MRI shoulder without contrast is unreliable method to explain prolonged morbidity after subacromial decompression

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ARTICLE INFO

ABSTRACT

Introduction: Subacromial decompression is a common surgical procedure in patients with subacromial impingement. The results are often good, although some patients develop prolonged morbidity with postoperative pain and stiffness. The main aim of the present study was to analyze the reaction of the joint capsule 3 months after subacromial decompression using MRI without contrast. We also wanted to study if there was a relation between the capsular reaction and the Constant score (CS) or the subjective shoulder value (SSV).
Materials and methods: Forty-eight patients with a mean age of fifty-six years underwent subacromial decompression. They were investigated with a standard x ray and MRI before surgery and at three months after surgery. The CS and SSV were measured preoperatively and at three months, six months, and two years postoperatively. Two musculoskeletal radiologists independently evaluated the MRI images and used a scoring system from 0 to 7 to evaluate capsular changes.
Results: The inter-rater reliability was fair. Spearman's correlation was calculated between CS scores at baseline, 3 months and 6 months with MRI score rater 1, MRI score rater 2. None of the relationships were significant. Spearman's correlation was also calculated for those with a CS score <60 and none were significant. The improvement in the CS from baseline to three- and six months postoperative was significant. The subjective shoulder value improved at three, six and 24 months after surgery.
Conclusions: The persistent pain and stiffness in some patients after subacromial decompression cannot be explained by the development of capsular changes shown by non-arthrographic MRI, which seems to be unreliable method due to high subjectivity in the assessment between the radiologists.
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1. Introduction

The shoulder joint is the only joint in the body that is affected by adhesive capsulitis. This condition restricts active and passive range of motion in all directions. Frozen shoulder was first described by Codman in 1934.[1] The name adhesive capsulitis was given by Neviaser in 1945 when he described synovial changes in the glenohumeral joint.[2] The disease is categorized into idiopathic or primary, and secondary adhesive capsulitis. The pathogenesis of the idiopathic form is not very clear. Some authors suggest endocrine, immunologic, inflammatory and biochemical changes as possible causes.[3]

The term secondary adhesive capsulitis is used when the cause is known. Possible causes include micro- and macrotrauma, surgical trauma or prolonged immobilization of the shoulder. Subacromial decompression and more extensive procedures like: open shoulder stabilization and rotator cuff repairs may cause adhesive capsulitis.[4]

Although adhesive capsulitis is a clinical diagnosis, several MRI findings of the capsule have been described, such as thickening of the axillary recess, thickening of the coracohumeral ligament and shortening of the rotator interval.[5–9]

Arthroscopic subacromial decompression is a common surgical procedure with good results. Nevertheless, in our experience some patients can have a prolonged postoperative morbidity due to pain

and stiffness.

The aim of this investigation was to study if MRI is a good modality to demonstrate reactions of the shoulder joint capsule and the cause of persistent suffering of some patients following arthroscopic subacromial decompression. An additional aim was to correlate the MRI findings with the clinical assessments over time.

2. Materials and methods

2.1. Study population

2.1.1. Inclusion criteria

All Patients with impingement syndrome who underwent a subacromial decompression in our institute between December 2007 and October 2010 were included.

2.1.2. Exclusion criteria

Patients with other shoulder pathologies like rotator cuff injuries, patients with history of shoulder trauma, and patients with a history of a previous shoulder surgery were excluded from the study.

Standard X rays of the shoulder with an AP view in internal and external rotation, an AC-joint view and a supraspinatus outlet view were performed preoperatively.

An MRI of the affected shoulder was done preoperatively. Patients with cuff tears, osteoarthritis of the glenohumeral joint, labrum injuries, diabetes mellitus or rheumatoid arthritis were excluded from the study.

The inclusion and the surgery were performed by the author and another experienced shoulder surgeon, but the follow-ups were performed by the author only. The clinical assessments were done before the surgery, at approximately 3 months and 6 months after surgery. By telephone, an independent secretary did a follow-up interview of the SSV two years after the surgery.

