Bursectomy compared with acromioplasty in the management of subacromial impingement syndrome

A PROSPECTIVE RANDOMISED STUDY

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In a prospective randomised study we compared the results of arthroscopic subacromial bursectomy alone with debridement of the subacromial bursa followed by acromioplasty. A total of 57 patients with a mean age of 47 years (31 to 60) suffering from primary subacromial impingement without a rupture of the rotator cuff who had failed previous conservative treatment were entered into the trial. The type of acromion was classified according to Bigliani. Patients were assessed at follow-up using the Constant score, the simple shoulder test and visual analogue scores for pain and functional impairment. One patient was lost to follow-up.

At a mean follow-up of 2.5 years (1 to 5) both bursectomy and acromioplasty gave good clinical results. No statistically significant differences were found between the two treatments. The type of acromion and severity of symptoms had a greater influence on the clinical outcome than the type of treatment. As a result, we believe that primary subacromial impingement syndrome is largely an intrinsic degenerative condition rather than an extrinsic mechanical disorder.

Subacromial impingement causes symptomatic irritation of the rotator cuff and the subacromial bursa. It is the most prevalent disorder of the shoulder in primary health care, accounting for 44% to 65% of all shoulder complaints.1,2 It is characterised by pain, reduced range of movement and loss of power.2-6 It may range from reversible ‘inflammation’ of the rotator cuff and subacromial bursa to complete rupture of the cuff with secondary degenerative disease.1,7 Primary impingement is caused by a specific shoulder disorder, whereas secondary impingement is associated with problems such as instability, calcifying tendinitis, and post-traumatic or acromioclavicular disorders.8

The aetiology of primary subacromial impingement is not clearly understood. Two main theories have been described; a mechanical (extrinsic) theory, where symptoms are the result of compressive forces on the rotator cuff, and a degenerative (intrinsic) theory where symptoms result from tensile overload on the degenerating rotator cuff tendons.

Neer’s9,10 extrinsic impingement theory is widely accepted, whereby impingement of the rotator cuff under the coracoacromial arch causes irritation of the subacromial tissues. The rationale for acromioplasty is based on this theory, which is supported by numerous studies that often suggest a correlation between the morphology of the acromial arch and the incidence and severity of the syndrome.5,11-14

The alternative intrinsic theory suggests that the symptoms of impingement are caused by a degenerative tendinopathy of the rotator cuff.1,15,16 These degenerative changes may lead to a subacromial ‘inflammatory’ reaction17-20 and the symptoms result from tensile rather than compressive forces.

When conservative treatment fails, the classic surgical treatment of an impingement syndrome is acromioplasty. Satisfactory results have been reported in several studies, with success rates between 48% and 90%.21-25 However, in 2005, Budoff et al26 reported 79% good or excellent results of arthroscopic debridement without acromioplasty for partial-thickness rotator cuff tears, with an average follow-up of 114 months.

In order to compare the results of debridement of the subacromial bursa (bursectomy) without acromioplasty with those of acromioplasty we performed a prospective randomised controlled study of the two treatments in patients without rotator cuff rupture who had failed conservative treatment for primary subacromial impingement syndrome.
Patients and Methods

Patients with non-traumatic shoulder complaints referred by primary health physicians were selected for this study. The diagnosis of subacromial impingement was based on the history, clinical examination, radiographs of the shoulder (anteroposterior in both external and internal rotation and Y scapular view) and the cervical spine and an MR arthrogram. The type of acromion was described according to Bigliani’s classification. Subacromial impingement was diagnosed when patients complained of non-traumatic pain in the deltoid region, with an inability to lie on the affected side. Clinically, pain was provoked by abduction and retroversion or internal rotation against resistance. All patients had a full passive range of movement, a positive Neer’s sign, and a positive lidocaine impingement test.

Patients were excluded if they had clinical signs of glenohumeral instability or impairment of movement of the glenohumeral joint, such as those with adhesive capsulitis, arthritis of the glenohumeral or acromioclavicular joint on radiographs or MRI, rheumatoid disease, a history of trauma or surgery to the shoulder, biceps tendinitis, full- or partial-thickness rupture of the rotator cuff, signs of cervical radiculopathy, or a calcifying tendinitis. Small calcifications near the greater tuberosity or acromion on the radiographs were not a criterion for exclusion, nor was previous conservative treatment.

