# The Treatment of Symptomatic Os Acromiale\*

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ABSTRACT: During a four-year period, fourteen individuals (fifteen shoulders) who had been seen at the shoulder service of our institution because of pain in the shoulder had a radiographic finding of an os acromiale. On clinical examination, the pain appeared to be due to an unstable os acromiale because the patients had point tenderness over the acromion and pain on forward elevation of the shoulder. The diagnosis of an os acromiale was confirmed on radiographs, magnetic resonance images, or a bone scan. Eight patients had an associated tear of the rotator cuff. The os acromiale was located in the pre-acromion in one shoulder, the meso-acromion in eleven shoulders, and the meta-acromion in three shoulders. At the operation, the anterior aspect of the acromion was found to be unstable in all shoulders.

Eleven patients (twelve shoulders) had open reduction of the os acromiale and insertion of an autogenous iliac-crest bone graft. Of those patients, four (five shoulders) had open reduction and internal fixation with a tension-band procedure with use of pins and wires. Only one of those shoulders had a solid osseous union, and the other four shoulders had a non-union that was due to a disruption of the fixation. The remaining seven patients (seven shoulders) had open reduction and internal fixation with use of cannulated screws and a tension-band construct; a solid osseous union was achieved in all but one of them. One patient had excision of the pre-acromion, which relieved the pain. Two patients who had had failed open reduction and internal fixation had excision of a grossly unstable os acromiale in the meso-acromion; both patients had pain and weakness after this procedure.

Of the twelve shoulders that had open reduction and bone-grafting, seven had union of the os acromiale; the average time to radiographic and clinical union was nine weeks (range, seven to twenty weeks). We concluded that, although it is rare, symptomatic unstable os acromiale does occur and can be effectively treated with use of autogenous bone-grafting and internal fixation with a rigid tension-band construct and cannulated screws.

The acromial apophysis develops from four separate centers of ossification. Three of these centers (the preacromion, meso-acromion, and meta-acromion) normally fuse to each other when an individual is fifteen to eighteen years old, whereas the fourth (the basiacromion) typically fuses to the spine of the scapula by the age of twelve years<sup>3</sup> (Fig. 1). When osseous union between the acromial apophysis and the spine of the scapula fails to occur in a skeletally mature individual, the unfused acromial apophysis is called an os acromiale. Although the radiographic prevalence of os acromiale in skeletally mature shoulders has ranged from 1.4 per cent (twenty-five of 1800 shoulders) to 8.1 per cent (twenty-two of 270 shoulders), the condition rarely causes pain<sup>3,5</sup>. The presence of an os acromiale may be an incidental finding on a plain axillary radiograph, a computed tomography scan, or a magnetic resonance image, but it usually is not associated with pain in the shoulder. Nevertheless, a symptomatic os acromiale has been described in association with impingement syndrome<sup>4</sup> and with a tear of the rotator cuff<sup>6</sup>. In the few studies on the treatment of this condition, the authors have recommended either excision of the unstable acromial fragment or modified acromioplasty<sup>1,4,6</sup>. Bigliani et al. observed that an attempt to achieve fusion of the unstable acromial fragment by operative treatment was usually unsuccessful. The purpose of the present study was to report our experience with operative treatment and bone-grafting of an unstable os acromiale. This treatment preserves the acromial origin of the deltoid muscle and avoids the weakness of the deltoid that occurs after acromionectomy.