2.1.3. Surgical technique

The operative procedure was a modification of the technique described by Ellman.[11] All procedures were performed in the beach chair position, under general anaesthesia or long acting scalene block, with the arm in forward traction. The passive range of motion was assessed prior to the procedure without any attempt for manipulation. The arthroscope was first introduced into the glenohumeral joint through a posterior portal, and when no other pathologies were detected, the subacromial space was inspected from the same posterior portal. An anterior acromioplasty was performed with a motorized resector. The adequacy of the decompression was judged by introducing a straight blunt probe through the posterior portal. This determined whether the undersurface of the acromion was flat and whether the anterior hook of the acromion had been eliminated. For those patients who had symptomatic arthritic changes of the AC joint, an arthroscopic resection of the outer end of the clavicle was performed through an anterior portal.

2.1.4. Postoperative rehabilitation

The training during the first three weeks postoperatively included passive training of range of motion and scapulae positioning training with relaxation of the shoulder girdle. From week four patients were allowed to move the joint freely and use it for activities of daily living. All patients continued on to follow-up under the care of a physiotherapist at the outpatient clinic.

2.1.5. Follow-up assessments

All patients underwent a preoperative and a 3-month post-operative MRI without contrast of the affected shoulder. The MRI was taken in a standard way by including an oblique coronal dual-echo T2-weighted, an oblique coronal inversion recovery, a sagittal dual-echo T2-weighed, an axial gradient-echo and an axial dual-echo T2-weighted image. All images were obtained using 4-mm section thickness with a 0.4-mm intersection gap. Capsule reaction was defined by using a scoring system, giving two points for edema of the axillary capsule, two points for thickening of the axillary capsule, two points for the pericapsular edema and one point for the rotator interval edema. A total score of seven points indicated a maximum value for adhesive capsulitis.[5—9]

Two musculoskeletal radiologists independently evaluated the images.

The clinical assessment included range of motion by goniometer, external rotation with the arm in 0º of abduction, Constant score (CS),[12] and the Subjective Shoulder Value (SSV).[13]

2.1.6. Statistics

The data were set up as longitudinal data with each visit corresponding to a visit on a timeline. The first visit was a baseline value taken before surgery or the day of the surgery, the second was at three months and the third at six months.

The intraclass-correlation coefficient ICC (with 95% CI) was used to evaluate the interobserver reliability. For ICC, the value of 0.00—0.20 was considered slight, 0.21—0.40 was considered fair, 0.41—0.60 was considered moderate, 0.61—0.80 was considered substantial and 0.81—1.00 was considered excellent.[17] The Constant scores were reported at baseline, three months and six months.

The correlations between the MRI scores and the CS at three months and six months for both raters were analyzed using Spearman's test.

Standard ANOVA methods were used to evaluate a possible difference in the mean values for the three Constant scores and the difference in each individual mean score with each other. The same analysis was done for the mean value for the subjective shoulder value (SSV) at each visit, although an additional time period at 2 years post-operative was included.

Simple linear regression was used to establish the relationship between the change in rotation at 0° and the MRI score at three months. A baseline adjustment was used in the regression.

3. Results

Forty-eight consecutive patients (18 men and 30 women) with a mean age of 56 years (range 33—77) were included in the study. All had a subacromial impingement with or without concomitant AC joint arthritis.

The diagnosis was established according to the criteria described by Neer.[10] All patients had a positive Hawkins sign, painful arch and a positive Neer test. There were no clinical signs of rotator cuff tear or adhesive capsulitis. Twenty-two patients had painful AC joint with a positive compression sign. The dominant side was affected in 26 patients. There were no complications.

The intraclass-correlation coefficient ICC for the two MRI raters was fair as 0.3, (95% CI 0.30—0.69).

Spearman's correlation was calculated between CS scores at baseline, 3 months and 6 months with MRI score rater 1, MRI score rater 2. None of the relationships were significant. Spearman's correlation was also calculated for those with a CS score <60 and none were significant.

