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Operative release of the impingement syndrome
Indication, technique, results

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Abstract We examined the long-term results of two different methods of shoulder decompression (Neer acromioplasty and resection of the coracohumeral ligament) after an average observation period of 8 years. Clinical and radiological features were evaluated in 48 patients with 50 treated shoulders, as was the subjective result of the treatment in 58 patients with 61 operated joints. Pain was substantially eased in 93% (acromioplasty) and 100% (ligament resection), mobility improved in 76% and 83%, respectively. A favourable result was achieved in 86% of the acromioplasty cases and in 75% of the ligament resection cases. In one-third of the shoulders, an increasing degeneration of joint structures could be demonstrated radiologically; the degree depended on the severity of the initial rotator cuff injury, not on the method of shoulder decompression. The differences between both surgical methods examined were not statistically significant, but acromioplasty provides a superior extension of the subacromial space and protection for the reconstructed rotator cuff tendons. Our results compare favourably with other published studies. The methods described are suitable for the treatment of subacromial impingement.

Introduction

The painful shoulder is not one pathological entity, but includes various painful restrictions in the function of the shoulder joint, which manifest themselves above all in abduction. Subacromial impingement is held to be one of the essential causes. This describes symptoms caused by many factors which are characterized by restriction of the subacromial space, with mechanical irritation and compression of the soft parts located there. Space for the tendinous and bursa tissue is limited, which can be additionally restricted by a congenital or degenerative enlargement of the acromion. If as a result of the limitation of space and the many different movements—above all abduction—inflammatory reaction of the soft parts ensues in this area, the process becomes automatic because of swelling and a decrease in space (Rockwood and Lyons 1993).

Therapy consists of resection of the coracohumeral ligament, which was introduced by Burman in 1949, or in more extensive operations which nowadays usually involve a modification of the acromioplasty introduced by Neer (1972). In recent years arthroscopic methods of treatment have been increasingly used for subacromial impingement (Mendoza et al. 1987; Paulos and Franklin 1990).

The more radical technique (acromioplasty) has many advantages. First, the resection of the coracohumeral ligament only effects a release in the anterior direction, whilst acromioplasty effects a release of the shoulder joint in several planes. Moreover, there is better protection of the sutures of the rotator cuff tendons, which in some cases have been simultaneously reconstructed, and this can be seen as an additional advantage of the more extensive operation.

In the study presented here, the surgical methods of treatment of the impingement syndrome are compared (resection of the coracohumeral ligament alone as against acromioplasty according to Neer). As generally only one method has been described in numerous publications, and the criteria of success are not uniform (Lirette et al. 1992), the question cannot be decided at the present time on the basis of a literature review. The following questions were investigated by means of the results obtained from our patients.

• Is one of the techniques superior to the other as far as functional and radiological findings are concerned?
• How do our own results compare with the results published in the literature?
• Is the initial success of the therapy as documented in numerous studies still evident years later?

Finally, an attempt was made to find recommendations for operative practice from a combination of our own results and those stated in literature.
Materials and methods

Patients

Between 1974 and 1989, 76 patients were operated on for a subacromial impingement in the Orthopaedic University Clinic of Tübingen. Between December 1980 and February 1991, 48 patients with 50 operated shoulders were examined for the clinical and radiological long-term results. The subjective functional result of the shoulder was also evaluated with the help of a standardized questionnaire. The proportion of male patients was significantly higher (43 patients; 74.1%); at the time of the follow-up examination the patients were between 30 and 76 years of age (average age 57 years). The examination took place between 14 months and 17 years (average 8 years) after the operation.

A further 10 patients with 11 operated shoulders were not examined personally, but filled out the questionnaire, so that altogether the retrospective study includes 58 patients and 61 operated joints.

Operation procedure

The resection of the coracoacromial ligament was always carried out within the framework of a revision of the shoulder joint. The approach lay above the anterosuperior shoulder aspect as described by Neer (1972). After the fibres of the deltoid muscle had been separated for a length of 3-5 cm, the coracoacromial ligament was exposed and partly resected. After suturing of the deltoid muscle and closing of the wound, the shoulder was immobilized by means of a Gilchrist bandage. This was followed by active exercises in the course of the 1st week.

