



Surgical technique

Stabilization of *os acromiale* with cannulated screws and high-resistance sutures

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ABSTRACT

Os acromiale is defined as the absence of fusion of any of the primary acromial ossification centres with the basal acromion. Affected patients usually present nonspecific symptoms such as pain (generally nocturnal), difficulty performing activities involving abduction above 90°, and weakness.

First line treatment should not consist of surgery; instead, the administration of nonsteroidal anti-inflammatory drugs or local corticosteroid infiltrations are indicated. Nevertheless, surgery often proves necessary due to high refractoriness to conservative management.

Many surgical techniques have been described, though agreement is lacking as to which option is best for the fixation of mesoacromion type unstable symptomatic *os acromiale*.

The present technical note describes our preferred surgical approach for such cases, based on the use of cannulated screws reinforced by a high-resistance suture tension band distributed in an "8" pattern, without added bone grafting and employing a transacromial medial to lateral surgical approach with minimum disinsertion of the deltoid muscle. The advantages and limitations of the procedure are also described, and the key aspects to be taken into account when performing the technique are commented.

Key words: *Os acromiale*. Cannulated screw. Sutures.

ABSTRACT

Estabilización de *os acromiale* con tornillos canulados y suturas de alta resistencia

El *os acromiale* se define como la ausencia de unión de cualquiera de los centros de osificación acromial primario con el acromion basal. Los pacientes suelen presentar síntomas inespecíficos como dolor, generalmente nocturno, dificultad para realizar actividades por encima de los 90° de abducción y debilidad.

La primera línea de tratamiento debe ser no quirúrgica, mediante la administración de antiinflamatorios no esteroideos o infiltraciones locales con corticosteroides. Sin embargo, en un gran número de casos se precisa tratamiento quirúrgico por la elevada refractariedad al tratamiento conservador.

Gran variedad de técnicas se han descrito, sin existir consenso sobre cuál es la mejor opción para la fijación del *os acromiale* inestable sintomático de tipo mesoacromion.

El objetivo de esta nota técnica es describir nuestra opción quirúrgica de preferencia para estos casos, mediante la utilización de tornillos canulados reforzados con una banda de tensión de sutura de alta resistencia dispuesta en una configuración en "8" sin el agregado de injerto óseo, utilizando un abordaje transacromial, de medial a lateral, con mínima desinserción del deltoides. Así también, enumerar ventajas y limitaciones del procedimiento, y nombrar los puntos clave que se deben tener en cuenta en el momento de llevarlo a cabo.

Palabras clave: *Os acromiale*. Tornillo canulado. Sutures.



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Introduction

The acromion originates from four separate ossification centres: the preacromion, the mesoacromion, the meta-acromion and the basiacromion, from anterior to posterior. Their fusion occurs between 18 and 25 years of age⁽¹⁾. The *os acromiale* is defined as the absence of fusion of any of the primary acromial ossification centres with the basal acromion (basiacromion)⁽²⁾. It can be classified into three types according to the non-ossified segment located immediately anterior to the absence of fusion (preacromion, mesoacromion and meta-acromion), with mesoacromion being the most frequent presentation⁽³⁾. The incidence of the condition is 1-15% in radiographic and anatomical studies⁽⁴⁾. Affected patients usually present nonspecific symptoms. The manifestations may include pain (generally nocturnal), difficulty performing activities involving abduction above 90°, and weakness⁽⁵⁾. It is important to establish a differential diagnosis and rule out other pain-causing disorders such as rotator cuff rupture, SLAP (Superior Labrum Anterior and Posterior) lesions or arthritic changes of the acromioclavicular (AC) joint⁽⁵⁾.

Anterior acromial mobility, assessed through local palpation, is a clinical finding strongly suggestive of symptomatic *os acromiale*, and which in some cases may predispose to tendon rupture of the supra- or infraspinatus muscle^(6,7).

