



# Operative Treatment of Symptomatic Meso-Type Os Acromiale

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**Abstract:** Os acromiale occur frequently in the population and can be a cause of significant shoulder dysfunction and rotator cuff impingement. When symptomatic os acromiale fail conservative management, surgical intervention may become necessary. The purpose of this article is to describe our preferred surgical technique for osteosynthesis of os acromiale using cannulated screws and tension-band wiring.

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**O**s acromiale is defined as an unfused ossification center of the acromion and can be classified as one of 3 different types named for the unfused segment immediately anterior to the nonunion (Fig 1).<sup>1</sup> Of the 3 types, the meso-type is the most common.<sup>2</sup> Overall, os acromiale are widespread in the population, occurring in 8% of individuals.<sup>3</sup> They can be asymptomatic and thus require no specific treatment<sup>4</sup>; however, for those that do cause symptoms, conservative therapy often fails, thereby leading to the need for surgical intervention.<sup>1,5</sup> Additionally, os acromiale have often been found to be associated with rotator cuff tears.<sup>1,5-7</sup> In the context of a rotator cuff tear, stabilization of the os acromiale may prevent further rotator cuff impingement and damage due to dynamic impingement.<sup>1</sup> Historically, the choice

of treatment for symptomatic os acromiale has chiefly depended on the size of the os acromiale.<sup>1</sup> Excision, either arthroscopic or open, is reserved for pre-acromion-type os acromiale. Removal of larger fragments may result in deltoid dysfunction due to the deltoid muscle's origin at the acromion's lateral edge.<sup>5</sup> For all other types, osteosynthesis is commonly recognized as the treatment of choice.<sup>1</sup>

The purpose of this article and Video 1 is to describe our preferred technique of osteosynthesis for a symptomatic meso-type os acromiale after concomitant arthroscopic rotator cuff repair. Advantages and disadvantages for this technique are outlined in Table 1.

## Surgical Technique

### Preoperative Planning

Os acromiale is a common finding; however, operative management is only indicated when the patient suffers from persistent symptoms like pain or functional deficits after a trial of conservative treatment. Moreover, a highly unstable os acromiale should be fixed to prevent its acting as a contributing factor to subacromial impingement and further rotator cuff damage. The clinical history and physical examination findings for os acromiale can be similar to the clinical presentation of an extra-articular shoulder impingement syndrome.<sup>1</sup> Patients often report chronic symptoms including limited range of motion (ROM) in overhead activities and pain during the night while lying on the affected side. Palpation of the nonunion typically causes tenderness and discomfort. Clinical examination may reveal pain with impingement signs, painful ROM, and rotator cuff weakness. Gross motion of the anterior

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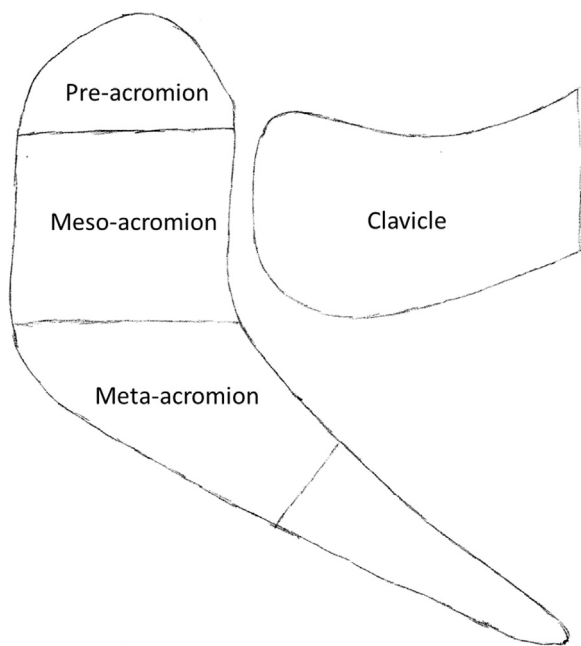
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**Fig 1.** Illustration of left acromion and clavicle from a superior view. The ossification centers, pre-acromion, meso-acromion, and meta-acromion, are illustrated. In general, the type of os acromiale is defined by the unfused segment immediately anterior to the nonunion.

acromion is a unique clinical finding that suggests symptomatic os acromiale.

