Anterior Acromioplasty for the Chronic Impingement Syndrome in the Shoulder

A Preliminary Report *

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Impingement of the rotator cuff beneath the coraco-acromial arch has been recognized as one of the causes of chronic disability of the shoulder [1,5,6,7,9,10]. Complete acromionectomy [1,5,10] and lateral acromionectomy [6,9] at various levels have been advocated for the condition. Disappointment with the results of these procedures, because of weakening of the leverage of the deltoid muscle, displacement of the attachments of the origin of the deltoid, formation of sinuses with bursal or joint fluid draining through the skin, deep scars, and, in the case of lateral acromionectomy, the persistence of symptoms because of residual impingement, stimulated us to a new study of the role, in the impingement syndrome, of the undersurface of the acromion.

This paper describes relevant anatomical findings and the rationale, the indications, the technique, and the preliminary results of anterior acromioplasty, which has been a procedure performed in our clinic since 1965.

Anatomical Considerations

Inspection of 100 dissected scapulae with special attention to the acromion revealed alterations attributable to mechanical impingement in eleven. The ages of the cadavera were unknown but the majority were in the sixth decade or older. A characteristic ridge of proliferative spurs and excrescences on the undersurface of the anterior process was seen frequently, apparently caused by repeated impingement of the rotator cuff and humeral head, with traction on the coracoacromial ligament, and it was quite prominent in eight specimens (Fig. 1-A). Eburnation with erosion of the acromion was thought to be a later manifestation, and was found in three specimens (Fig. 1-B). Without exception, it was the anterior lip and undersurface of the anterior third that was involved. In one scapula, the eburnation and erosion, accompanied by an old massive cuff tear, extended somewhat further toward the center of the acromion but the posterior third was spared.

My observations at surgery have consistently supported the hypothesis that the critical area for degenerative tendinitis and tendon rupture is centered in the supraspinatus tendon, extending at times to include the anterior part of the infraspinatus tendon and the long head of the biceps [3,7] (Fig. 2). However, it has not been adequately emphasized that, with the arm in the anatomical position, all of these structures lie anterior to the acromion. With internal rotation, the position in which the arm is often used, they are brought even more anterior. With external rotation, the facet for the insertion of the supraspinatus lies just lateral to the anterior third of

* Read at the Annual Meeting of The American Orthopaedic Association, Hot Springs, Virginia, June 21, 1971.

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FIG. 1-A

FIG. 1-B

Figs. 1-A and 1-B: Photographs of the undersurface of the acromion of elderly cadavera.
Fig. 1-A: Showing a large anterior acromial spur and excrescences of the anterior third, thought characteristic of chronic impingement with traction on the coraco-acromial ligament. Spatial relations can be determined by the location of the articular facet for the clavicle.
Fig. 1-B: Another specimen showing erosion of this area and eburnation, which appeared to be a later manifestation.

the acromion (Fig. 3). Thus, elevation of the arm in internal rotation or in the anatomical position of external rotation causes the critical area to pass under the coraco-acromial ligament or the anterior process of the acromion. The critical area does not touch the posterior two-thirds of the acromion. With scapular rotation the acromion is tilted backwards, leaving the anterior process as the leading edge.

At about 80 degrees of abduction, the critical area of the supraspinatus tendon passes beneath the acromioclavicular joint and this joint tilts with overhead elevation of the arm. With the joint in this position, it is logical to assume that excrescences on the undersurface of the anterior margin of the acromion may impinge on the cuff. Arthrograms seem to substantiate this point.

One thesis of this study is that a lateral acromionectomy not only weakens the deltoid unnecessarily, which is especially bad when the rotator cuff is deficient, but also removes an innocent part of the acromion, that part posterior to the site of pathological involvement. It seems important that the rough surface on which the supraspinatus tendon is rubbing be removed. One should therefore remove the anterior edge and the undersurface of the anterior process along with the attached coraco-acromial ligament. If other pathological areas are discovered at operation, that is, a hypertrophic acromioclavicular joint, or spurs and adhesions at the long head of the biceps or greater tuberosity, they too should be removed. The attachments of the deltoid should be minimally disturbed.