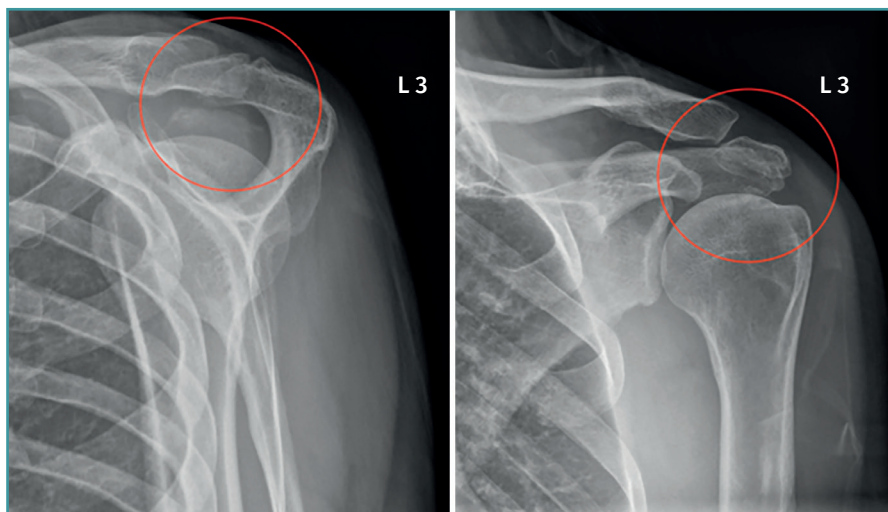


Figure 1. Left shoulder. Preoperative radiographic view showing a "double density" sign (red circle) suggestive of *os acromiale*.

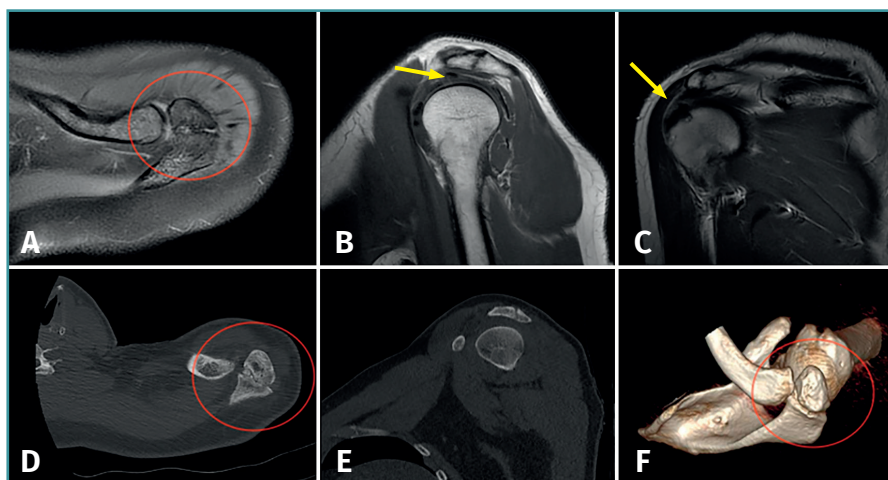


Figure 2. Preoperative magnetic resonance imaging and computed tomographic views showing deformation of the distal extremity of the acromion with the presence of an acromial ossicle of irregular morphology (images A, D and F, red circle) associated to incipient supraspinatus tendinopathy, with enhanced signal intensity of the tendon in the bursal surface (images B and C, yellow arrow).

The basic imaging diagnostic explorations should include anteroposterior, axillary and scapular Y projection radiographs (Figure 1), with the axillary view being the most useful option in this regard⁽⁸⁾. Magnetic resonance imaging (MRI) can identify additional disease conditions such as concomitant rotator cuff injury, for example⁽⁹⁾. The presence of bone oedema in axial sections in fat-suppressed T2-weighted sequences is an expected sign in the MRI assessment of symptomatic *os acromiale* (Figure 2).

First line treatment should be non-surgical in all cases, based on the administration of nonsteroidal anti-inflammatory drugs or local corticosteroid infiltrations during a maximum period of 6 months⁽¹⁰⁾. Nevertheless, surgery often proves necessary due to high refractoriness to conservative management^(11,12).

A great variety of surgical techniques are available, with variable results⁽¹³⁻¹⁸⁾.

The present technical note describes our preferred surgical procedure for mesoacromion type symptomatic *os acromiale* treatment.