Imaging evaluation should always include anteroposterior, scapular Y, and axillary radiographs (Fig 2). Of these views, the axillary is the most helpful to identify the os acromiale and should be evaluated thoroughly. Magnetic resonance imaging (MRI) should additionally be performed to identify additional shoulder pathology, such as a concomitant rotator cuff tear.

A diagnostic injection with a local anesthetic into the site of nonunion may also help to determine whether the os acromiale is a pain generator. As such, comprehensive preoperative evaluation is advocated to determine whether the patient requires surgical management.

### Anesthesia and Patient Positioning

After the induction of general anesthesia and placement of a regional interscalene block, the patient is placed in the beach-chair position, and the operative extremity is situated in a pneumatic arm holder (Tenet T-Max Beach Chair and Spider arm positioner; Smith & Nephew, Memphis, TN). The affected shoulder and axilla are prepared and draped using sterile techniques. The bony landmarks of the os acromiale and acromion, clavicle, acromioclavicular joint, and coracoid are palpated and marked with an indelible marker, along with the planned incision site.

### Diagnostic Arthroscopy

The complete surgical technique is shown in Video 1. Diagnostic arthroscopy is first performed after establishing a posterior standard viewing portal. Next, an anterior standard working portal through the rotator interval is created, and a probe is inserted. In the glenohumeral joint, the rotator cuff, capsulolabral complex, articular cartilage, and long head of the biceps tendon are thoroughly evaluated. If synovectomy and lysis of adhesions are necessary, a 4.0-mm shaver (APS II; Arthrex, Naples, FL) and a 3.75-mm suction radiofrequency cautery device (Super Turbo-Vac 90; ArthroCare, Austin, TX) are used. If tenosynovitis is present, a biceps tenotomy is performed from the origin of the biceps tendon anchor at the superior labrum for open subpectoral tenodesis at the end of the case. The arthroscope is then introduced in the subacromial space via the posterior standard portal. An additional anterolateral portal is established to perform bursectomy and subacromial spur removal. Dynamic evaluation of the os acromiale can be performed to assess for hypermobility of the unfused segment of bone. If a rotator cuff tear is present, an arthroscopic double-row knotless self-reinforcing repair is performed using the technique recently described by the senior author (P.J.M.).<sup>10</sup> All arthroscopic instruments are then removed to prepare for osteosynthesis of the os acromiale.

### Osteosynthesis

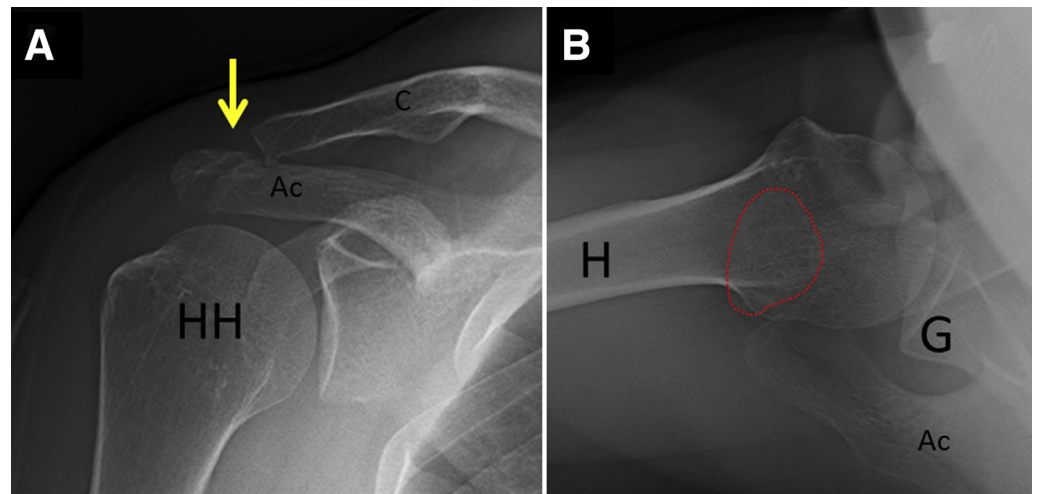
A transacromial incision of approximately 8 cm is made extending from the distal clavicle to the posterolateral border of the acromion. The incision is carried down through the skin and subcutaneous tissue to the periosteum overlying the acromion (Fig 3A).

