ORIGINAL ARTICLE

Os acromiale, a cause of shoulder pain, not to be overlooked

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KEYWORDS
Acromion; Iliac graft; Internal fixation

Summary

Introduction: Os acromiale is a failure of fusion of the acromial process. It is usually asymptomatic and discovered by chance. When it is painful a differential diagnosis must be made in relation to the subacromial impingement syndrome.

Hypothesis: Unstable os acromiale is the cause of atypical scapulalgias. Stabilization by tension band wiring and an embedded slot shaped graft achieves union and relieves pain.

Patients et methods: This series includes 10 patients mean age 43 years old presenting with shoulder pain resistant to a mean 15 months of conservative treatment. Pain followed trauma in three cases. Three patients had a history of acromioplasty, which had not relieved pain. All had pain during palpation of the superior aspect of the acromion. The diagnosis was confirmed in eight patients by positive results to local injection of the os acromiale. The mean preoperative Constant score was 53.4. The procedure included open reduction and fixation of the acromion by tension band wiring and pinning associated with an embedded iliac crest graft without acromioplasty.

Results: The mean follow-up was 48 months. Pain was relieved in seven cases and all patients had improved and were satisfied. Union of os acromiale was confirmed on CT scan in all patients. The mean Constant score was 82.2.

Discussion: The role of os acromiale in the origination of pain is confirmed by the efficacy of preoperative injection of the os acromiale and pain relief after achieving union. Moreover, our technique is reliable and always resulted in union of the os acromiale. Internal fixation by tension banding favors minimal upward migration of the os acromiale and union. In case of subacromial impingement syndrome an os acromiale should be looked for, as this condition could deteriorate with simple acromioplasty.

Level of evidence: Level IV retrospective observational study.
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Introduction
The term os acromiale is used to define failure of an acromial ossification center to fuse to the acromion. It was first described by Gruber [1] who distinguished three anatomical subtypes in relation to the size; os acromiale usually involves the mesiacromion, just behind the acromioclavicular joint [2,3]. It is sometimes bilateral and is also found as frequently in the general population as in symptomatic shoulders (approximately 10% of cases) [2—5]. Several studies in the literature have evaluated the association between os acromiale and rotator cuff tears, and most have concluded that there is no relationship between the two [2,3]. It can also become painful on its own, and must then be recognized as a differential diagnosis of subacromial impingement syndrome.

Our hypothesis was that the mobility of an unstable os acromiale would be directly responsible for pain and that stabilization by tension band wiring and an embedded slot shaped graft would result in union and pain relief.

The aim of this retrospective study was to analyze the results of open reduction and internal fixation with a slot shaped iliac crest graft in the treatment of unstable symptomatic os acromiale.

Materials and methods
Between 1995 and 2010, 10 patients underwent surgery for scapulalgia associated with unstable os acromiale (Table 1) including seven men and three women, mean age 43.3 years old (16—65 years old). The right shoulder was involved in five cases and the left in five cases. On the day of surgery all patients had pain that was resistant to a mean 15.4 months of conservative treatment (8—22 months). Pain had developed suddenly in three cases following a fall on the shoulder stump, and was progressive in seven cases. In three patients, this pain was incorrectly diagnosed as a subacromial impingement syndrome and had been treated with acromioplasty in another center, which worsened symptoms in two cases and was ineffective in one case. A context of a work related disability or a work accident was found in three cases. All patients described pain in the shoulder during anterior elevation and abduction. The clinical examination always revealed pain during palpation of the upper surface of the acromion. Mean preoperative active range of motion was 144.5° during anterior elevation (85°—180°), 131° during abduction (90°—180°), and 61° during external rotation (20°—90°). All shoulders were limber during passive range of motion. Resistance during in rotation (Neer, Hawkins et Yocum) always caused pain. The acromioclavicular joint was never painful when touched and the cross arm test was painful in one case. Rotator cuff tests were always normal. Preoperative strength was reduced in all cases by a mean 53% compared to the contralateral side. The mean preoperative Constant score was 53.4 (39—64). Preoperative radiographic tests included standard X-rays and Arthro CT or MRI (Fig. 1A). X-rays identified os acromiale in six cases and CT scan or MRI always identified os acromiale. Mesoacromion was always the type. Moreover, no acromioclavicular or rotator cuff involvement was found and there were no signs suggesting subacromial bursitis.

In eight patients, the role of os acromiale in the development of pain was confirmed by a CT (6 cases) or X-ray (2 cases) guided injection of the os acromiale, which was always positive (Fig. 1B). A subacromial injection was performed in five cases and only partially relieved the pain in one case.