The study population shows a significant improvement in constant score both at three months and at six months visit (Table 1). No patients have developed sever capsulitis according to MRI staging (Table 2).

The average score for SSV was 50 (95% CI 45—55) (out of 100) at baseline, 69(95% CI 63—75) at three months, 76(95% CI 70—82) at

Table 1
Constant score (CS) of the study population preoperative, at 3 months and 6 months respectively. The difference between the baseline visit and the 3- and 6-month visit were significant. *CS:* constant score, *CI:* confidence interval.

CS preoperative	CS 3 months	CS 6 months	Difference (preoperative-3m)	Difference (preoperative-6m)
46 (95% CI 41—51)	70 (95% CI 66—74)	77 (95% CI 73—81)	P < 0.05 (95% CI 19—29)	P < 0.05 (95% CI 26—36)

Table 2
Distribution of severity of postoperative capsule changes in the study population.

MRI staging	No. of patients (total:48)
0	1
1	9
2	18
3	16
4	4
5	0
6	0
7	0

six months, and 97 at two years (95% CI 96—99). The differences between the average SSV between the individual visits were all significant.

The changes in external rotation at 0° abduction and passive range of motion and the change in MRI score as the outcome variable were used in the regression with each rater evaluated separately. No relationship was found between ROM and the MRI score with the fitted regression.

4. Discussion

Few studies have focused on capsular reactions after shoulder arthroscopy. In this study, we examined how the joint capsule reacts after arthroscopic subacromial decompression with or without concomitant resection of the outer end of the clavicle. In our earlier experience, some patients suffer from pain and stiffness postoperatively despite the fact that both procedures are extra-articular to the glenohumeral joint.

In our study, we found no relationship between the CS and MRI score after surgery for either of the radiological raters. The poor reliability between the raters after surgery indicates that it is difficult to achieve an exact measurement of the edema and thickness of the joint capsule. It may even be difficult to define an appropriate anatomy using the non arthrographic MRI. These limitations were also seen in a study by Emig.[6]

Emig[6] measured the capsular thickness in the axillary fold. A measurement greater than 4 mm on MR images suggests a diagnosis of adhesive capsulitis. Since different areas other than glenohumeral capsule involvement might be involved, such as the rotator interval, the axillary recess or the subacromial space, we chose to score different kinds of pathologies. We measured edema or thickening of the capsule in the axillary recess, middle glenohumeral ligament, rotator interval, and thickening of the axillary capsule), in an attempt to include other areas that might be affected by capsulitis.

A decrease in external rotation is one of the signs that will be noted in the early phase of adhesive capsulitis. None of our patients had developed a fulminant capsulitis, but 12 patients had decreased, and five had more than 20° reduction in external rotation, indicating a milder form of capsulitis. We sought after a correlation between the change in external rotation and the changes in MRI score for both raters, but no clear relationships were found.

Evans JP et al. studied 200 patients who underwent either ASD or ASD in combination with arthroscopic acromioclavicular joint (ACJ) excision, to establish the incidence of frozen shoulder postoperatively. The study showed that simple arthroscopic shoulder surgery carries a risk for developing frozen shoulder of just over 5% with no increased risk if the ACJ is also excised.[14]

Previous research has concentrated on the incidence of stiffness of the shoulder, severe enough to warrant further surgery, in arthroscopic rotator cuff repair, rather than isolated ASD. A review of the literature shows the risk of postoperative stiffness after rotator cuff repair to range from 0 to 14%.[15,16] The results from Huberty et al. showed that one of the risk factors associated with an increased incidence of stiffness after cuff surgery was adhesive capsulitis (15%).[18]