## **Materials and Methods**

From 1991 through 1994, the senior one of us (J. J. P. W.) managed fourteen patients (fifteen shoulders) who had pain in the shoulder associated with an os acromiale (Table I). There were seven men and seven women who had an average age of fifty-seven years (range, nineteen to seventy-six years). The six patients who did not have a concomitant tear of the rotator

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Case	Gender, Age (yrs.)	Location of the Os Acromiale	Previous Diagnosis	Tear of the Rotator Cuff	Procedure*	Union	Outcome
1	<b>M</b> , 67	Pre-acromion	Thoracic outlet syndrome	No	Primary excision	No	Good
2	F, 76	Meso-acromion		Yes (massive)	Failed repair, excision	No	Poor
3	M, 48	Meso-acromion		No	Failed repair, excision	No	Poor
4	M, 66	Meso-acromion		Yes (massive)	Technique I	No	Poor
5	M, 66	Meso-acromion		Yes (massive)	Technique I	No	Poor
6	F, 34	Meso-acromion	Tendinitis	No	Technique I	No	Poor
		Meso-acromion	Tendinitis	No	Technique I	No	Poor
7	M, 66	Meta-acromion		Yes (large)	Technique I	Yes	Good
8	M, 36	Meta-acromion		No	Technique II	No	Poor
9	F, 59	Meso-acromion		No	Technique II	Yes	Good
10	M, 67	Meso-acromion		Yes (massive)	Technique II	Yes	Good
11	F, 19	Meso-acromion	Psychosomatic pain	No	Technique II	Yes	Good
12	F, 61	Meso-acromion		Yes (large)	Technique II	Yes	Poor
13	F, 68	Meta-acromion		Yes (small)	Technique II	Yes	Good
14	F, 63	Meso-acromion		Yes (small)	Technique II	Yes	Good

TABLE I Data on the Patients

\*Technique I = tension-band fixation with pins and wires, and Technique II = tension-band fixation with cannulated screws and wires.

cuff had a history of trauma to the shoulder. Although only eight patients had clinical findings and imaging studies that confirmed a tear of the rotator cuff in addition to the os acromiale, all fourteen patients had pain on palpation directly over the acromion in the region of the os acromiale. No patient was able to actively flex the shoulder to more than 120 degrees, regardless of the presence or absence of a tear of the rotator cuff. Axillary radiographs demonstrated that the os acromiale was in the meso-acromion in eleven shoulders, the meta-acromion in three (Fig. 2-A), and the preacromion in one. Magnetic resonance imaging or computed tomography demonstrated the os acromiale in all patients (Fig. 2-B), and three patients had a bone scan



Drawing showing the three ossification centers of the acromion that determine os acromiale. PA = pre-acromion, MSA = mesoacromion, and MTA = meta-acromion.

that demonstrated increased uptake on the symptomatic side (Fig. 2-C).

The average time to the diagnosis of a symptomatic os acromiale in the eight patients who had an associated tear of the rotator cuff was thirteen months (range, three to thirty-six months). Of the six patients (seven shoulders) who did not have an associated tear of the rotator cuff, three had had a previous diagnosis other than an unstable os acromiale. One patient (two shoulders) had had a misdiagnosis of chronic tendinitis two years earlier; one, a misdiagnosis of thoracic outlet syndrome one year earlier; and one (a nineteen-year-old swimmer), a misdiagnosis of psychosomatic pain one year earlier (Table I). The eight patients who had an associated tear of the rotator cuff represented 2 per cent of the 340 patients who had a repair of the rotator cuff performed by the senior one of us during the four-year period of this study. Four patients had a massive tear of the rotator cuff, two had a large tear, and two had a small tear.

Arthroscopy was performed in six patients (seven shoulders)<sup>11</sup>: two patients (two shoulders) who had a small tear of the rotator cuff and four patients (five shoulders) who had findings consistent with impingement. The acromion was inspected after subacromial bursectomy, and its stability was assessed by observing movement of the undersurface of the acromion when manual pressure was applied to the superior surface<sup>12</sup>. In one patient, a small unstable acromial fragment (the pre-acromion) was excised through a formal open anterior approach with repair of the deltoid origin to the remaining part of the acromion. The other five patients (six shoulders) had a large acromial fragment (the



## Fig. 2-A

Figs. 2-A, 2-B, and 2-C: Imaging studies of a patient who had a painful os acromiale in the meta-acromion.