The acromioplasty was carried out in a modified form according to Neer (1972). From an anterosuperior approach under the anterior rim of the acromion, the deltoid muscle was separated from the tip of the acromion near the bone and then split distally in the direction of its fibres for about 5 cm. The coracoacromial ligament was exposed and divided at the coracoid insertion. Tangential osteotomy was then carried out by means of an oscillating saw.

During this procedure the anterior inferior part of the acromion and the whole of the coracoacromial ligament were removed. Following this, the rotator cuff was inspected after opening of the bursa subacromialis, and if necessary, a debridement or a suturing of the rotator cuff was carried out. When there were pronounced degenerative changes in the acromioclavicular joint, the lateral 2 cm of the clavicle were removed, taking care not to damage the acromioclavicular ligaments. The reinsertion of the deltoid muscle was carried out medially at the acromioclavicular joint capsule and acromially at the remaining part of the resected tip of the acromion. These patients were immobilized in an abduction splint or a plaster cast to protect the deltoid reinsertion and cuff reconstruction where necessary; passive exercises were soon followed by active exercises. From the 6th week we began with a gradual reduction of abduction with exercises to strengthen the muscles of the shoulder.

Follow-up examination

The gathering of data was carried out according to a standard procedure, which included the following aspects:

- Retrospective evaluation of the case files comprising preoperative findings, surgical procedure and postoperative course of healing
- Clinical follow-up examination of mobility, strength, pain, impingement sign, sensitivity in the area of the axillary nerve
- Radiological examination in the form of an anteroposterior (AP) X-radiograph, which was evaluated according to the classification of degeneration proposed by Weber and Rompe (1987)
- A standardized questionnaire based on the shoulder score of the "American elbow and shoulder surgeons" in Gartsman’s modification (1990).

Table 1: Rating scale in accordance with the "American elbow and shoulder surgeons" (Gartsman 1990)

<table>
<thead>
<tr>
<th>Pain:</th>
<th>None</th>
<th>5 points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td></td>
<td>4 points</td>
</tr>
<tr>
<td>After unusual activity</td>
<td></td>
<td>3 points</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td>2 points</td>
</tr>
<tr>
<td>Marked</td>
<td></td>
<td>1 point</td>
</tr>
<tr>
<td>Complete disability</td>
<td></td>
<td>0 points</td>
</tr>
<tr>
<td>Work:*</td>
<td>Sedentary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labor, not overhead</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labor, overhead</td>
<td></td>
</tr>
<tr>
<td>Activities of daily living:*</td>
<td>Sleep on shoulder</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use back pocket</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wash opposite underarm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reach behind back</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dress</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comb hair</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eat with utensil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pull</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carry 5–10 kg, arm at side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lift</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use hand, arm at shoulder level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use arm above shoulder level</td>
<td></td>
</tr>
</tbody>
</table>

*Rating scale: 4 points = normal; 3 points = mild compromise; 2 points = difficult; 1 point = with aid; 0 points = unable

The functional value was assessed as "unsatisfactory" with a score of less than 25 points; a score of 25–44 points was considered "moderate"; 45–59 points "good" and 60–65 points "excellent" (Table 1).

Statistics

The statistical evaluation was carried out in the Institute of Biometry of the University of Tübingen by means of the program SAS. According to the structure of the data, the evaluation was carried out by $\chi^2$ test or variance analysis with the F-test, which corresponds to the t-test in the bivariate case. The level of significance was set as $P < 0.05$.

Results

History information

In almost all cases the operation had been preceded by unsuccessful conservative treatment. The most frequently used method was the application of local anaesthetics at the insertion of the ligament (in 88.5% of the joints), physiotherapy (83.6%) and oral medication with anti-inflammatory drugs (78.7%).

Intraoperative findings

Ruptures of the rotator cuff were observed in 39 cases (63.9%). In 25 cases there was a complete tear of the cuff,
in 14 a partial rupture. The operative procedure is shown in Fig. 1; four groups were formed for further assessment.