Warner and Greis reviewed rotator cuff repair studies that occurred over 2 decades. The techniques of repair were highly varied (open, mini-open, and arthroscopic-assisted), as were the rehabilitation protocols. In their review, Warner and Greis showed that 21 out of 500 patients (4%) had a painful loss of motion that was thought to be caused by postoperative adhesions.[19] Cameron et al. reported a 32% incidence of significant persistent postoperative stiffness after mini-open rotator cuff repair.[20] Severud et al. reported a comparative outcome analysis between their arthroscopic and mini-open rotator cuff repairs.[16] Despite using the same early motion protocols, they found a 14% incidence of postoperative adhesions and stiffness in the mini-open group and a 0% incidence in the arthroscopic group. A multicenter study from France with 576 arthroscopic rotator cuff repair cases found persistent postoperative stiffness in 3.1% of patients.[15]

In the last two decades, many RCT studies published in order to understand the cause of the shoulder pain. These studies have helped us to importance of intrinsic mechanisms as a possible underlying cause of shoulder pain. Hence, shoulder pain is not necessarily caused by the contact between the acromion and the cuff, but originates from the rotator cuff tendons and is mediated by the free nerve endings in the bursa.[21]

The literature reveals that outcomes after arthroscopic subacromial decompression have not been uniformly successful. The reported success rate ranges from 66 to 92%.[22—24] The factors that influence the results might be patient occupation, dominance of the affected shoulder, duration of preoperative symptoms, response to the impingement test, extent of the damage to the cuff, and the experience of the surgeon.[25]

We found a good result after subacromial decompression with or without AC-joint resection, which is the same as reported in the literature. The average CS preoperatively was 50, and it increased to 77 at 6 months. This increase is considered significant.

The mean SSV increased from 50 preoperatively to 69, 76 and 97 at three, six months and two years, respectively, after surgery.[13] The preoperative average was significant compared to all postoperative averages, but not between the three and six-month averages. This indicates that most patient satisfaction occurs directly after the intervention and it continues to improve over time thereafter.

One limitation of our study is that we did not have the possibility to do MR arthrography, which has gained increasing popularity as a diagnostic tool in assessing intraarticular derangements.[26,27] With MR arthrography the capsule edges would be defined more clearly, leading to a more exact measurement of the thickness. According to Emig et al. joint capsule and synovial thickness >4 mm was a useful

MR criterion for diagnosing adhesive capsulitis, with a sensitivity of 70% and specificity of 95% on T2-weighted coronal images.[6] Jung et al., using MR arthrography, showed a capsule and synovial thickness >3 mm, gave a reasonable diagnostic accuracy using the same images mentioned before.[7]

As mentioned before, we included all parts of the joint capsule in our scoring of MR images, because capsulitis generally involves a large part or the entire capsule. One part included in this process is the rotator interval in which there is controversy about the effectiveness or clinical relevance of this measurement. In the study of Emig et al. there were no significant differences between the study and the control groups.[6] This was applied to MR arthrography by Lee et al., and they found no differences in the rotator interval width between the groups in his study.[8] In contrast, Connell et al.,[5] Mengiardi et al.[9] and Jung et al.[7] found a significant difference of abnormal signal within the rotator interval between the groups in their studies. However, there was a rather low specificity.

Another limitation of our study was the absence of a control group with a confirmed diagnosis of adhesive capsulitis both clinically and by MRI. That might have shown a greater difference in the MRI changes between the two groups.

In conclusion, MRI assessment seems to be very subjective, and it has a low reliability between radiologists. Therefore, it will be difficult to rely on MRI for the diagnosis of capsular reactions. Magnetic Resonance Arthrography (MRA) with intra-articular injection of a gadolinium contrast agent could be a better tool for evaluating shoulder disorders postoperatively. MRA can clearly visualize the rotator interval, containing the coracohumeal ligament (CHL), by expanding the joint capsule. With MRA, postoperative inflammation and scarring may be distinguished from recurrent partial articular-side tears, a distinction not easily made by non-contrast fluid-sensitive sequences.

Compliance with ethical standards

The local ethical committee at Uppsala University Hospital approved the study.

Disclosures

The authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jajs.2019.05.004.

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