A total of 80 consecutive patients were studied. Following MR arthrography, a total of 14 patients were excluded because of full or partial cuff lesions in seven, labrum or superior labral anterior posterior (SLAP) lesions in seven and/or glenohumeral arthritis in two.

Before surgery was considered, all patients followed a protocol of conservative treatment consisting of three lidocaine and hydrocortisone injections into the subacromial space at four-week intervals, combined with NSAIDs and a period of exercise therapy of at least six weeks. When conservative therapy failed, arthroscopy of the shoulder was performed by an experienced shoulder surgeon (ERAVA).

Following diagnostic arthroscopy, a further nine patients were excluded (four with SLAP lesions, three with glenohumeral synovitis (two with both), three with glenohumeral arthritis, one partial rupture of the supraspinatus tendon). Thus, 57 patients were included in the study and randomised for surgical treatment by an automatically generated randomisation code. There were 26 men and 31 women with a mean age of 47 years (31 to 60). Group A was treated by debridement of the subacromial bursa (‘bursectomy alone’), and group B by debridement of the subacromial bursa, followed by an arthroscopic acromioplasty.

Arthroscopy was performed under a general anaesthetic with the patient in the lateral decubitus position and traction on the arm. A standard posterior portal was made, with a second anterior portal in the rotator cuff interval and a third lateral portal to access the subacromial space. An arthroscopic pump was used. Diagnostic arthroscopy of the glenohumeral joint and subacromial space was performed and noted in a standardised manner.

After randomisation, a complete debridement of the subacromial bursa was performed using a motorised shaver and an electrocautery probe (Opes; Arthrex, Naples, Florida). In patients randomised for acromioplasty, a flat undersurface of the acromion was created by viewing from the posterior portal and introducing a motorised burr (Arthrex) through the lateral portal. In order to complete the bony resection the portals were reversed, viewing from the lateral portal and introducing the burr through the posterior portal. After resection, electrocautery was used for haemostasis. Post-operatively, all patients undertook the same exercise programme under the guidance of a physiotherapist.

Outcome measures employed at follow-up were the Constant shoulder score (corrected for age and gender), the simple shoulder test and visual analogue scale (VAS) for pain and functional impairment varying from 1 (no pain/functional impairment) to 10 (maximum pain/functional impairment). Outcome was assessed by an independent examiner at intervals of three months. Neither the examiner nor the patient from Group A was aware of the method of treatment. One patient from group A was lost to follow-up because of lung cancer, diagnosed soon after the shoulder surgery.

The Medical Ethics Committee approved all stages of the study. Written informed consent was obtained from all patients.

Outcome measures from both groups were compared using Student’s t-test. Additionally, a univariate analysis of variance was performed to compare both groups and to analyse the influence of the type of acromion and confounding factors on outcome measures. A p-value < 0.05 was considered to be statistically significant. Analyses were processed using SPSS software (SPSS Inc., Chicago, Illinois).

Results

Of the 57 patients, 56 were included in the study as one was lost to follow-up. The mean follow-up was 2.5 years (1 to 5), and the duration of symptoms before surgery was > 1 year in 44 patients (77%). The patient demographics, including gender, age, body mass index, type of acromion and baseline clinical scores, are shown in Table I.

After follow-up of one year two patients treated by bursectomy alone and three treated by acromioplasty needed a second surgical procedure because of deteriorating symptoms. In the patients with a bursectomy alone, an acromioplasty was performed. Of the patients with an acromioplasty, one had a second, more extensive acromioplasty, and two had a resection of the acromioclavicular joint for degenerative disease. The follow-up data of these patients were included in the statistical analyses, up to the date of the second surgery.

The clinical scores for all patients in both groups improved. At final follow-up, the mean Constant score for patients treated by bursectomy was 69.6 points (SD 18.2), with a mean...
improvement of 13.9 points (SD 17.9). For patients treated by acromioplasty the mean was 75.8 points (SD 16.7), with a mean improvement of 18.5 points (SD 17.5). The mean difference in improvement between the treatment groups was 4.6 points (SD 4.8) in favour of an acromioplasty (p = 0.34 Student’s t-test, 95% confidence interval (CI) -14.1 to 4.9).