Clinical follow-up examination

At the time of clinical follow-up examination of 50 cases, there was no irritation at the side of the operation scar. Clinically, 9 shoulders exhibited an atrophy of the deltoid muscle, compared with the non-operated side; there were 6 cases of thinning of the supraspinatus and 4 of the infraspinatus muscles. Twelve patients exhibited a sensitivity to pressure in the area of the coracoid process, but on the whole the sensitivity to pressure in the shoulder was considerably reduced in comparison with the preoperative findings. A "painful arc" syndrome could still be found in 16 cases (32%), but this was only half the preoperative number. In 10 shoulders a positive impingement sign was evidence of a persistence or recurrence of a compression of the subacromial space; half of these patients had undergone acromioplasty.

Pain during the isometric resistance tests had been clearly reduced to half in a comparison with preoperative findings. Mobility was substantially increased in all degrees of freedom; the greatest gain was to be found in abduction, followed by anteversion, external and internal rotation. There were no significant differences as far as the type of operation was concerned; nevertheless, early functional treatment in the form of exercise, which was possible in 49 cases, led to a significantly higher extent of mobility at follow-up examination.

Subjective evaluation

Subjective assessment of shoulder mobility and pain showed a clear improvement (Fig. 2). Of the 11 patients whose mobility had not improved, 10 patients had no essential problems before the operation. At the time of the questionnaire, 48 patients (82.8%) were completely free from pain or experienced pain only after extraordinary strain. Activities in a sitting position could be carried out without restriction in 44 cases (72.1%) and with restrictions in 17 cases (17.9%). The results were similar for activities which did not include overhead work. Overhead activities were restricted in the majority of cases (n = 40, 66.7%); in 10 cases they were completely impossible (Table 2). Nevertheless, the final evaluation of the result was "excellent" or "good" in 80% of the cases, and this
Table 2 Activities of daily living at follow-up (n = 61)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Normal</th>
<th>Difficult</th>
<th>Unable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>44 (72.1%)</td>
<td>17 (27.9%)</td>
<td>0</td>
</tr>
<tr>
<td>Not overhead</td>
<td>41 (67.2%)</td>
<td>19 (31.1%)</td>
<td>1 (1.6%)</td>
</tr>
<tr>
<td>Overhead</td>
<td>21 (34.4%)</td>
<td>30 (49.2%)</td>
<td>10 (16.4%)</td>
</tr>
<tr>
<td>Use arm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eat with utensils</td>
<td>51 (83.6%)</td>
<td>9 (14.8%)</td>
<td>1 (1.6%)</td>
</tr>
<tr>
<td>Pull</td>
<td>43 (70.5%)</td>
<td>18 (29.5%)</td>
<td>0</td>
</tr>
<tr>
<td>Carry 5-10 kg</td>
<td>43 (70.5%)</td>
<td>15 (24.6%)</td>
<td>3 (4.9%)</td>
</tr>
<tr>
<td>Lift</td>
<td>29 (47.5%)</td>
<td>29 (47.5%)</td>
<td>3 (4.9%)</td>
</tr>
<tr>
<td>Extreme positions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dress</td>
<td>37 (60.6%)</td>
<td>24 (39.3%)</td>
<td>0</td>
</tr>
<tr>
<td>Comb hair</td>
<td>42 (68.9%)</td>
<td>16 (26.2%)</td>
<td>3 (4.9%)</td>
</tr>
<tr>
<td>At shoulder level</td>
<td>34 (55.7%)</td>
<td>25 (41.0%)</td>
<td>2 (3.3%)</td>
</tr>
<tr>
<td>Above shoulder level</td>
<td>25 (41.0%)</td>
<td>28 (45.9%)</td>
<td>8 (13.1%)</td>
</tr>
<tr>
<td>Reach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opposite arm</td>
<td>51 (83.6%)</td>
<td>10 (16.4%)</td>
<td>0</td>
</tr>
<tr>
<td>Back pocket</td>
<td>48 (78.7%)</td>
<td>12 (19.7%)</td>
<td>1 (1.6%)</td>
</tr>
<tr>
<td>Behind back</td>
<td>23 (37.7%)</td>
<td>24 (39.3%)</td>
<td>14 (23.0%)</td>
</tr>
</tbody>
</table>

Fig. 3 Radiological stages preoperatively and at follow-up

was independent of the type of operation. The average result of the whole group was 55 points and thus "good".