All patients received initial conservative medical treatment. The surgical indication was based on the presence of pain and an unstable os acromiale, which did not respond to traditional analgesics. The aim of surgery was to stabilize the os acromiale by grafted bone union and reduce os acromiale by internal fixation with tension band wiring. The patients were operated under general anesthesia in the beach chair position. The approach was superolateral centered on the acromion (Fig. 2A). The acromio-acromial new joint was exposed by detaching the subperiosteal trapezo-deltoid fascia to visualize tiny movements of the os acromiale (Fig. 2B). The surfaces of the acromio-acromial new joint were scraped and an anteroposterior slot shaped groove, which preserved the lower cortex and bridged the new joint was dug with an oscillating saw (Fig. 2C). Then a graft of 2.5 x 2.4 cm was harvested from the homolateral iliac crest with the cancellous graft obtained according to preoperative planning. The graft was shorter than the bone slot to allow compression. The acromial defect was reduced by raising the os acromiale using a spike retractor placed in front of the acromion. Internal fixation was obtained by pinning and superior tension band wiring to allow deflexion of the os acromiale, compression of the acromial defect and stabilization of the graft (Fig. 1C and 2D). The patient was immobilized for 4 weeks postoperatively in an abduction brace in neutral rotation.

During follow-up two patients presented with a complex regional pain syndrome of the elbow (case 5) and the shoulder (case 1). Internal fixation material was systematically removed a mean 6.8 months after surgery (3.5—13 months) after union had been confirmed by CT scan.

Analysis of the results included a clinical examination with determination of the Constant score [6] and functional analysis by the Quick Dash and SST self-reported questionnaires [7—9]. Union was confirmed by X-ray and CT scan (Fig. 1D) before the material was removed.

Differences were determined by the Fisher test. A P value of less than 0.05 was considered to be statistically significant.

Results
The mean follow-up at the final revision was 47.9 months (6—124 months) (Table 1).

All patients were satisfied. The mean functional score was 20.61 on the Quick Dash (0—61.4) and 8.9 on the SST (4—12) scores. Pain had improved in all cases. Only three patients still had residual pain during professional and/or sports activities. None of the patients had signs of subacromial impingement. Strength was reduced compared to the contralateral side in six cases by a mean 20%. Active range of motion had improved on all planes, with a mean anterior elevation of 161° (120°—180°), abduction of 163° (150°—180°) and external rotation of 64.5° (50°—85°). The mean Constant score at the final follow-up was 82.2 (40—100) and the

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### Table 1: Pre- and postoperative data for the patients in our series.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Delay to diagnosis before intervention</th>
<th>Bone History</th>
<th>WA/WD</th>
<th>Infiltrative test of the acromial bone</th>
<th>Preoperative constant score</th>
<th>Postoperative constant score</th>
<th>SST score postoperative (/12)</th>
<th>DASH score postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>W</td>
<td>13</td>
<td>Trauma, Ac</td>
<td>WA</td>
<td>+</td>
<td>55</td>
<td>70</td>
<td>8</td>
<td>15.9</td>
</tr>
<tr>
<td>2</td>
<td>56</td>
<td>M</td>
<td>2</td>
<td>Trauma, Ac</td>
<td>WD</td>
<td></td>
<td>65</td>
<td>71</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>55</td>
<td>M</td>
<td>3</td>
<td>Ac</td>
<td>WA</td>
<td></td>
<td>65</td>
<td>71</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
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<td>43</td>
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</tr>
<tr>
<td>5</td>
<td>34</td>
<td>W</td>
<td>1</td>
<td>Trauma, Ac</td>
<td>WA</td>
<td></td>
<td>34</td>
<td>34</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>55</td>
<td>W</td>
<td>2</td>
<td>Ac</td>
<td>WA</td>
<td></td>
<td>55</td>
<td>55</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>47</td>
<td>W</td>
<td>4</td>
<td>Trauma, Ac</td>
<td>WD</td>
<td></td>
<td>47</td>
<td>47</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>34</td>
<td>M</td>
<td>0</td>
<td>Trauma, Ac</td>
<td>WA</td>
<td></td>
<td>34</td>
<td>34</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>55</td>
<td>W</td>
<td>2</td>
<td>Trauma, Ac</td>
<td>WD</td>
<td></td>
<td>55</td>
<td>55</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>43</td>
<td>M</td>
<td>1</td>
<td>Trauma, Ac</td>
<td>WA</td>
<td></td>
<td>43</td>
<td>43</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Mean</td>
<td>43</td>
<td>15.4</td>
<td>53.4</td>
<td></td>
<td></td>
<td></td>
<td>53.4</td>
<td>82.2</td>
<td>8.9</td>
<td>20.61</td>
</tr>
</tbody>
</table>