Material

During the years 1965 to 1970, fifty shoulders of forty-six patients were operated on by the method to be described. The pathological findings in the supraspinatus tendon consisted of tendinitis or partial tears in nineteen shoulders, complete tears in twenty, and evidences of residual impingement following lateral acromionectomy in

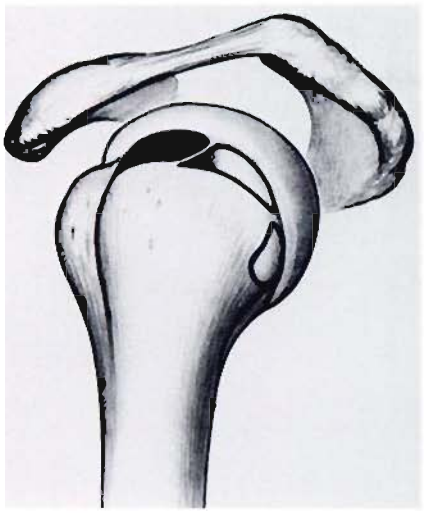

FIG. 2

FIG. 3

Fig. 2: Illustrating the relationships of the critical area with the coraco-acromial arch when the arm is held in the anatomical position. Note the overlapping insertion of the infraspinatus and the proximity of the bicipital groove. The critical area is anterior to the acromion.

Fig. 3: Drawing to show that with elevation into any of the functional arcs, the critical zone at the supraspinatus engages the anterior third of the acromion, not the posterior part.

eleven. Patients with roentgenographic evidence of calcification in the tendon, rheumatoid arthritis, fractures, or acute tears were not considered suitable for this study, which was restricted to what was considered mechanical impingement.

The ages of the patients ranged from forty-two to seventy-three years and averaged 51.5 years for those with tendinitis or partial tears and 58.1 years for those with complete tears. Twenty-eight patients were men and eighteen were women. The right shoulder was involved twice as frequently as the left.

Forty-seven shoulders were evaluated from nine months to five years following surgery, twenty-nine by examination and eighteen by questionnaire and records. Three shoulders had not been followed for the minimum period. Follow-up roentgenograms were obtained in all but six. The average duration of follow-up was two and one-half years.

Indications for Surgery

The procedure to be described was used in patients either with long-term disability from chronic bursitis and partial tears of the supraspinatus tendon, or with complete tears of the supraspinatus associated with tears of varying degree of the adjacent rotator cuff. The first lesion is regarded as an early stage of the second and the two lesions comprise the impingement syndrome. Calcific deposits in the rotator cuff did not necessarily occur at the critical area of impingement, and they were regarded as chemical irritants. Patients with such deposits were usually responsive to simple treatment and were not considered for the procedure under discussion. Nine patients in this series had a history of having had such deposits and were found to have scarred or torn supraspinatus tendons, with or without minute amounts of calcium which, when present, were inapparent roentgenographically.

Since the physical and roentgenographic findings in the two categories of patients were indistinguishable, arthrograms were required to demonstrate whether the tears were complete. The physical signs for both groups of patients included crepitus and tenderness over the supraspinatus tendon, a good range of assisted motion but a

FIG. 4-A

FIG. 4-B

Figs. 4-A and 4-B: Roentgenograms of an anterior acromial spur in a man aged fifty-six years. A three-centimeter complete tear of the supraspinatus was found at surgery.

Fig. 4-A: Anteroposterior roentgenogram showing the spur on the acromion and a corresponding excrescence at the greater tuberosity and bicipital groove.

Fig. 4-B: Axillary roentgenogram of the same patient showing that the spur is located at the anterior third of the acromion. Roentgenographic findings at the acromion are not always evident and, when present, may be compatible with normal function although the patient appears to be more vulnerable to minor trauma.

painful arc of active elevation from 70 degrees to 120 degrees, and pain at the anterior edge of the acromion on forced elevation. Patients with partial tears seemed more prone to have a lesser range of motion. The only common roentgenographic finding was the presence of cysts or sclerosis of the greater tuberosity, but on close inspection many roentgenograms showed corresponding areas of proliferation at the anterior edge of the acromion (Figs. 4-A and 4-B).