Radiological findings

According to the division into stages stated by Weber and Rompe (1987), the radiological findings of the follow-up examination were slightly worse than the preoperative findings; one-third of the patients exhibited a progression of degeneration. On the whole, however, the normal or only slightly changed joints predominated (Fig. 3). There was a significant frequency of radiological progression in joints which had been found to have a rupture of the rotator cuff intraoperatively; however, the type of operation performed had no essential influence on the radiological progression.

Complications

In one case there was an iatrogenic fracture of the acromion, which healed without any consequences after lag-screw osteosynthesis. Two deep wound infections were revised locally and healed after insertion of an antibiotic chain. Nine mobilisations under anaesthetic because of a painful restriction of movement postoperatively remained without affecting the further functional result. In the case of a 53-year-old woman, there was a lesion of the lower nerve plexus of the upper extremity after a fall. The functional result was unsatisfactory in spite of free passive mobility.

Discussion

In the study presented here we were able to demonstrate that surgical treatment of the impingement syndrome of the shoulder by decompression of the anterior deltoïd leads to a good functional result and freedom from pain even several years later. The radiological, clinical and functional result in the type of examination which we have selected does not depend on the type of operation performed, but rather on the size of the rotator cuff lesion which existed preoperatively. The decision as to whether a resection of the coracoacromial ligament is sufficient or whether an operation on the bone in the form of an acromioplasty is necessary must be decided by the surgeon on the basis of a preoperative examination and the expected intraoperative findings: if there are ruptures in the rotator cuff, or extensive changes at the tip of the acromion, a decision to perform acromioplasty is more or less inevitable. In young patients without degenerative changes in the rotator cuff or the tip of the acromion, a resection of the coracoacromial ligament is absolutely sufficient. In such cases the simpler way should be selected, as complications are not so likely. Our own results are on the whole similar to those in the published literature. With regard to pure resection of the ligament, similarly positive results were stated by numerous authors.
In the short term Ha'eri and Wiley (1982) and Johannson and Barrington (1982) found over 90% good and satisfactory results in patients without ruptures of the rotator cuff. When rotator cuff ruptures were surgically managed in addition to resection of the ligament, there were also over 80% good results (Samilson and Binder 1975; Watson 1978; Eulert et al. 1981; Skrudøyes and Köhl 1987). Just like Apoil et al. (1977), we found that easing of pain was most evident after resection of the coracocapral ligament. Our contribution to the findings in literature is that good subjective and functional results are obviously stable over a much longer period of time, while patients with a rupture of the rotator cuff have a limited long-term prognosis as far as degenerative changes in the shoulder-joint are concerned.

Our own results with acromioplasty with or without an operation of the rotator cuff are of the same order as those in literature published earlier; it is interesting to note that studies comparable to our own are based on much shorter periods of observation. Acromioplasty according to Neer achieves an effective easing of pain caused by the impingement syndrome, particularly in patients over 40 years old, but also in younger ones (Penny and Welsh 1981; Raggio et al. 1985; Thorling et al. 1985; Post and Cohen 1986; Coifield and Azvedo 1987; Hawkins et al. 1988; Bigliani et al. 1989; Gerber 1989; Watson 1989; Rockwood and Lyons 1993).

Our observation that ruptures of the rotator cuff worsen the long-term prognosis of the operated shoulder is also confirmed in the literature: Coifield and Azvedo (1987) observed successful easing of pain in over 90% of patients who had undergone acromioplasty and had an intact rotator cuff, but in only 79% of patients with a cuff rupture.