The os acromiale is identified by applying vertical pressure to the acromion at various positions along its length while examining for gross movement occurring at the edge of the os acromiale (Fig 3B). Once the site of the os acromiale is accurately identified, the periosteum is split along the length of the os and reflected anteriorly and posteriorly to expose the edges of the

**Table 1.** Advantages and Disadvantages

Advantages	Disadvantages
The fixation construct with cannulated screws and tension bands has a high load-to-failure <sup>8</sup>	Removal of hardware may be required
Transacromial approach results in an improved rate of bony union <sup>9</sup>	
The wire-crossover technique of the tension-band construct resists the inferior bending moment of the deltoid and ensures that the loads are evenly distributed over the acromion	

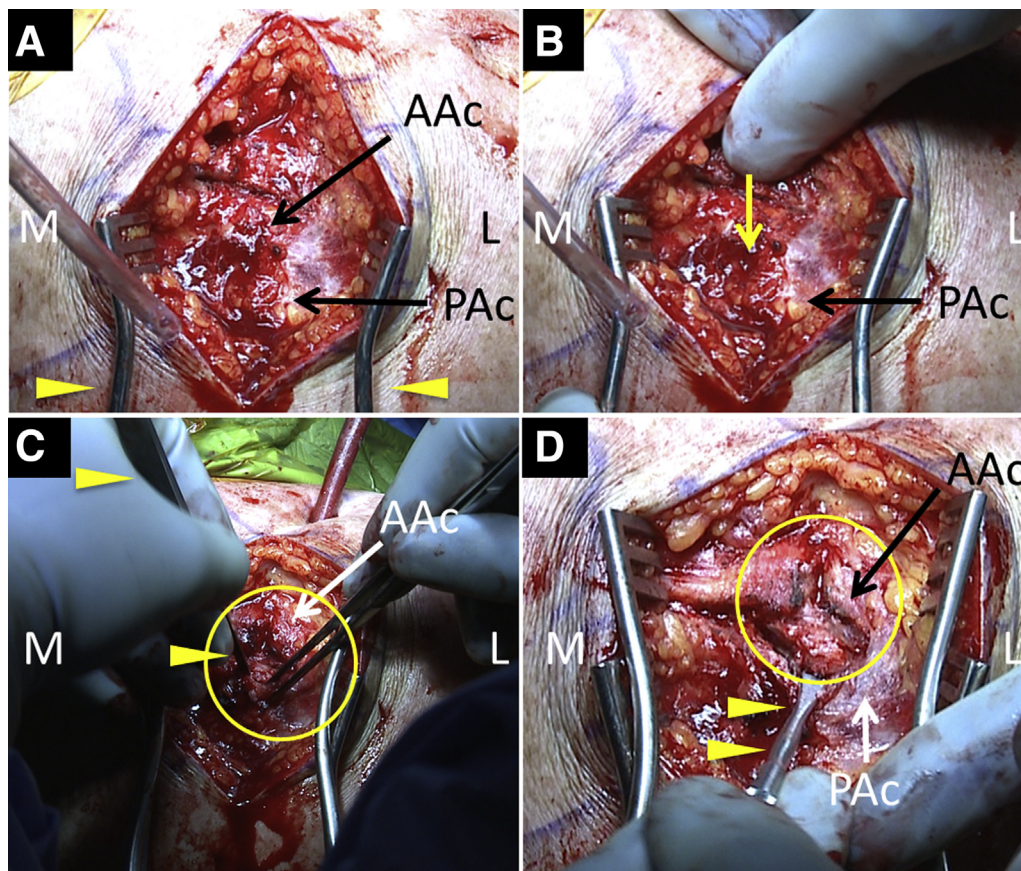
**Fig 2.** Preoperative radiographs of a right shoulder showing an os acromiale. (A) Anteroposterior view with the site of nonunion (arrow) somewhat visible. (B) Axillary view showing the best visualization of the os acromiale (red dotted line), in this case a meso-type. (Ac, acromion; C, clavicle; G, glenoid; H, humerus; HH, humeral head.)