Surgical technique (Tables 1-3)

Under general anaesthesia and interscalene locoregional block,

Table 1. Step-by-step surgical technique. Stabilization of *os acromiale* with cannulated screws and high-resistance sutures

	Description
1	General anaesthesia and interscalene locoregional block. Patient placed in deck chair position
2	Italic "S" skin incision from the distal clavicle to the posterolateral margin of the acromion
3	Identify the "non-fusion", dissect the periosteum over the full length of the acromion, and retract from anterior to posterior
4	Eliminate pseudoarthrosis with rongeur type forceps, motorized drill or oscillating saw. Perforate orifices to allow increased bleeding using a 1.2 mm drill
5	Reduce and stabilise the <i>os acromiale</i> using two parallel Kirschner wires (K-wire), from anterior to posterior
6	Use a 2.4 mm cannulated drill to drill through both K-wires. Two partially threaded 3.0 mm HPS® screws are implanted from anterior to posterior
7	Second fixation using no. 5 Hi-Fi® high-resistance suture with an "8" pattern
8	Reinsertion of the deltoid muscle using transosseous sutures
9	Closing of the skin with resorbable intradermal suture

Table 2. Advantages and limitations**Advantages**

- Minimally invasive surgical technique
- The use of non-metal high-resistance sutures avoids possible complications such as intolerance of the osteosynthesis material, and the possible need for further surgery to remove it
- The risk of damage to the supraspinatus tendon, associated with the use of plates and screws, is avoided
- Reproducible surgical technique
- Rapid recovery and early postoperative mobilization

Limitations

- Risk of affecting vascularization of the unstable fragment if wide disinsertion of the anterior deltoid muscle is carried out
- Moderate learning curve
- Need for specific material (HPS® screws, suture passers)

the patient is placed in deck chair position (Figure 3). Under conditions of asepsis and antisepsis, the surgical field is delimited and the anatomical references are marked (*os acromiale*, acromion, clavicle, AC joint and coracoid process), with planned incision (Figure 3).

An italic "S" skin incision of approximately 8 cm is made from the middle third of the clavicle to the posterolateral margin of the acromion, reaching the acromial periosteum (Figure 3).

Mobility of the acromion is assessed by applying vertical pressure along its length. Once the non-fusion site of

Table 3. Key points

- Once the non-fusion site has been identified, if a saw or drill is chosen, a soft tissue protector should be used to avoid unintentional damage to the supraspinatus tendon
- To favour consolidation and obviate bone grafting, perforate orifices to allow increased local bleeding using a 1.2 mm drill
- Provisional stabilization is achieved with two Kirschner wires parallel to the acromial bone, without invading the subacromial space
- Passing of the high-resistance suture makes use of a flexible looped wire as transport mechanism
- Full disinsertion of the deltoid muscle from the anterior margin of the acromion is to be avoided, in order not to damage the terminal branches of the thoracoacromial artery. Disinsertion should be the minimum needed required to manipulate the mesoacromion
- If disinsertion of part of the deltoid muscle proved necessary, it is reinserted using transosseous sutures

the *os acromiale* has been identified, the periosteum is dissected along the full length of the acromion and is retracted from anterior to posterior, exposing the margins of the non-fusion zone and allowing correct coverage at the end of the operation (Figure 4). The elevator is positioned between the *os acromiale* and the acromion to improve its exposure.

Full disinsertion of the deltoid muscle from the anterior margin of the acromion is not advised, in order to avoid damaging the terminal branches of the thoracoacromial artery.