M: man; W: woman; WA/WD: work-related accident or work-related disease; Ac: acromioplasty; Trauma: initial trauma.
Figure 1  Thirty-three-year-old right-handed patient, high-level athlete with posttraumatic scapulalgia, and pain during palpation of the upper surface of the acromion. A. X-ray and CT scan: Presence of (OA). B. CT guided injection of the acromio-acromial joint space. C. Postoperative X-rays. D. Six-month postoperative CT Scan before removal of fixation material. Union of os acromiale.
Unstable os acromiale

Figure 2  Surgical technique. A. Superolateral approach centered on the acromion. B. Exposure of os acromiale of the mobile acromio-acromion joint. C. A slot is cut into a single cortex of the bone bridging the acromio-acromion joint. D. Iliac autograft and internal fixation by pinning and tension band wiring. Notice how this raises the os acromiale.
mean improvement was 33.1 points. Bone union was always obtained on imaging (Fig. 1D).

The subjective delay until recovery was 9.5 months. The nine patients who were not retired returned to work in the same job. Two patients went back to work part time (cases 2 and 8) because of work related disability. The jobs of two of the patients were adapted due to complex regional pain syndrome of the elbow (case 5) and the shoulder (cases 1) and the outcome was favorable in two cases. Two athletic patients (cases 9 and 10) were able to return to sports at the same level after 4 and 6 months (competitive sports). The functional and clinical results in patients with work related accidents, or work related disabilities were significantly poorer (Quick Score DASH, \( P = 0.0181 \)) and (Constant score, \( P = 0.0352 \)) respectively.

**Discussion**

The first description in the literature of os acromiale was in 1863 by Gruber [1]. He described failure of one of the three acromial ossification centers to fuse to the acromial process in patients between 18 and 25 years old. The estimated incidence is between 1.3% and 15% in the general population and bilateral involvement is found in 33.3–62% of the cases [2,4]. These figures are twice as high in African patients and men [4] but do not seem to be more frequent in patients with symptomatic arms [5,10–15]. The population is usually young, under the age of 50 [12,16,17]. Depending upon the level of non-union, there are three anatomical types: pre-acromion in front of the acromioclavicular joint, mesoacromion, behind this, and meta-acromion at the base of the acromion [2–5,16]. However, painful os acromiale is usually mesoacromion [5,11,18]. Therefore os acromial should be defined according to the clinical symptoms and painless and painful os acromiale should be differentiated.

Several hypotheses can explain the pathogenesis of os acromial. Pain could be linked to the unstable acromio-acromion articulation, involvement of the acromioclavicular joint, or secondary subacromial impingement. Indeed, for Warner et al. [19,20], pain is due to subacromial impingement caused by mobilization of os acromiale during contraction of the anterior deltoid muscle, which favors rotator cuff injuries, from tendinitis to tears. However, the efficacy of preoperative infiltration in the os acromiale and the ineffectiveness of subacromial bursa injections or acromioplasty clearly show the role of unstable os acromiale in pain. Moreover, preoperative imaging does not show any signs suggesting subacromial bursitis, involvement of the rotator cuffs or the acromioclavicular joint. Moreover, this is confirmed by the efficacy of os acromial union for pain. A painless os acromiale becomes symptomatatic when it is unstable.

The diagnosis of painful os acromiale in the presence of scapulalgia is based on a radiological and clinical examination that should confirm the role of os acromiale as the source of pain [21] and exclude the main differential diagnoses [22] (rotator cuff damage and subacromial impingement of an “aggressive” acromion). A causative factor should be looked for including direct or indirect trauma to the shoulder or a history of surgery, even if this is not always found (four cases in our series, two cases in the series by Pagnani et al. [11] and 58% in the series by Abboud et al. [23]). The clinical examination reveals pain during palpation of the superior surface of the acromion, across from the new joint. X-rays should look for the presence of a double-density sign on the surface and a cortical irregularity on a supraspinatus outlet view or a Liotard view (Fig. 1A) [21]. CT Scan or MRI with sequences centered on the acromion [4,24] are often useful because in our series X-rays only identified os acromiale in 6 cases. The role of os acromiale in shoulder pain can be confirmed by the efficacy of the CT Scan guided injection of the os acromiale [13] and a negative subacromial bursa injection. We do not feel there is any indication for diagnostic arthroscopy as suggested by certain authors [5,12,25,26] and this procedure could destabilize a stable os acromiale or worsen existing instability [12,15].