Patients suspected of having incomplete tears were advised not to have surgery until the stiffness of the shoulder had disappeared, and the disability had to persist for at least nine months before surgery was performed. Many patients not included in the series were suspected of having impingement but responded well to conservative treatment. This suggests that while such patients had pathological changes in the cuff that were vulnerable to swelling and inflammation following minor trauma, the acute reaction was reversible. In this series, all patients with incomplete tears had had symptoms for from ten months to ten years, averaging four years. The effects of a xylocaine injection beneath the acromion or into the acromioclavicular joint was a useful guide as to what the procedure would accomplish.

The patients in this series who had complete tears had had symptoms for from six weeks to twelve years. The symptoms sometimes were intermittent and often became more intense a few months prior to surgery. When a complete tear was suspected and there was no response to conservative treatment for six weeks, arthrography was advised. If the arthrogram was positive, surgery was recommended. In the occasional patient who was suspected of having a massive cuff avulsion, because of a history of minor trauma followed by complete inability to raise the arm, we tried to make the arthrogram and to do the repair promptly before there was permanent shortening of the cuff muscles.

A special indication for anterior acromioplasty was residual impingement and chronic disability following partial lateral acromionectomy. The shoulders of those patients were decompressed anteriorly according to the same principle. We tried to use the old skin incision as much as possible and, at times, we did a reconstruction of the central part of the origin of the deltoid.

This procedure has also been used at the time of glenohumeral arthroplasty for rheumatoid and degenerative arthritis. These cases are not included in this study. It

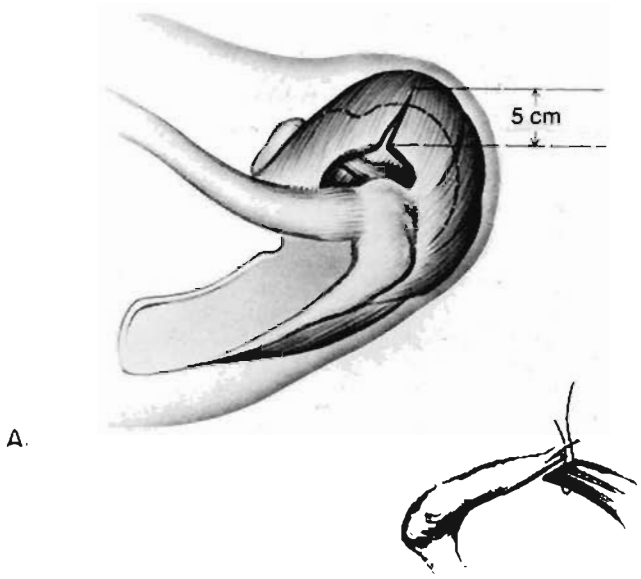

FIG. 5

Illustrating detachment and repair of the deltoid origin. *A:* The muscle is split from above downwards five centimeters and is detached from the anterior third of the acromion and acromioclavicular joint capsule. The tendinous origin on the anterior third of the acromion is elevated dorsally prior to removing bone, exposing the anterior edge of the acromion and providing a rim of tissue for repair. *B:* Secure closure of the deltoid is accomplished by suturing the lateral flap to the rim of tendinous tissue on the acromion as shown. The medial flap is sutured to the capsule of the acromioclavicular joint or, when the joint has been excised, to the trapezius muscle. The split is closed last.

was thought that the inclusion of results of combined procedures for other types of disease would introduce too many variables to permit an analysis of the subacromial impingement syndrome.

Operative Technique and Postoperative Regimen

The patient was placed high on the table, positioned so that the point of the affected shoulder protruded over the corner of the table. The shoulder, which was draped free, could be fully extended without interference from the table. Folded towels were placed under the scapula. The head was supported with an armboard, avoiding hyperextension. The table was adjusted to the beach chair position. The anesthesiologist was draped from the field; we preferred intratracheal anesthesia.