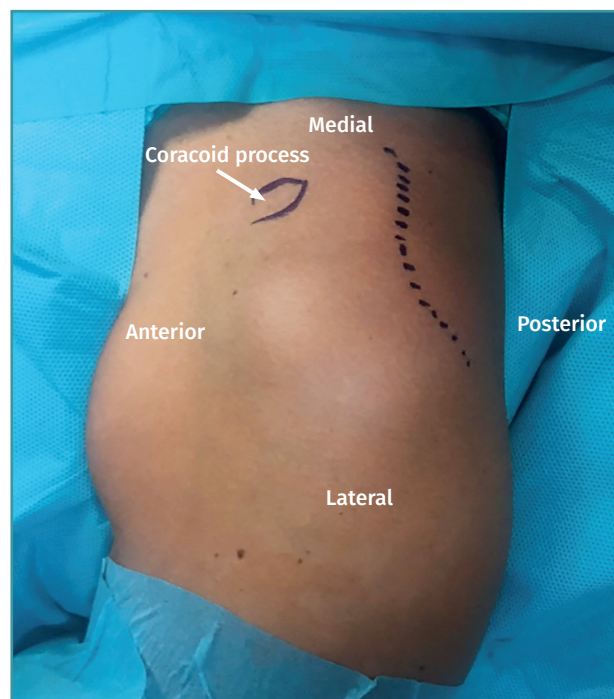


Figure 3. Left shoulder. Patient in deck chair position. Lateral view. Italic "S" skin incision from the distal clavicle to the posterolateral margin of the acromion.

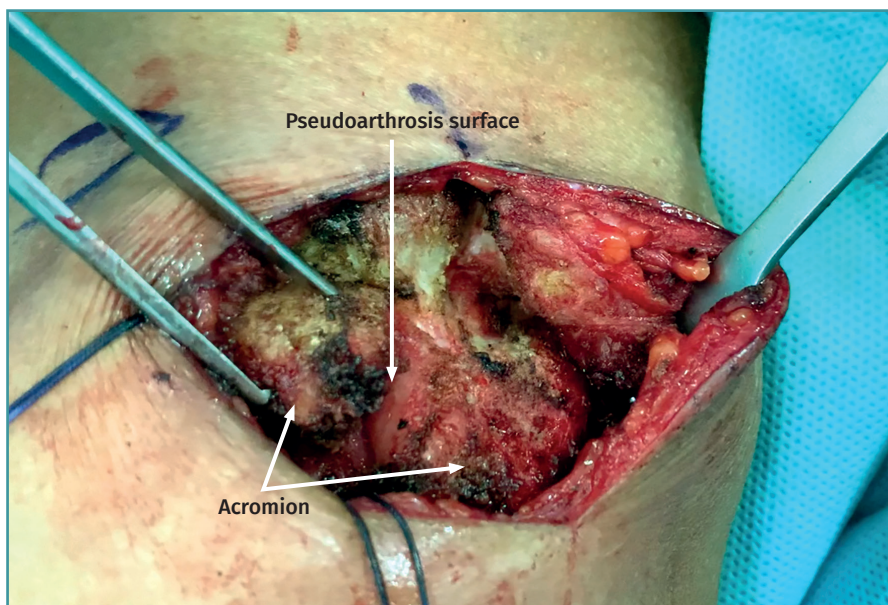


Figure 4. Non-fusion site of *os acromiale*; dissect the periosteum over the full length of the acromion, and retract from anterior to posterior.

If needed, release of the anterior deltoid should be the minimum required to allow manipulation of the mesoacromion and implant the osteosynthesis material.

The pseudoarthrosis surface may be eliminated using rongeur type forceps, motorized drills or an oscillating saw (Figure 5). If a saw or drill is chosen, it is advisable to use a soft tissue protector with the aim of avoiding unintentional damage to the supraspinatus tendon (Figure 6). In order to favour consolidation of the mesoacromion, it is advisable to perforate orifices to allow increased local bleeding using a 1.2 mm drill.

Following removal of the pseudoarthrosis, and after exposing the margins of the *os acromiale*, fixation is carried out. The *os acromiale* is reduced to its anatomical position and is provisionally kept fixed with reduction forceps. After confirming anatomical reduction, provisional stabilization is achieved with two parallel Kirschner wires (K-wires), perforating from the anterior margin of the exposed *os acromiale* to emerge from the posterior surface of the basiacromion, making sure that the K-wire is directed par-

allel to the acromial bone without invading the subacromial space.

At this point we determine the length of the screws needed for fixation, with the help of an additional K-wire to measure, or by superimposing the screw over the acromion (Figure 7).

With a 2.4 mm cannulated drill, we drill through the previously used two K-wires, and two partially threaded 3.0 mm HPS® screws (MedcomTech) are implanted from anterior to posterior in order to ensure the maximum compression possible.