Long-term confirmation is presented by the fact that studies limited to patients without ruptures of the rotator cuff demonstrated unusually successful results after acromioplasty (Raggio et al. 1985; Gerber 1989); Gerber went so far as to state that if the rotator cuff was intact, every incomplete restoration of function and freedom from pain was a failure. On the other hand, if there is a rupture of the rotator cuff, easing of pain can only be achieved if a functional deficit of the order of 20%-30% is accepted (Post et al. 1983; Hawkins et al. 1985; Thorling et al. 1985; Ellman et al. 1986; Skrudøyes and Köhl 1987).

The reason for the more unfavourable prognosis is the so-called "rotator cuff defect arthropathy", in which an accelerated arthrosis arises because of insufficient nutrition of the joint cartilage combined with an inactivity osteoporosis (Neer et al. 1983; Patte 1990).

Whether a completely sealed reconstruction of the capsule is really necessary to avoid this delayed effect (McLaughlin 1963; Nevisier 1971, 1980; Nevisier et al. 1978) or a debridement is sufficient (Apoil et al. 1977; Koeehlin and Apoil 1981; Rockwood and Burkhead 1988; Wülker et al. 1991) remains controversial.

The great extent of correlation between our own results and those of hitherto published material, which is more often than not based on a significantly shorter period of observation of 3 years, points to the fact that no essential worsening of the findings is to be expected in subsequent years. Watson's (1989) assumption that a final result can be expected after about 2 years is probably correct, except for cases in which a further trauma has occurred in the meantime (Harryman et al. 1991; Wülker et al. 1991).

Our study indicates that ligament resection and acromioplasty are equally successful, and this fact is also confirmed in the literature (Penny and Welsh 1981; Tibone et al. 1985; Skrudøyes and Köhl 1987). When indications have been properly followed, it is usually preferable to perform the lesser operation, the ligament resection, when no osteophytes additionally decrease the subacromial space (Neer 1972; Hawkins and Kennedy 1980; Penny and Welsh 1981; Post and Cohen 1986). The risk of infection is higher after more extensive resections of the acromion (Neer and Marberry 1981).

A further reason for reservations concerning more extensive operations in this age group is the observation of Tibone et al. (1985) that an effective easing of pain in young sportmen and women by acromioplasty is usually obtained at the expense of a relatively significant decrease in achievement. Moreover, the extensive resection makes early functional treatment by exercise more difficult, and it is this which influences the functional prognosis favourably, as is borne out by our study and that of Wülker et al. (1991). For older patients on the other hand, numerous authors (see above) subscribe to a more generous indication for acromioplasty.

If arthroscopic treatment, which has become established in the meantime (Mendoza et al. 1987; Van Holtsbeek et al. 1992), will ever oust open surgery remains to be seen. In the end the same prerequisites for success are valid: an exact diagnosis, selective treatment, in some cases adequate resection of the bone, repair of the rotator cuff and early functional follow-up treatment (Paulos and Franklin 1990).

Basically, the lesions of the rotator cuff must be sufficiently dealt with in addition to release of the subacromial space, as a successful reconstruction is extremely significant for the prognosis (Münzinger et al. 1981; Coifield 1985; Hawkins et al. 1985; Ellman et al. 1986; Rockwood and Burkhead 1988; Gerber 1989; Patte 1990; Post 1990).

It would seem that restoration of the physiological tension of the rotator ligaments is essential (Patte et al. 1981; Packer et al. 1983; Calvert et al. 1986; Post 1990).

Finally it appears to be important not to delay the operation for too long. One reason is that the prognosis for cases with a (still) intact rotator cuff is decidedly better, and secondly, conservative treatment which has gone on for a long time is especially dangerous if it has involved numerous intra-articular injections of steroids (Neer and Welsh 1977).

In conclusion, the results of the present study suggest that an adequate decompression of the subacromial space by ligament resection or acromioplasty, if necessary in conjunction with a reconstruction of the rotator cuff, can lead to the relief of pain and the restoration of shoulder function.
References


Burman M (1949) Compression of the supraspinatus tendon by the coracoacromial ligament. A syndrome simulating tear of the supraspinatus tendon. JAMA 144:1145