Fig. 2-A: Axillary radiograph demonstrating the unfused metaacromion (arrows).



Fig. 2-B

Computed tomography scan demonstrating the unfused metaacromion in the left shoulder (arrowhead) compared with a fused meta-acromion in the contralateral, right shoulder (arrow).

meso-acromion), which was unstable when depressed from the superior surface. The procedure in these patients was converted to an open anterior-superior approach in order to stabilize the loose acromial fragment. Two of them had repair of the rotator cuff as well.

Two patients (one who had a massive tear of the rotator cuff and one who had no tear) had an attempted repair of the unstable anterior aspect of the acromion. However, as the procedure was not technically possible in these two individuals, the unstable os acromiale in the meso-acromion was excised. Another patient, who had involvement of the meta-acromion, had open stabilization without arthroscopy because an unstable os acromiale was clearly evidenced by point tenderness, increased uptake on a bone scan, and demonstration of a non-union on a computed tomography scan.

The remaining five patients who had a concomitant

large or massive tear of the rotator cuff were managed with an open anterior-superior approach in order to assess acromial stability and to repair the loose acromial fragment as well as the tear of the rotator cuff. The acromion was exposed, but the deltoid was not initially detached from the anterior acromial surface. The mesoacromion or meta-acromion was identified, and instability at this unfused ossification center was confirmed by pushing down on the anterior aspect of the acromion and observing movement at the os acromiale.

## **Operative** Techniques

#### Tension-Band Fixation with Pins and Wires

This procedure was used in the initial four patients (five shoulders) who needed stabilization of the os acromiale. The patient is placed in a modified seated position and is stabilized on a pneumatic beanbag so that the anterior and posterior aspects of the shoulder are fully exposed. The ipsilateral hip is also exposed and elevated by placing a folded blanket underneath the buttock. Both the shoulder and the hip are prepared and draped.

An anterior-superior incision is made over the top of the shoulder and is centered over the acromion. This incision extends from the posterior edge of the acromion to a point approximately one centimeter lateral to the coracoid process. Subcutaneous dissection is performed to expose the entire acromion and the deltoid origin. Electrocautery is used to divide the periosteum off the top of the acromion, perpendicular to the os acromiale. When the os acromiale is located, the periosteum is elevated both medially to the acromioclavicular joint and laterally to the lateral border of the acromion. Downward pressure is applied to the anterior aspect of the acromion, and movement is observed at the os acromiale. The periosteal incision is then extended anteriorly in line with the deltoid fibers, and the deltoid is elevated subperiosteally off the anterior and lateral edges of the acromion. Care is taken not to disrupt the



FIG. 2-C

Bone scan showing increased uptake of radioisotope at the symptomatic os acromiale (arrow).

acromioclavicular ligaments as these ligaments lend A pas some stability to the loose anterior acromial fragment active

by keeping it fixed to the clavicle. A small curet is inserted into the os acromiale, and cartilage and fibrous tissue are curetted out of the site of the non-union. This step is facilitated by pushing down on the anterior aspect of the acromion in order to open up the os acromiale. Care is taken not to disrupt the soft tissue on the undersurface of the acromion as the soft tissue acts as a hinge to keep the anterior acromial fragment aligned with the remaining posterior aspect of the acromion. When all of the cartilage and fibrous tissue have been removed, a small motorized burr is used to abrade the adjacent surfaces of the acromion. The anterior aspect of the acromion then is tilted up by digital pressure from underneath so that it is reduced against the posterior osseous surface of the acromion and diverges from the humeral head.