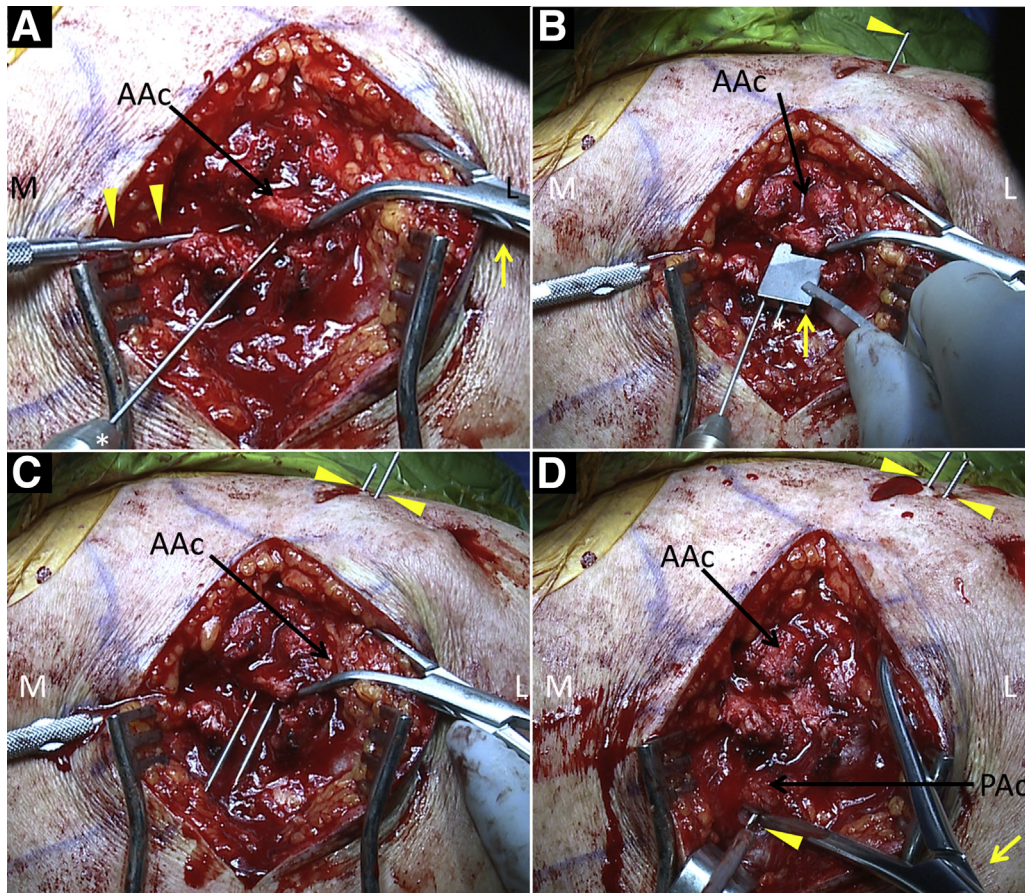
nonunion (Fig 3C). An elevator is then introduced between the os acromiale and the acromion to further improve exposure (Fig 3C). The margins of the nonunion are then burred down to a bleeding surface using a motorized rasp (PowerRasp, 5.5 mm × 13 cm; Arthrex), thereby removing any fibrous tissue and residual soft tissue.