An incision, about nine centimeters long, was made obliquely in Langer's lines from the anterior edge of the acromion to just lateral to the coracoid. The deep fascia was incised and the deltoid muscle was split from above downward, in the direction of its fibers, five centimeters distal to the acromioclavicular joint. Further splitting jeopardizes the axillary nerve. By sharp dissection, anticipating cutting the acromial branch of the thoraco-acromial artery, the deltoid was detached from the front of the acromion and acromioclavicular joint capsule (Fig. 5). This exposed the coraco-acromial ligament. The claviculopectoral fascia, extending laterally from this ligament, was divided to permit placing a wide elevator under the acromion. With traction on the arm the undersurface of the anterior process was palpated manually for sharp edges and osteophytes and to determine the thickness of the acromion. To facilitate repair of the deltoid, the stump of its tendinous origin on the anterior acromion was elevated upward exposing the front of the acromion and the attach-

ment of the coraco-acromial ligament (Fig. 5). A thin, sharp, nineteen-millimeter osteotome was directed horizontally in a posterolateral direction (Fig. 6) to remove the anterior edge and lateral portion of the undersurface of the anterior process. This wedge-shaped piece of bone, which was usually about 0.9 centimeter thick anteriorly and 2.0 centimeters long and which included the entire attachment of the coraco-acromial ligament, was removed and the ligament was cut across proximal to the coracoid. With the aid of an elevator the undersurface was inspected for any residual fragments of bone or prominences. The undersurface of the acromioclavicular joint was next palpated and if excrescences were present, or if an arthritic joint had been symptomatic, the distal 2.5 centimeters of the clavicle was excised and the prominences on the acromial side of this joint were removed.

FIG. 6

To depict removal of the anterior lip and undersurface of the anterior process of the acromion. *A:* A thin nineteen-millimeter osteotome is seen directed posterolaterally removing the anterior edge with the attached coraco-acromial ligament and the deep surface. *B:* The osteotomy is directed just lateral to the articular facet for the clavicle. *C:* Having removed this wedge-shaped fragment, the deep margins of the acromioclavicular joint are palpated, and if prominent, or more exposure of the supraspinatus is required, this joint is excised.

This approach placed the supraspinatus in the center of the field and provided a wider exposure than would be expected. Because of the slope of the acromion, with hyperextension of the shoulder, the humerus was brought forward and with internal rotation the teres minor could readily be visualized. With flexion and external rotation the subscapularis was well exposed. At this stage, with patience and

persistence, in most cases the torn end of a supraspinatus tendon could be adequately brought into contact with the humerus where a groove was cut to allow repair without tension when the arm was at the side. In the more difficult cuff repairs, the distal part of the clavicle had to be excised as has been advised by Bateman, to enhance mobilization of the supraspinatus, but with care to avoid excessive traction on the suprascapular nerve.

Prior to closure of the incision, the long head of the biceps and its groove were routinely inspected. This tendon was rarely transplanted because it is thought to aid the stability of the shoulder joint. Osteophytes in the biceps groove or on the greater tuberosity and thickened bursal tissues were removed.

The repair of the deltoid was important. The medial flap was first sutured to the capsule of the acromioclavicular joint (Fig. 6) or when the distal end of the clavicle had been excised, to the trapezius muscle. The lateral flap was sutured to its tendinous stump of origin that had been reflected upward on the dorsum of the acromion. The split in the deltoid was closed last.

Postoperatively, active forward elevation was prohibited for ten days to give the deltoid a chance to reattach. Assisted external rotation was thought to be especially important, and so were pendulum exercises. They were begun on the third or fourth day and, depending on the status of the cuff, the motions were progressively increased until there was full assisted overhead extension, done first with the patient supine. Abduction splints were not used postoperatively except in a few complicated secondary repairs and then early assisted external rotation exercises were stressed. I have worked primarily for recovery of the range of motion. Strength comes later with purposeful use.

Findings and Results

The results were graded as satisfactory or unsatisfactory. In a satisfactory result, the patient was satisfied with the operation and had no significant pain. He had full use of the shoulder, less than 20 degrees of limitation of overhead extension, and at least 75 per cent of normal strength. In an unsatisfactory result, these criteria were not met.