Different surgical techniques have been proposed in the literature. Our series reports 10 cases of unstable and painful os acromiale with an intact rotator cuff treated surgically with a bone graft and internal fixation by pins and tension band wiring. This technique is reliable because all patients improved with good clinical results and union was obtained in all cases. Other authors also recommend fixation of symptomatic, unstable os acromiale (Table 2). In the 1980s, Neer [25,27] already proposed curette-graft of the acromio-acromion articulation, with open reduction and internal fixation to treat pain because he had already noticed that the results of excision of os acromiale were poor. Indeed certain authors in short series [3,16,28,29], have proposed simple excision of the os acromiale, but results in the mesoacromion were poor and resulted in dysfunction and deltoid weakness.

There are numerous techniques depending on the series, and the rates of union vary from 20–86% [3,13,22,25,27–32]. The necessity of a bone graft has been clearly shown in the literature and in our series [21,25]. On the other hand, the type of internal fixation is the subject of debate. We suggest internal fixation with tension band wiring and pins because this type of fixation with a tension band placed on the upper surface of the acromion makes it possible to raise the anterior fragment and also plays a dynamic role by transforming deltoid traction into a compressive force thus favoring union. Others [17,20,29,30,32] suggest internal fixation by cannulated screws to compress the acromial defect without dynamically raising the anterior fragment, and the association of tension band wiring and cannulated screws does not increase compression. Peckett et al. [30] did not find any difference between the rate of union between the three types of internal fixation: two screws and tension band wiring, two pins and tension band wiring or one screw and one pin and tension band wiring. However Simovitch et al. [32] reported unsuccessful union in 14% of the cases after treatment by graft and internal fixation with two cannulated screws and metal tension band wiring, while Satturlee [20] reported excellent results with 100% union in six patients who underwent fixation with two cannulated screws and a graft. Warner et al. [20] and Jemlisi et al. [17] suggest internal fixation with a cannulated screw rather than wires because the rate of union was 86% in seven patients who underwent surgery with cannulated screws and only 20% in the 5 patients who underwent surgery with wires.
Table 2: Review of the literature for fixation techniques of unstable os acromial with intact rotator cuffs.

<table>
<thead>
<tr>
<th>Author</th>
<th>Date</th>
<th>n</th>
<th>Techniques</th>
<th>Rate of fusion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peckett et al. [30]</td>
<td>2004</td>
<td>26</td>
<td>2 screws 3.5 mm + tension band wiring + bone graft</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 pins + tension band wiring</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 screw + 1 pin + tension band wiring</td>
<td>88</td>
</tr>
<tr>
<td>Ryu et al. [24]</td>
<td>1999</td>
<td>4</td>
<td>Graft harvested on the trochanter 2 screw 3.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>Satterlee et al. [29]</td>
<td>1999</td>
<td>6</td>
<td>2 cannulated screws 4.5 mm, tension band wiring and bone graft</td>
<td>100</td>
</tr>
<tr>
<td>Warner et al. [20]</td>
<td>1998</td>
<td>12</td>
<td>2 cannulated screws 4.0 mm</td>
<td>Synthetic tension 86</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 pins</td>
<td>band + iliac graft 20</td>
</tr>
<tr>
<td>Simovitch et al. [32]</td>
<td>2006</td>
<td>15</td>
<td>2 cannulated screws 4.0 mm and metallic tension band, bone graft</td>
<td>86</td>
</tr>
</tbody>
</table>

n: number of patients.

There were no complications with the technique used in our series. Removal of fixation material was an integral part of the surgical procedure because all of the other series reported that internal fixation material was often uncomfortable whatever the technique [29,30,32].

The association of os acromiale and a rotator cuff tear is a specific entity with a different therapeutic strategy. Most studies [11,18,23,28,31] seem to agree that there is no relationship between os acromiale and a rotator cuff tear and the presence of an associated rotator cuff can worsen clinical results and reduce the rate of union [11,18,23,28,31].

Conclusion

Investigating unstable os acromiale is a key element in the clinical evaluation of subacromial impingement. Preoperative imaging should search for this entity. Palpation of the new acromio-acromion joint and the infiltration test should help determine the role of this entity in the cause of pain. In the presence of mobile and painful os acromiale without involvement of the rotator cuffs, surgical treatment by embedded graft and tension band wiring gives good results and frequent union. On the other hand, care should be taken not to perform acromioplasty in the presence of painful os acromiale.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


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