Once the nonunion is taken down and the margins of the os acromiale are exposed, fixation is performed. Initially, a double-ended Kirschner-wire (K-wire) that

can fit through a 4.0-mm cannulated screw is drilled from the exposed posterior edge of the os acromiale out through the skin of the anterior shoulder (Fig 4A). Care is taken to ensure that the K-wire is drilled parallel to the thin acromial bone and that the wire does not inadvertently enter the subacromial space. A parallel drill guide is then placed over the posterior end of the first K-wire, and a second double-ended K-wire is drilled in a similar fashion from posterior to anterior through the os acromiale out the skin of the anterior



**Fig 3.** Right shoulder from a posterior view. (A) An 8-cm incision is made over the lateral acromion in a posterolateral direction followed by soft tissue dissection down to the acromion with a retractor placed (arrowheads). (B) The senior surgeon (P.J.M.) locates the site of nonunion with vertical pressure inferiorly (yellow arrow), which causes gross movement of the distal fragment. (C) The periosteum is sharply dissected with a scalpel (arrowheads), thereby exposing and debriding the edges of the bone and nonunion site (circle). (D) An elevator (arrowheads) is used to lever the anterior part of the acromion into anatomic position. (AAc, anterior acromion; L, lateral; M, medial; PAC, posterior acromion.)



**Fig 4.** Right shoulder from a posterior view. (A) While the anterior acromion (AAc) is held in place by a reduction clamp (yellow arrow) and freer elevator (arrowheads), using a drill (\*), a K-wire is advanced anteriorly through the posterior aspect of the anterior fragment of the acromion and (B) out the anterior skin (arrowhead); a drill guide (yellow arrow) is then placed over the first K-wire to allow the second K-wire (\*) to be placed parallel to and at a fixed distance away from the first. (C) The K-wires (arrowheads) are advanced anteriorly. (D) The os acromiale is reduced into desired position with the reduction clamp (yellow arrow); the K-wires (arrowheads) are then drilled posteriorly into the posterior acromion, providing provisional fixation. (AAc, anterior acromion; L, lateral; M, medial; PAC, posterior acromion.)

shoulder. The parallel drill guide ensures that the second K-wire is positioned at a fixed distance from and parallel to the first (Fig 4 B and C). Both K-wires are then advanced further with the drill such that the posterior ends are flush with the edge of the os acromiale. The os acromiale is then reduced to its anatomic position and held provisionally with a large bone-holding clamp (Fig 4D).

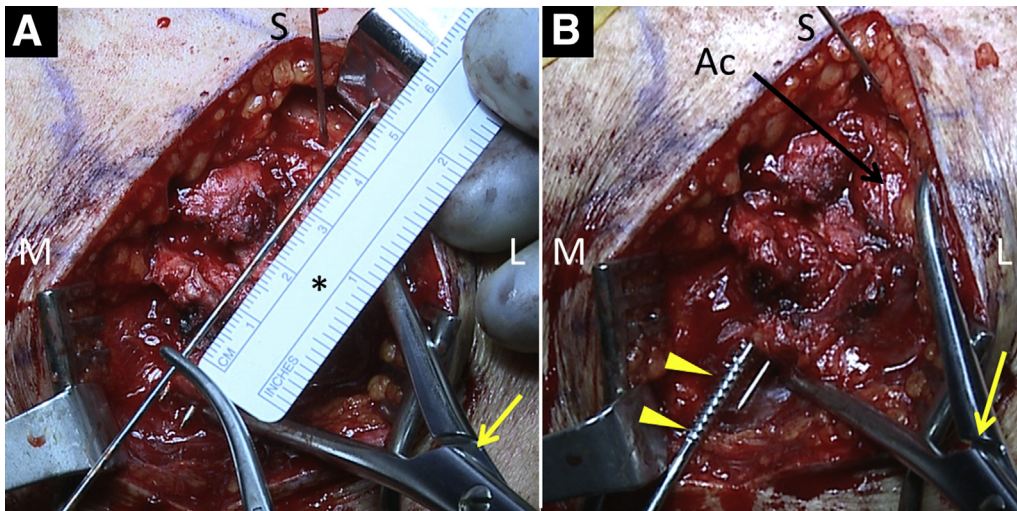
Once the os acromiale is reduced and anatomic reduction is confirmed, the double-ended K-wires that had been previously drilled through the os acromiale posterior to anterior are then drilled anterior to posterior back through the os acromiale into the posterior acromion (Fig 4D).