Chronic Bursitis with Fraying or Partial Tear of the Supraspinatus

The period of hospitalization following surgery in this group averaged seven days. At surgery, all nineteen patients with this type of lesion were also found to have proliferative bursitis and a prominence of the coraco-acromial ligament and anterior third of the acromion. There were distinct excrescences in eight. Irregularities in the greater tuberosity were common. Minute calcium deposits inapparent roentgenographically were found in six. The long head of the biceps was abnormal in five and ruptured in one. It was transplanted in three. The acromioclavicular joint was found to be involved by hypertrophic arthritis in three and it was excised in two of the patients.

There were two patients in this group with significant shoulder stiffness preoperatively and they required a number of months to be rehabilitated. One patient, who was discharged from the hospital on the second day, partially detached his deltoid by too vigorous activity and a large hematoma developed. There were no other significant complications.

The results of the sixteen shoulders evaluated were: fifteen satisfactory and one unsatisfactory. Three shoulders were not evaluated, two because of an insufficient interval since surgery and one in a patient who could not be located. Those with satisfactory ratings had normal deltoids, full range, and strength. The unsatisfactory rating was in a patient who had arthritis of the cervical spine and of the acromio-

TABLE I

CLINICAL SERIES AND RESULTS, 1965 TO 1970

	Acromioplasty	With Acromioclavicular Joint Excision	Satisfactory Results
Proliferative bursitis with tendinitis or partial tears of the supraspinatus	19	2	15 of 16
Complete tears of supraspinatus	20	2	19 of 20
Impingement after lateral acromionectomy	11	4	4 of 11
Total	50	8	38 of 47

clavicular joint, which was not excised. It was thought that his acromioclavicular joint should have been excised.

Complete Tears of the Supraspinatus

No previous surgery had been performed in the twenty shoulders in this group. All were found to have degenerative changes in the tendon as well as complete, but not acute, tears. The lesion was always centered in the supraspinatus tendon and in the overlapping insertion of the infraspinatus. It extended posteriorly for a varying distance. Calcium deposits were noted in three patients. The width of the tears were two centimeters in two, three centimeters in nine, and four centimeters in nine. Their lengths ranged from three centimeters to seven centimeters. While mobilization of the larger lesions required high dissection and preliminary traction on the tendons, the exposure offered by this approach was no handicap and all could be repaired by the McLaughlin technique. The outer portion of the clavicle was excised in two patients.

The results in all twenty shoulders operated on for complete tears (no previous operation) were: nineteen satisfactory, all of which approached normal, and one unsatisfactory. The unsatisfactory result was in a patient in whom seizures occurred and who damaged his shoulder.

Lateral acromionectomies had been performed from six months to four years previously in eleven patients, one for a supraspinatus tendinitis without a tear in the tendon and ten for complete tears of the supraspinatus. All eleven patients had varying degrees of deltoid weakness. The patient who previously had an incomplete lesion and had had one operation for biceps tendinitis and also a lateral acromionectomy was found to have marked anterior acromial excrescences and to have a three-centimeter full-thickness tear. Of the ten patients who had prior cuff repairs, two had healed sinuses between the shoulder joint and the old skin incision and all were found to have anterior impingement. The cuff was found to be intact in six. Two patients had massive attenuation of the cuff and retraction of the tendons of the cuff muscles. The outer clavicle was removed to facilitate repair in four patients. The central part of the deltoid was found reattached to the humerus in six patients.

The results in the eleven patients who previously had had lateral acromionectomies, all of whom had less pain but residual weakness, were rated, four as satisfactory and seven as unsatisfactory. Of the unsatisfactory results, three were borderline. Two more, who had massive, retracted, cuff tears, became much more comfortable but the shoulders were quite weak. Advancement of the supraspinatus muscle, as described by Debeyre and associates, was later attempted in one without improvement. The remaining two unsatisfactory results were in patients whose rotator tendons were found intact, but they had marked deltoid deficiencies and bouts of pain related to fatigue and, in one patient, an osteoarthritic acromioclavicular joint.