Once the cannulated screws have been positioned, the K-wires are removed and we apply a second fixation based on the tension band principle, using a high-resistance suture Hi-Fi® no. 5 (ConMed, FL,

USA), tunnelled through the cannulated screws. Passing of the suture makes use of a flexible looped wire as transport mechanism (Figure 8).

An "8" pattern is preferred, tightened with a sliding knot, manual tension and posterior 8-knot reinforcement, until no loss of tension is observed. This is a modification of the classical technique⁽¹⁹⁾ based on the tension band

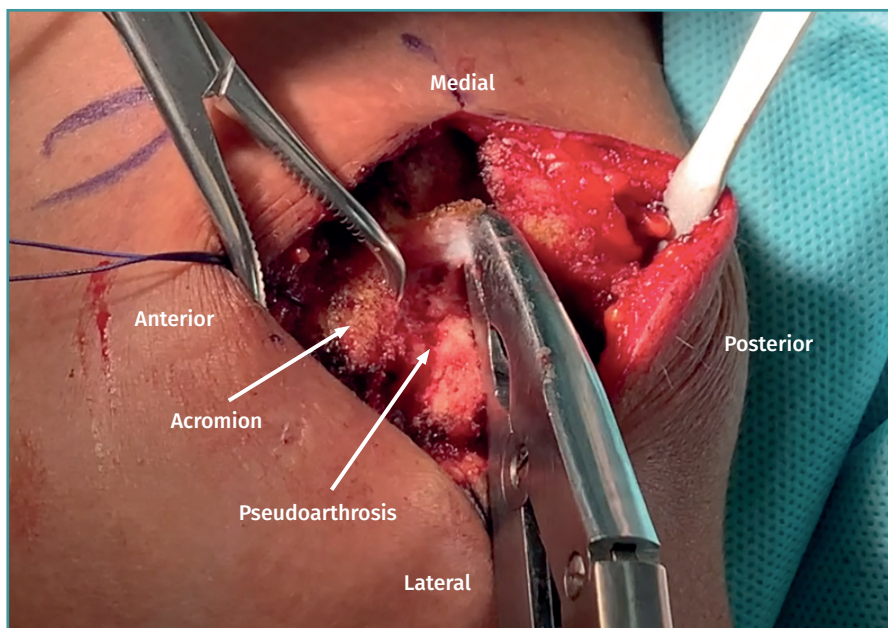


Figure 5. Left shoulder. Patient in deck chair position. Lateral view. The pseudoarthrosis surface may be eliminated using rongeur type forceps.

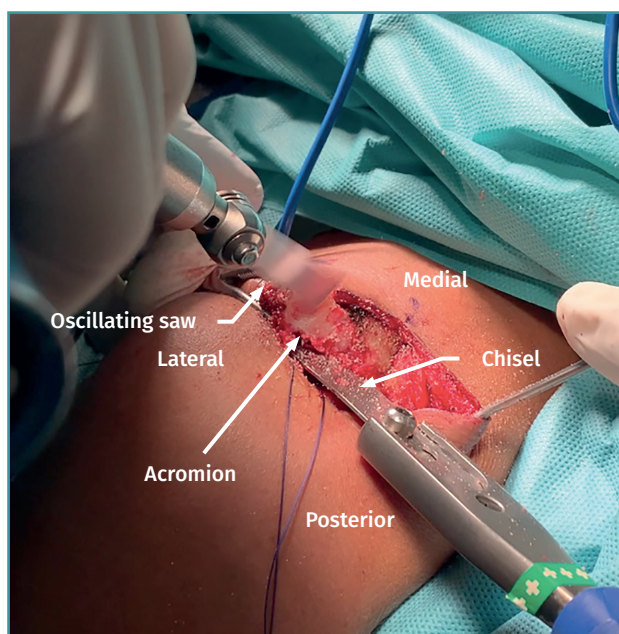


Figure 6. If an oscillating saw is chosen to eliminate pseudoarthrosis, use a soft tissue protector with the aim of avoiding unintentional damage to the supraspinatus tendon.