The mean simple shoulder test improved by 3.8 points (SD 3.6) in patients treated by bursectomy alone, and by 4.4 points (SD 4.0) in those treated by acromioplasty, with a mean difference in improvement of 0.6 points (SD 1.0) (p = 0.59 Student’s t-test, 95% CI -2.6 to 1.5) in favor of acromioplasty. The VAS for both pain and functional impairment showed a mean improvement of three points in both groups (p = 0.88 for pain, p = 0.82 for functional impairment, Student’s t-test) (Table II).

As the type of acromion, gender, age and baseline scores were not equally distributed in the treatment and acromion subgroups, a multivariate analysis of variance was performed to study factors of influence on the clinical scores. Separate analyses were performed for both the baseline scores and the scores at final follow-up. The type of treatment and gender were used as factors. The acromion type and the baseline score were covariates. The type of acromion was considered a linear (ordered) covariate in order to detect a ‘dose-response’ relation between the type and outcome measures.
The mean baseline Constant score was 56.6 points (SD 15.3). The multivariate analysis demonstrated that male gender had a mean positive effect of 12 points (p = 0.003, 95% CI 4.3 to 20.1) on the baseline score. For all other variables no statistical significance was reached, and confidence intervals did not, in our opinion, contain any clinically relevant values (Table III). The mean final Constant score was 72.9 points (SD 17.6). The baseline preoperative Constant score had, on average, a statistically significant effect of 0.4 (p = 0.007, 95% CI 0.1 to 0.7) on the final Constant score, meaning that a difference between patients of 10 points on the baseline score had, on average, an effect of 4.3 points on the final score. The type of acromion had an average effect of 6.3 points (p = 0.08, 95% CI -13.4 to 0.7) on the final Constant score. A type III acromion scored 12.6 points less than a type I acromion. There was no indication that acromion type had any influence on the effect of the treatment performed (p = 0.532), meaning that there was no indication that a patient with a type III acromion had a greater advantage if treated by acromioplasty than a patient with a type I acromion.

For the simple shoulder test, the mean baseline score was 5.3 points (SD 3.3). Male gender was the only factor with a nearly statistically significant effect on the baseline score (p = 0.05, 95% CI -0.02 to 3.56) (Table III). The mean final simple shoulder test score was 9.5 points (SD 3.8). The baseline simple shoulder test score had a statistically significant effect of 12.2 points (p = 0.04, 95% CI -10.0 to 0.8) on the final simple shoulder test score. The type of acromion had a statistically significant negative effect of 1.8 points (p = 0.08, 95% CI -1.0 to 0.9) on the final simple shoulder test score, meaning that a type III acromion scored 4.5 points higher than a type I acromion. All other variables had no statistically and clinically relevant effect on the final simple shoulder test score (Table IV). Furthermore, on neither VAS was there any indication that the type of acromion had any influence on the effect of treatment performed (p = 0.219 for pain, p = 0.279 for functional impairment).

**Discussion**

In this relatively small prospective randomised controlled study, both bursectomy alone and bursectomy with acromioplasty have improved clinical scores. There was a tendency for a better result from an acromioplasty with bursectomy over a bursectomy alone, but the differences in the clinical scores were small and in our opinion not clinically relevant. There was no evidence that a patient with a Bigliani type III acromion had a better result from treatment by an acromioplasty than a patient with a type I acromion at a mean follow-up of 2.5 years. Our results suggested that the type of acromion has more effect on the clinical outcome.
than the type of surgical treatment. Thus, in this study, a less hooked acromion such as type I led to a better clinical outcome, whatever the surgical procedure. This effect was statistically significant for the simple shoulder test and VAS for functional impairment but the clinical relevance of these effects was questionable, in particular for the effect on the simple shoulder test, with -1.6 points per step up in Bigliani classification. Furthermore, the pre-operative baseline scores appeared to have a statistically significant effect on the final outcome in both the Constant score and the simple shoulder test. Overall, the effects of baseline scores, type of treatment, type of acromion, gender and age at surgery were small on all clinical scores. Even when statistical significance was reached the effects were not, in our opinion, clinically relevant.