Two Kirschner wires are drilled parallel to one another from the anterior aspect of the acromion across the site of the non-union and out the posterior aspect of the acromion. A small rectangular trough is created perpendicularly across the site of the non-union. This trough is only three to four millimeters deep, no more than three to four millimeters wide, and ten millimeters long. The iliac crest then is exposed, and a corticocancellous bone graft of similar dimensions is obtained and placed into the osseous trough across the site of the non-union. Additional cancellous bone graft is packed over the abraded surface of the superior aspect of the acromion. Eighteen-gauge wire is placed around the Kirschner wires in a figure-of-eight fashion and is tightened securely. Each end of the Kirschner wires is bent down and cut off. The periosteum then is sewn down over the Kirschner wires and the bone graft. Patients who have a tear of the rotator cuff then have an open repair, but an acromioplasty is not performed.

# Tension-Band Fixation with Cannulated Screws and Wires

On the basis of our initial experience with the procedure just described, we modified the technique in order to achieve more rigid fixation. The operative technique is essentially the same except that the Kirschner wires are replaced with 4.0-millimeter cannulated cancellousbone AO screws (Synthes USA, Paoli, Pennsylvania) after drilling with a cannulated 2.7-millimeter drill-bit (AO; Synthes USA). An 18-gauge wire is passed through each screw (a total of two wires) but is not tied down until the bone graft is placed as previously described. The 18-gauge wires are then oriented over the top of the acromion in a figure-of-eight fashion and tightened securely (Figs. 3-A through 3-E).

# Postoperative Management

The arm is placed in a shoulder immobilizer, and the patient is discharged from the hospital the next morning.

A passive range of motion is started after one week, and active motion is permitted after six weeks but is limited to simple activities of daily living with use of the arm below the level of the shoulder. After twelve weeks, full active motion is permitted. Serial radiographs are made starting at one week postoperatively and then at six, twelve, and twenty-four weeks.

# Results

The average duration of follow-up was thirty-four months (range, twenty-four to forty-seven months).

# Non-Union

Two patients who were managed with excision of the meso-acromion after technical failure of internal fixation had a poor result. One of them had a concomitant repair of a massive tear of the rotator cuff; she had moderate pain at rest and was unable to use the arm above the level of the mouth. The tear of the rotator cuff appeared to have healed as evidenced by the clinical finding of good strength in external rotation. The other patient had mild pain with use of the arm and was able to flex the shoulder to 140 degrees. However, the patient was bothered by marked weakness, which made it difficult for him to work as a plumber. Of the four patients (five shoulders) who had open reduction and internal fixation with use of the tension-band construct with pins, three (four shoulders) did not have radiographic union and all had removal of loose hardware between three and six months after the operation. None of these patients elected to have a repeat attempt at bone-grafting of the os acromiale. Although all could flex the shoulder to at least 120 degrees (maximum, 140 degrees), all reported marked weakness of the shoulder and pain at rest.

One patient had a non-union after open reduction and internal fixation with use of the tension-band method with screws; an attempt to repair the non-union with repeat bone-grafting was not successful. The hardware was removed, and the patient continued to have limitation of flexion to 90 degrees and mild pain at rest.

The patient who had excision of the pre-acromion and then repair of the deltoid had a good result — that is, no pain and full symmetrical flexion of the shoulder to 150 degrees.

#### Osseous Union

Seven patients (seven shoulders) had clinical and radiographic union of the os acromiale, at an average of nine weeks (range, seven to twenty weeks). All but one of these patients had a good result, with flexion to at least 140 degrees (maximum, 160 degrees) and no pain. One of these patients, a college student who participated in competitive swimming, was able to return to full competition one year after the operation and remained asymptomatic thirty-two months postoperatively. One patient who had union of the os acromiale



Figs. 3-A, 3-B, and 3-C: Drawings showing the technique for open reduction, internal fixation, and bone-grafting of an unstable os acromiale.

Fig. 3-A: The unstable anterior portion of the acromion is tilted upward after cartilage and fibrous tissue are curetted out of the os acromiale. Kirschner wires are then drilled from anterior to posterior for provisional fixation and are replaced with short-thread 4.0-millimeter cannulated cancellous-bone AO screws (Synthes USA, Paoli, Pennsylvania). An 18-gauge wire is then passed through each cannulated screw (a total of two wires).