When both K-wires have been passed into the posterior acromion, length of the screw needed to fix the os acromiale is determined indirectly by an additional K-wire superimposed over the acromion and a ruler (Fig 5A). A 2.7-mm cannulated drill is then used to

overdrill the 2 K-wires. Two 4.0-mm cannulated partially threaded screws of appropriate length (Synthes, West Chester, PA) are advanced posteriorly to anteriorly (Fig 5B). Short partially threaded screws are used to achieve maximum compression of the os acromiale. When the bone quality is good and there is excellent screw purchase, screw fixation alone may be used. This is most typical in young patients with excellent-quality bone. In older patients with lower-density bone or those in whom screw purchase is not ideal, a tension-band construct is added. This has been shown biomechanically to strengthen the construct.<sup>8</sup>

#### Tension-Band Wiring

Once the screws are placed, the double-ended K-wires are removed and two 18-gauge wires are threaded through the cannulated screws posteriorly to anteriorly. The anterior ends of the wires are retrieved anterior to the acromion at the anteriormost aspect of



**Fig 5.** Right shoulder from a posterior view; the acromion is held in place with a reduction clamp (yellow arrows), and a spinal needle (S) marks the anterior end of the acromion. (A) A ruler (\*) is used to measure the length of the screw needed to fix the os acromiale. (B) A 3.5-mm cannulated partially threaded screw (arrowheads) is advanced posteriorly to anteriorly, and the short threads of the screw are used to achieve maximum compression of the os acromiale. (Ac, acromion; L, lateral; M, medial.)

the incision (Fig 6A). The anterior end of the lateral 18-gauge wire and the posterior end of the medial 18-gauge wire are crossed and twisted in a tension-band fashion (Fig 6B). The same process is then repeated for the anterior end of the medial wire and posterior end of the lateral wire (Fig 6C). The excess K-wire is then cut at this point. Both remaining twisted wire stumps are bent down so as not to be prominent (Fig 6D). This tension-band fixation resists the inferior bending moment applied by the deltoid, and the crossover of wires during tensioning ensures the loads are distributed evenly across the acromion. The incision is then closed in standard fashion. Deep periosteal closure is performed with no. 0 Vicryl and then the subcutaneous tissue and skin is closed in a layered fashion. Radiographs of the final construct are presented in Figure 7. Pearls and pitfalls of the complete surgical technique are presented in Table 2.