These findings challenge Neer’s9,10 widely accepted extrinsic theory of impingement, where subacromial tissues impinge under the coracoacromial arch, leading to inflammation and damage to these tissues.

In 1986, Bigliani introduced a classification system for the shape of the acromion.13,33,34 Several studies have suggested a correlation between the shape and the severity of impingement.5,11,12 Epstein et al33 described a tendency for a higher prevalence of a type III acromion in patients diagnosed with impingement, and Hirano, Ide and Takagi35 reported that rotator cuff tears were significantly larger with a type III acromion, compared with types I and II. However, Liotard, Cochard and Walch36 concluded that there was no such relationship and others have underlined difficulties in using the Bigliani classification because of the high intra- and inter-observer variance.33,37,38

Several studies conflict with the extrinsic theory of impingement. First, the term ‘bursitis’ or ‘tendinitis’, which is often used as a synonym for the impingement syndrome, is not supported by histological studies of the subacromial bursa or rotator cuff in patients with impingement. Degeneration and fibrosis of the subacromial bursa and rotator cuff have been observed and not inflammation.1,15,16 Several studies show a relationship between the amount of fibrosis and the severity of symptoms.17-20

Second, the majority of partial tears of the rotator cuff are either intra-tendinous or found on the articular side of the rotator cuff and not on the bursal side, where they would be expected if the rotator cuff impinged on the acromion.39

Third, McCallister et al40 described a substantial improvement in shoulder comfort and function following rotator cuff repair without acromioplasty, with results comparable to those of studies where the repair of the rotator cuff was combined with an acromioplasty. Additionally, several studies concluded than an acromioplasty did not influence further degeneration of the rotator cuff in the long term.41,42

Finally, a higher incidence of a type III acromion has been observed in older people than in young asymptomatic athletes.43,44 Ozaki et al,45 in a cadaver study reported that rotator cuff pathology predated spur formation of the acromion. Additionally, spur reformation has been described following acromioplasty.46,47 These findings suggest that

<p>| Table IV. Analysis of variance of final scores: baseline score (per 1 point), type of treatment (acromioplasty vs bursectomy), acromion type (per one step up in Bigliani classification), gender (male vs female) and age at surgery as factors and covariates |</p>
<table>
<thead>
<tr>
<th>Clinical score</th>
<th>Final score (SD)</th>
<th>Variable</th>
<th>Effect</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>72.9 (17.6)</td>
<td>Baseline score</td>
<td>0.4</td>
<td>(0.1 to 0.7)</td>
<td>&lt; 0.01</td>
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<tr>
<td>Treatment</td>
<td>-4.9</td>
<td>(-4.7 to 14.4)</td>
<td>0.31</td>
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<td></td>
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<tr>
<td>Acromiontype</td>
<td>-6.3</td>
<td>(-13.4 to 0.7)</td>
<td>0.08</td>
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<td></td>
</tr>
<tr>
<td>Gender</td>
<td>5.0</td>
<td>(-4.4 to 14.3)</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at surgery</td>
<td>0.3</td>
<td>(-0.3 to 1.0)</td>
<td>0.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SST</td>
<td>9.5  (3.8)</td>
<td>Baseline score</td>
<td>0.4</td>
<td>(0.1 to 0.7)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.8</td>
<td>(-1.3 to 2.9)</td>
<td>0.45</td>
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<td></td>
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<tr>
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<td>(-3.2 to 0.1)</td>
<td>0.04</td>
<td></td>
<td></td>
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<tr>
<td>Gender</td>
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<td>(-1.2 to 0.1)</td>
<td>0.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at surgery</td>
<td>0.07</td>
<td>(-0.1 to 0.2)</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS pain</td>
<td>3.9  (2.6)</td>
<td>Baseline score</td>
<td>0.1</td>
<td>(-0.3 to 0.6)</td>
<td>0.52</td>
</tr>
<tr>
<td>Treatment</td>
<td>-0.9</td>
<td>(-2.6 to 0.7)</td>
<td>0.25</td>
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<td></td>
</tr>
<tr>
<td>Acromiontype</td>
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<td>(-0.1 to 2.3)</td>
<td>0.06</td>
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<td></td>
</tr>
<tr>
<td>Gender</td>
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<td>(-1.7 to 1.1)</td>
<td>0.64</td>
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<td></td>
</tr>
<tr>
<td>Age at surgery</td>
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<td>(0.2 to 0.1)</td>
<td>0.32</td>
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<td></td>
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<tr>
<td>VAS functionality</td>
<td>3.9 (2.6)</td>
<td>Baseline score</td>
<td>0.2</td>
<td>(-0.2 to 0.6)</td>
<td>0.30</td>
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<tr>
<td>Treatment</td>
<td>-0.1</td>
<td>(-2.5 to 0.5)</td>
<td>0.20</td>
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<tr>
<td>Acromiontype</td>
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<td></td>
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<tr>
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<td>(-0.1 to 0.1)</td>
<td>0.57</td>
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<td></td>
</tr>
</tbody>
</table>