A bone trough is created with a motorized burr in the superior portion of the acromion so that the trough traverses the site of the os acromiale. Autogenous corticocancellous bone graft from the iliac crest is shaped to fit the trough.

had a poor result; she continued to have pain, flexion to only 100 degrees, and weakness that was due to a repeat tear of the repaired rotator cuff.

Five of these seven patients had removal of the screws (or pins) and wires between six and twelve months postoperatively because of prominence of palpable hardware on the top of the shoulder or discomfort from the hardware. In all of these patients, stable union was confirmed at the time that the hardware was removed.

## Concomitant Repair of a Tear of the Rotator Cuff

Of the eight shoulders that had a concomitant repair of a tear of the rotator cuff, five did and three did not have a solid union of the os acromiale. Union of the os acromiale was achieved in two shoulders that had a small tear, two that had a large tear, and one that had a massive tear of the rotator cuff. All three shoulders that did not have union had a massive tear; two had been treated with internal fixation with use of the tensionband technique with pins, and one had had a failure of fixation during the operation that had necessitated resection of the unstable anterior acromial fragment.

### Discussion

Although most pain in the shoulder that affects individuals in the third, fourth, or fifth decade of life is due to disease of the rotator cuff, occasionally an os acromiale can contribute to pain. Non-union of an acromial fragment has been reported in a few series<sup>1,3-7,9</sup>, but there has been little information on the results of treatment. The radiographic finding of an asymptomatic os acromiale in a skeletally mature patient has also been reported<sup>2</sup>. Thus, the clinical relevance of an os acromiale as a cause of pain in the shoulder remains unclear.

Neer<sup>7</sup> as well as Mudge et al. noted that a large os acromiale that is associated with a tear of the rotator cuff should be repaired rather than resected at the time that the rotator cuff is repaired. Resection may lead to weakness. Bigliani et al. suggested that arthroscopic subacromial decompression rather than operative repair is a reliable form of operative management in patients who have pain in the shoulder that is due to an os acromiale. However, others have not found this to be the case<sup>4</sup>.

Our experience with the diagnosis and management of fourteen skeletally mature individuals showed that an



The 18-gauge wires are tightened in a figure-of-eight configuration over the corticocancellous bone graft, and morseled bone graft is placed over the surface of the acromion.



FIG. 3-D

Figs. 3-D and 3-E: Radiographs demonstrating fixation of the os acromiale. Fig. 3-D: Postoperative radiograph in the axillary plane.



FIG. 3-E Postoperative supraspinatus outlet radiograph.

os acromiale was either the primary cause of pain in the shoulder or a contributing cause in combination with a tear of the rotator cuff. The patients had a wide range of ages, and several were young, active individuals who had had a delay in the correct diagnosis and proper treatment because the pain had been attributed to other causes. One patient, who was nineteen years old, might have been considered to have an acromial apophyseal growth plate that had not yet fused, as the fusion of this growth plate may not occur until the age of twentyfive years; however, a radiograph of the contralateral shoulder as well as a computed tomography scan demonstrated fusion of the acromial apophysis in the contralateral shoulder. Thus, we concluded that the patient had a symptomatic os acromiale in the painful shoulder. Successful arthrodesis of this site eliminated the pain.

The consistent finding in the examination of our patients was point tenderness over the acromion in the region of the os acromiale. Furthermore, our routine radiographic series included an axillary radiograph, which demonstrated the os acromiale. Computed tomography or magnetic resonance imaging was helpful in demonstrating sclerocystic changes at the site of the non-union, and bone-scanning was done for a few younger individuals who had pain that could not be attributed to other abnormalities. Although we are reporting on fourteen patients who had an unstable, symptomatic os acromiale, we do not know the total number of patients who had a radiographic appearance of an os acromiale but no related symptoms during the same four-year period. Thus, it was impossible to calculate the prevalence of this condition in our patients during this time-period.