This patient was one of the early cases—in retrospect we should have excised the joint at the same time that anterior acromioplasty was done.

Over-All Results

There were no postoperative infections. In five patients subcutaneous hematomas developed that resolved spontaneously. The scars were well healed. Excessive new-bone formation, which has been described as a serious problem following partial lateral acromionectomy [1], did not occur in this series. Since only the anterior half of the deltoid was detached and the central portion remained intact, this muscle quickly responded to rehabilitation and, in acute cases, recovered normal strength. In contrast, a deficient deltoid played a major role in the high incidence of unsatisfactory results in those patients who had had lateral acromionectomies.

Discussion

The majority of patients in the group having incomplete tears of the supraspinatus had been diagnostic problems for years. Many had had arthrograms which did not prove diagnostic. The previous provisional diagnosis had most frequently been bicipital tenosynovitis. As has been stated, one third of the patients in this group were found at operation to have abnormalities of the biceps tendon. In those patients the abnormalities in the tendon were thought to have developed because of the proximity of the long head of the biceps to the critical area of impingement. The biceps tendon and adjoining tissues were normal in two-thirds of the patients in this group. Some of the patients had cysts in or excrescences on the greater tuberosity of the humerus, presumably caused by the impingement. At times these excrescences extended into the bicipital groove and were associated with scarring of the long head of the biceps. The close relationship of bicipital tenosynovitis to impingement becomes obvious when one considers how often this tendon and adjoining structures were abnormal when the cuff was completely torn. We now consider it unwise to operate on the biceps tendon alone without having considered the possibility of a concomitant element of subacromial impingement.

The value of anterior acromioplasty is thought to be that it relieves pain and inflammation from chronic impingement; that technically it improves exposure of other involved structures and allows appropriate measures to be taken with reference to them; and that it retards the wear caused by persistent impingement and may prevent rupture of the supraspinatus tendon or of the long head of the biceps, or both. The recent literature suggests that the repair of complete cuff tears requires more complicated techniques [4, 8], but judging from a review of the operative findings in our clinic over the past ten years, it is a rare cuff tear that cannot be repaired through this simple approach. This is in agreement with Bateman who has evolved a similar anterior approach with the objective of resection of the acromioclavicular joint. However, it is important that the occasional patient with a massive tear of the supraspinatus tendon be treated promptly, before fixed shortening of the cuff muscles makes it unlikely that an effective repair can be accomplished by any method. The rare patient with an irreparable tear can be made more comfortable if impingement is relieved and can gain surprising function if the deltoid is permitted to remain strong.

Summary

Impingement on the tendinous portion of the rotator cuff by the coraco-acromial ligament and the anterior third of the acromion is responsible for a characteristic syndrome of disability of the shoulder. A characteristic proliferative spur and ridge has been noted on the anterior lip and undersurface of the anterior process of the acromion and this area may also show erosion and eburnation. The treatment of the

impingement is to remove the anterior edge and undersurface of the anterior part of the acromion with the attached coraco-acromial ligament. The impingement may also involve the tendon of the long head of the biceps and if it does, it is best to decompress the tendon and remove any osteophytes which may be in its groove, but to avoid transplanting the biceps tendon if possible. Hypertrophic lipping at the acromio-clavicular joint may impinge on the supraspinatus tendon when the arm is in abduction and, if the lip is prominent, this joint should be resected. These are the principles of anterior acromioplasty.

Fifty shoulders in forty-six patients have been subjected to anterior acromioplasty during the past five years. Nineteen had proliferative bursitis and tendinitis or partial tears of the supraspinatus, without roentgenographic evidence of calcium deposits, and twenty had complete tears of the supraspinatus and the results in these thirty-nine patients from one to five years following surgery were good. Eleven patients with residual impingement following partial lateral acromionectomy were improved but their results were impaired by pre-existent deltoid weakness and scar. Anterior acromioplasty may offer better relief of chronic pain in carefully selected patients with mechanical impingement, while it provides better exposure for repairing tears of the supraspinatus, and may prevent further impingement and wear at the critical area without loss of deltoid power.

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