### Postoperative Rehabilitation

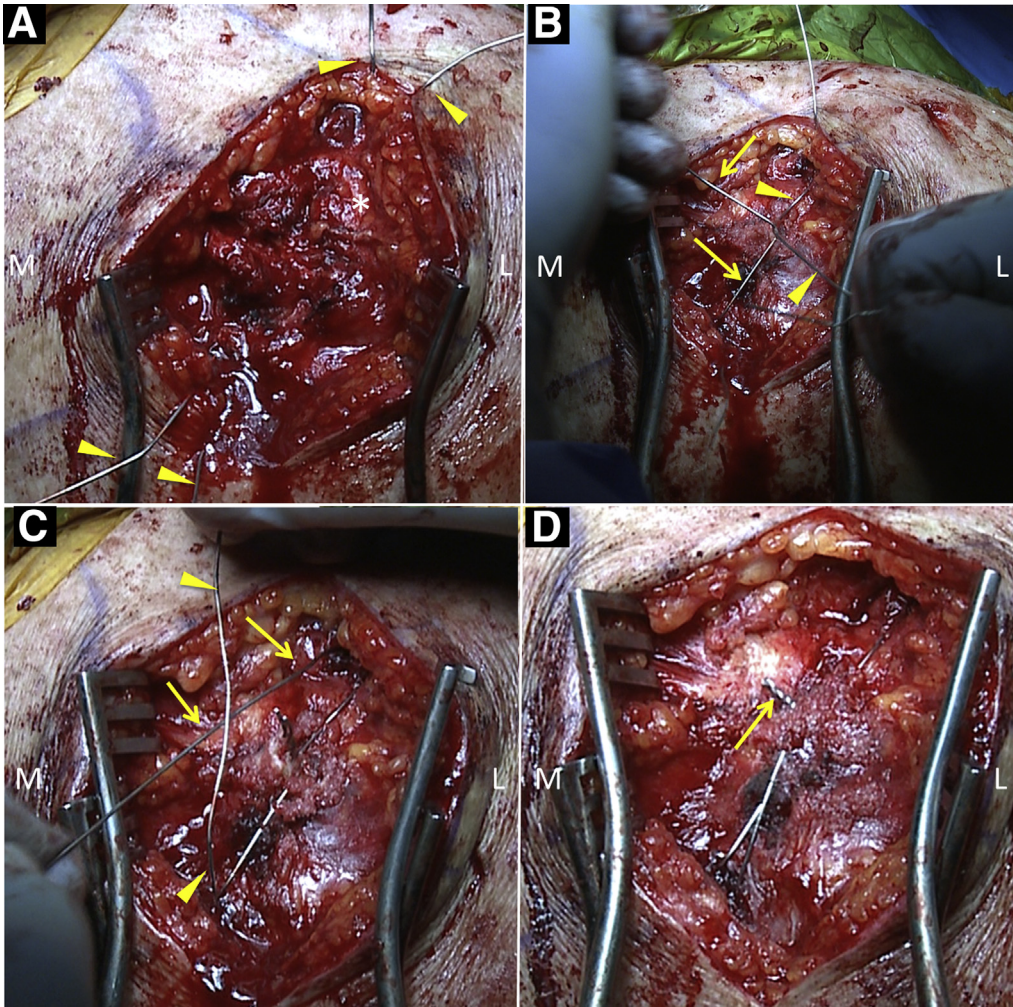
The patient is placed in a sling postoperatively. Passive ROM is permitted for 4 weeks. At this point, gentle active ROM and activities of daily living are permitted. At 12 weeks postoperatively, full unassisted active ROM is permitted. If a biceps tenodesis is performed, resisted elbow flexion should be restricted for approximately 6 weeks.

### Discussion

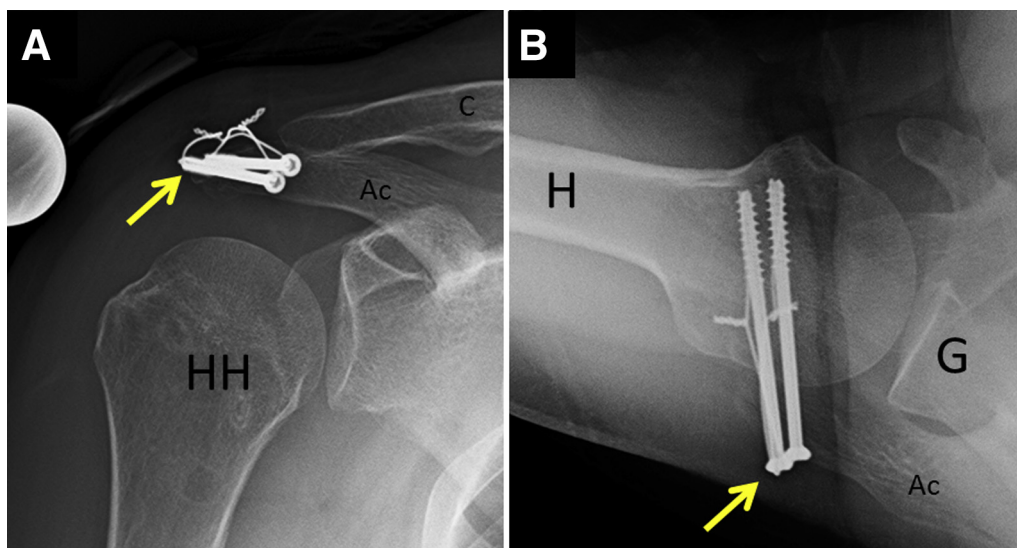
In general, clinical outcomes for fusion of os acromiale are positive; however, outcomes do vary depending on the surgical approach and fixation