The instability of the os acromiale was confirmed in all of our patients either arthroscopically or by direct open inspection. We believe that the mechanism of pain is not only motion at the site of the non-union but also inferior displacement of the anterior aspect of the acromion onto the rotator cuff causing impingement. This mechanism occurs as a result of the downward pull of the deltoid through its origin on the anterior aspect of the acromion (Fig. 4). Therefore, we did not attempt an acromioplasty in our operative procedure, as the anterior portion of the acromion was fixed after it had been reduced so that it tilted upward and away from the rotator cuff. Furthermore, we did not want to compromise the fixation across the site of the non-union by removing bone with an acromioplasty.

The operative technique was crucial to the achievement of a stable osseous union across the site of the non-union. The tension-band method with use of pins and wires was our initial approach, and it failed in four of five shoulders. We believe that the failure was due to the inability to achieve rigid fixation across the site of the non-union. As a result of this experience, we modi-



Drawing showing the mechanics of an unstable os acromiale. When the deltoid contracts, the unstable anterior aspect of the acromion is pulled downward onto the rotator cuff and the humeral head.

fied the technique by using cannulated screws with wires placed through the screws and tightened in a figure-ofeight configuration. We believe that this approach resulted in a more rigid construct and also kept the bone graft securely fixed over the top of the acromion. A solid osseous union was achieved in six of the seven patients who were managed with this method.

Most patients reported discomfort from the wires on top of the acromion. As the subcutaneous tissue is quite thin at that location, it was necessary to remove the hardware in most of our patients.

Three patients had resection of the loose acromial fragment followed by repair of the deltoid. The only patient who had a good result with this approach was the one who had the os acromiale in the pre-acromion. The other two patients, who had the os acromiale in the meso-acromion, had a greater acromial resection, and it is likely that the pain that they had after the operation was due to loss of the normal acromial fulcrum for the function of the deltoid. This type of resection resulted in an acromionectomy, and both patients had weakness and pain. Such poor results after acromionectomy were described in another study<sup>8</sup>.

Although an association between os acromiale and a tear of the rotator cuff has been reported<sup>6</sup>, an isolated os acromiale that causes pain in the shoulder has been less clearly described<sup>2,4,10</sup>. We reported on patients who had an os acromiale with and without an associated tear of the rotator cuff in order to emphasize the clinical and radiographic findings as well as the method of operative treatment. It is difficult to conclude from the results in our patients that an associated tear of the rotator cuff results in a worse outcome than an unstable os acromiale without an associated tear. Four of the eight patients who had a tear had a poor result. Two of those poor results occurred after operations performed with our first technique of repair (the tension-band construct with pins and wires), whereas one occurred after a procedure performed with our second method (the tension-band method with screws and wires). The fourth patient had excision of the os acromiale after failure of an attempted repair.

We chose not to perform an arthroscopic acromioplasty and not to ignore the os acromiale because all of our patients had gross instability of the anterior aspect of the acromion. Thus, we were concerned about continuing pain resulting from functional impingement and an unstable non-union.

On the basis of our experience, we recommend that an axillary radiograph be made routinely and inspected for the presence of an os acromiale in patients who have pain in the shoulder and tenderness on palpation over the acromion. If a question remains about the importance of this finding, a bone scan may be useful. Increased uptake on the bone scan suggests active boneremodeling in the area of an unstable non-union. Comparison radiographs or a computed tomography scan can also demonstrate if the condition is unilateral and thus more likely to be clinically relevant in the shoulder that has pain. The pre-acromion can be excised if the deltoid origin is repaired. Resection of the meso-acromion or the meta-acromion usually results in pain and weakness. In such patients, stabilization and bone-grafting should be performed with use of tension-band fixation with cannulated screws as this approach results in a high rate of union and treats the condition effectively.

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