scores of patients with the absent, partial, and complete fat replacement grades were like Table 2. PROM of all patients in all fat replacement grades improved significantly, but no difference was detected between grades.

DISCUSSION

In the present study, to compare treatment outcome according to MRI findings, 57 patients with adhesive capsulitis were divided into each 3 groups by the grades of axillary joint capsular thickness or rotator interval fat replacement, respectively. The results of this study showed no significant differences among capsular thickness or fat replacement groups in post-treatment outcomes in VAS and PROMs including forward flexion, abduction and internal and external rotations. On the other hand, there were significant improvements between pre- and post-treatment measurements in all the groups. Based on the current findings, capsular distension treatment was effective regardless of capsular thickness or fat replacement grades. Therefore, such MRI findings might not be influenced to treatment outcome of capsular distension.

The development of musculoskeletal radiology has contributed to the treatment of shoulder disorders. Normal plain X-rays in patients with adhesive capsulitis may rule out other pathologies, such as calcific tendinitis, osteoarthritis, Hill-Sachs lesions, Bankart lesions, dislocation, and fracture. Ultrasound can detect soft tissue pathologies, such as fluid collection and rotator cuff tears, and visualize cartilage and bone surfaces better than those on simple X-rays. Specific adhesive capsulitis findings on ultrasound include increased vascular flow and thickening of the rotator interval structures, and bulging of the supraspinatus tendon rather than smoothly gliding beneath the acromion during abduction[2]. Characteristic MRI findings of adhesive capsulitis are well documented. In 1995, Emig et al.[3] reported that a combined capsule and synovial thickness of the axillary recess >4 mm has 95% specificity and 70% sensitivity for diagnosing adhesive capsulitis. In 1999, Carrillon et al.[4] described gadolinium enhancement of the joint capsule and synovial membrane in all 25 patients evaluated and in the axillary recesses of 22 of the 25 patients with clinical evidence of adhesive capsulitis. They reported that gadolinium-enhanced MRI can help differentiate adhesive capsulitis of the shoulder from a rotator cuff tear. In 2002, Choi et al.[5] reported that the thickness of the capsule and synovium around the axillary fold >5.1 mm and decreased volume of the biceps tendon sheath are useful MRI parameters for diagnosing adhesive capsulitis of the shoulder. In the same year, Connell et al.[6] reported that MRI can be used to identify changes in fibrovascular scar tissue in the rotator interval, soft tissue thickening around the biceps anchor, and thickening of the axillary pouch in patients with adhesive capsulitis that corresponded to abnormalities seen during arthroscopic capsulotomy surgery. In 2005, Lefevre-Colau et al.[7] reported that the mean thickness of axillary recess on the coronal plane was 9.0 ± 2.2 mm in patients with adhesive capsulitis and 0.4 ± 0.7 mm in healthy shoulders, and that mean thickness of the rotator interval on the sagittal plane was 8.4 ± 2.8 mm in patients with adhesive capsulitis and 0.6 ± 0.8 mm in healthy shoulders on MRI after a gadolinium-chelate injection. In 2008, Sofka et al.[8] described that routine MRI of the shoulder without intra-articular administration of gadolinium was useful to diagnose all stages of adhesive capsulitis. They found that thickness of the capsule and synovium ranged from 2 to 13 mm, with a mean of 7 mm. In 2012, Ahn et al.[9] reported that pain intensity in patients with adhesive capsulitis was linked to contrast-enhancement grades of the joint capsule and that shoulder external rotation limitation was associated with thickness of the joint capsule in the axillary recess on MRI.

In our study, joint capsule thickness ranged from 2.5 to 6.4 mm, with a mean of 4.0 ± 0.71 mm, which is thinner than that of previous studies using enhanced MRI. MRI examination did not include enhanced imaging because patients worried about the side effects of contrast, such as burning, itching, swelling, tightening of the skin, raised yellow patches on the eyes, red or darkened skin patches, papules or plaque, muscle weakness, sharp bone pain, hardening of internal organs, inability or difficulty walking or extending the arms, and nephrogenic systemic fibrosis, particularly in patients with kidney problems.

Only a few studies have exmined the associations between clinical features and non-contrast MRI findings of adhesive capsulitis. Sofka et al.[8] reported that capsular and synovial thickening in the axillary pouch was increased only in stage 2 adhesive capsulitis compared to other stages, and, based on these results, proposed that shoulder MRI provides information differentiating between the early (1 and 2) and late (3 and 4) stages of adhesive capsulitis. In the present study, because symptom durations of capsular thickness groups were not significantly different (6.78 ± 7.31 vs. 7.32 ± 5.70 vs. 5.65 ± 3.08 months, Table 1), these groups would not have seen the differeces in post-treatment outcomes. In addition, the authors also reported that the degree of scarring in rotator interval was not statistically significant between any stages of adhesive capsulitis. Therefore, rotator interval changes in non-contrast shoulder MRI might not be associated with clinical features, and our fat replacement groups also would not have seen the differeces in post-treatment outcomes.

In the previous studies, ROM limitation in adhesive capsulitis was most profound in external rotation[20–22]. Furthermore, Ahn et al.[9] reported, in their gadolinium enhancement MRI study, that external rotation of PROM was correlated with capsular thickness of the axillary joint in patients with adhesive capsulitis. In the present study, limitation of motion, which is assumable by ratio to full range, at baseline was also prominent at external rotation followed by abduction, interal rotation and flexion, whereas the grades of capsular thickness was correlated with only abduction. Discordances in imaging modality (e.g., enhanced or not), ROM measuring methods (e.g., external rotation with abduction 0° or 90°) and inclusion and exclusion criterias might be contributable to these difference in correlation of PROM with MRI findings. In addition, many researchers, including Ahn et al., did not evaluate and anlyze abduction ROM in patients with adhesive capsulitis, hence, it may be difficult to directly compare our data with previous results.

The present study has some limitations. First, because of its retrospective nature, this study failed to control the patient factors, such as clinical stage or severity of adhesive capsulitis. Second, the authors did not evaluated the effect of combined shoulder pathology, such as rotator cuff lesions. Ahn et al.[9] and Yoo et al.[23] reported the proportion of combined rotator cuff

pathologies in patients with adhesive capsulitis as 83.5% and 61.7%, respectively, although these additional findings did not affect to outcome of arthroscopic capsulotomy. Finally, our capsular distension protocol with a total of 20 ml volume could not have reached to enouch expansion of joint space in the patients with mild severity of adhesive capsulitis, because the volume of normal glenohemeral joint was known as 28–35 ml, whereas the volume was known as 10 ml or less in adhesive capsulitis[1, 3, 18, 24]. However, the injection contained 40 mg of triamcinole, hence the authors assumed that this protocol would be effective for treatment of adhesive capsulitis since combined action of mechanical expansion and anti-inflammatory potency.

In the patients with adhesive capsulitis, capsular distension aimed at comparing effectiveness according to MRI findings showed favorable outcomes regardless of the grades of axillary joint capsular thickness or rotator intercal fat replacement. Further study with more controlled subjects in clinical features is needed for its broad and effective application.

Conflicts of interest

No potential conflicts of interest relevant to this article are reported.

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