technique. Warner et al.<sup>5</sup> reported osseous union at an average of 9 weeks in 6 of 7 shoulders (86%) that underwent open reduction, bone grafting, and internal fixation with tension-banding and cannulated screws.<sup>5</sup> By contrast, osseous union was only achieved in 1 of 5 shoulders (20%) that underwent fixation with isolated tension banding.<sup>5</sup> Comparable results were found by Peckett et al.,<sup>11</sup> who reported bony union at an average 4 months in 25 of 26 patients (96%) treated with os acromiale fusion using tension banding and either K-wires or cannulated screws. In 15 shoulders undergoing os acromiale fusion with isolated tension banding, Hertel et al.<sup>9</sup> compared an anterior deltoid-off approach versus a transacromial approach with preservation of the deltoid origin. At a mean follow-up of 44 months, the patients with transacromial approach had significantly higher rates of bony union compared to the anterior deltoid-off group (88% vs 43%).<sup>9</sup> Boehm et al.<sup>6</sup> found successful bony union in 15 of 22 patients (68%) who underwent os acromiale fusion with isolated tension banding at an average follow-up of 41 months. In that case series, Constant scores for patients with bony unions and nonunions did not significantly differ at 81% and 84%, respectively.<sup>6</sup>

Our preferred fixation technique was recently biomechanically evaluated by Spiegl et al.<sup>8</sup> In that study, the authors tested different fixation techniques for meso-type os acromiale in a cadaver setup and found that ultimate load to failure was significantly higher with the use of tension banding and cannulated screws compared to cannulated screws alone.<sup>8</sup> Overall, outcomes series and biomechanical studies have shown



**Fig 6.** Right shoulder from a posterior view. (A) View of closure of the deep tissue layer (\*) just superior to the acromion; the 18-gauge wires (arrowheads) pass out through the incision but not the skin. (B) The anterior end of the lateral 18-gauge wire (arrowheads) and posterior end of the medial 18-gauge wire (arrows) are crossed and twisted in a tension-band fashion. (C) The anterior end of the medial wire (arrows) and posterior end of the lateral wire (arrowheads) are crossed and twisted in the same manner. (D) The final construct is viewed; the wires have been twisted, cut, and bent inferiorly (arrow) to minimize soft-tissue irritation. (L, lateral; M, medial.)



**Fig 7.** Postoperative radiographs of a right shoulder showing an os acromiale fixed with 2 cannulated screws and a tension band (arrow). (A) Anteroposterior view of the final fixation construct. (B) Axillary view showing the best visualization; the os acromiale no longer appears to be present. (Ac, acromion; C, clavicle; G, glenoid; H, humerus; HH, humeral head.)

**Table 2.** Pearls and Pitfalls

Surgical Steps	Pitfalls	Pearls
Diagnostic arthroscopy	Missing concomitant lesions	Performing a thorough and standardized examination allows for identification of concomitant lesions.
Approach to the os acromiale	Difficulty locating the site of the nonunion	The surgeon should place inferior pressure on the anterior acromion to help identify the distal fragment of the nonunion.
Preparation of nonunion prior to osteosynthesis	Insufficient preparation resulting in postoperative nonunion	The margins of the nonunion can be burred down to a bleeding surface with a motorized rasp to remove fibrous tissue and residual soft tissue, and generate an environment that is enhances healing.
K-wire insertion	Improper drilling through the acromion resulting in penetrating the superior or inferior cortex	Ensure the K-wire is drilled parallel to the acromion. Drill first through the os acromiale and then into the acromion in a retrograde fashion.
Tension-band construct	Insufficient fixation	Crossover of the K-wires during tensioning ensures the loads are evenly distributed across the acromion.
Postoperative rehabilitation	Postoperative stiffness	Early passive range of motion for 4 weeks Progression to full passive motion and start of active and active-assisted motion at 4 weeks postoperatively

that osteosynthesis to achieve bony union is a safe, effective, and reliable technique for the treatment of large and unstable symptomatic os acromiale; however, high-level studies are still needed to compare outcomes between different techniques.

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