* CS, Constant score; SST, simple shoulder test; VAS, visual analogue scale
† 95% CI, 95% confidence interval
changes in the acromion are, at least in some patients, more than the result of rotator cuff pathology than its cause. The findings in this study that patients with more hooked acromions had more symptoms before, and were less active after, surgery, also suggest that the type of acromion is part of a degenerative process, when more hooked acromions are seen in the later stages of impingement.

In this study, Neer’s impingement test was used as a definite criterion for localised subacromial pain. Most studies that report the results of acromioplasty consider the lidocaine impingement test to be the gold standard for the diagnosis of subacromial impingement. An unexpected finding in this study was that 14 of 80 patients (17.5%), diagnosed as having subacromial impingement with a positive impingement test, had to be excluded following MR arthrography because of specific shoulder pathology. Another nine (11%) were excluded following diagnostic arthroscopy because of a specific shoulder disorder, mainly localised in the glenohumeral joint. These findings may be explained by the low specificity of Neer’s impingement test, such that a lidocaine injection into the subacromial space does not differentiate adequately between an impingement syndrome and other shoulder pathology. Further, we performed the impingement test without radiological control. The inaccuracy of this procedure may also explain the high number of patients that had to be excluded following MR arthrogram and arthroscopy.

The good results of a bursectomy alone are in agreement with the study by Budoff et al., who reported 79% good or excellent results of an arthroscopic debridement without acromioplasty for partial-thickness rotator cuff tears. These and our results are comparable with those of many studies describing the results of acromioplasty. This raises the question whether an acromioplasty may, at least in some patients, simply have a placebo effect.

A possible explanation for the improvement seen after bursectomy alone might be that subacromial bursal tissues contain a rich supply of nociceptive nerve fibres compared with other structures around the shoulder joint. Mechanical irritation may cause recruitment of nerve fibres, or lowering of the threshold of those nerve fibres as is seen in the tendo-Achillis or facet joints of the spine. This might also explain the chronic nature of symptoms in patients with impingement syndrome, even if they limit the use of their shoulder over a long period of time.

There are several limitations to this study. First, despite randomisation, there were differences in distribution of age, gender and the type of acromion in the two treatment groups. We corrected for these differences in our statistical analyses in order to avoid potential confounding factors. In addition, the Constant score is corrected for age and gender, which also precludes effects on final scores. Secondly, the size of our study group was relatively small and underpowered. Therefore, the results should be interpreted with care. Thirdly, the simple shoulder test may not be suitable for detecting differences between the treatment groups owing to the dichotomous nature of the test and the limited number of questions.

We believe that the pathogenesis of subacromial impingement can be explained by several mechanisms. Neer’s extrinsic theory may be true for a subgroup of patients with subacromial pain, but in this study we were not able to identify such a group.

We conclude that both bursectomy and acromioplasty can give good clinical results in patients with primary subacromial impingement who fail conservative treatment. There was a small difference in favour of acromioplasty but this did not reach clinical relevance in this relatively small study. The type of acromion and the severity of symptoms have a greater influence on the final outcome, than the type of treatment. Patients with a more hooked acromion have a worse prognosis, and the results of this study suggest that this may not be solved by an acromioplasty.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