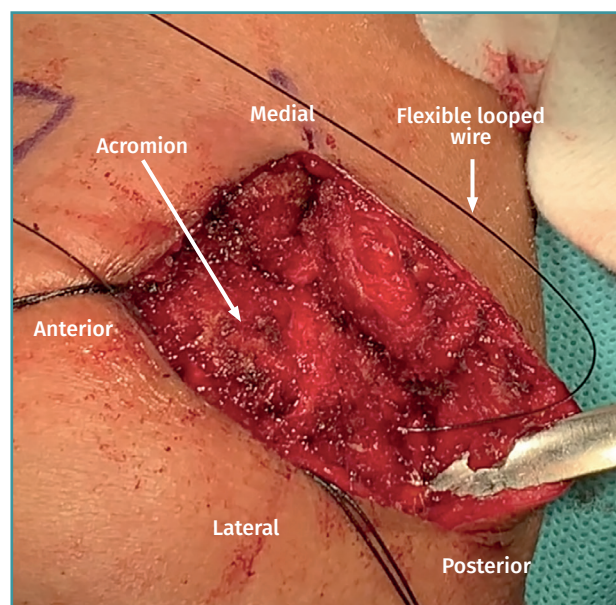


Figure 8. Once the cannulated screws have been positioned, the Kirschner wires are removed and a second fixation is applied using high-resistance suture. Passing of the suture is done with a flexible looped wire as transport.

principle with a 1-mm metal wire in a similar shroud knot pattern (**Figure 9**). The use of non-metal high-resistance sutures avoids possible complications such as intolerance of the osteosynthesis material, which could require further surgery for removal. Radioscopic control is carried out at the end of the procedure (**Figure 10**).

The periosteum is reinserted, securing full coverage of the construct. If disinsertion of part of the deltoid muscle is proved necessary, it is reinserted using transosseous sutures. The subcutaneous layer is then tightly sealed in place. For closing of the skin, intradermal suture with resorbable material is to be preferred.

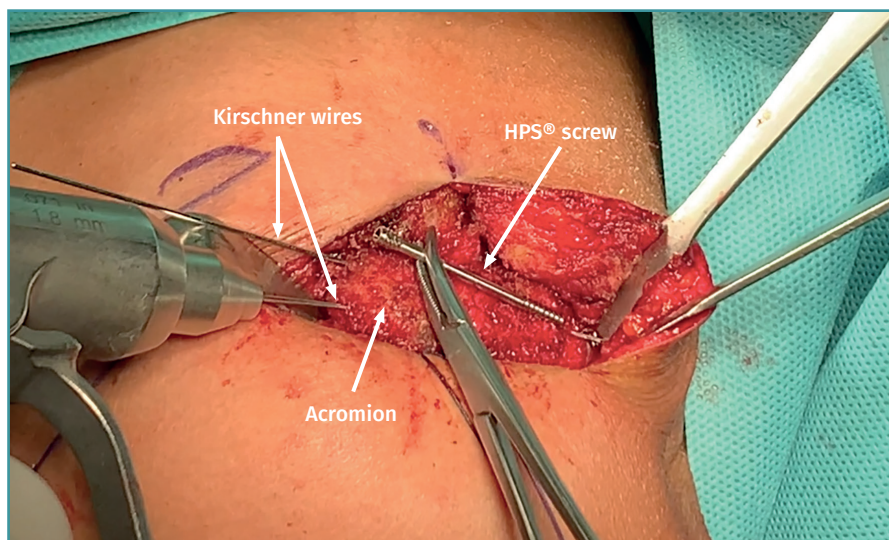


Figure 7. Stabilization by using two parallel Kirschner wires, perforating from the anterior margin of the exposed os acromiale to emerge from the posterior surface of the basicromion. Determine the length of the screws needed for fixation by superimposing the screw over the acromion.

Postoperative period

The patient is immobilized with a sling for two weeks. Passive joint balancing and pendular exercises are allowed from the immediate postoperative period and during the first four weeks. From week four, active mobilization can begin, together with strengthening exercises and activities of daily living. The return to sports activities is allowed after 6-8 weeks.

Discussion

There is no agreement as to which is the best option for the fixation of mesoacromion type unstable symptomatic os acro-

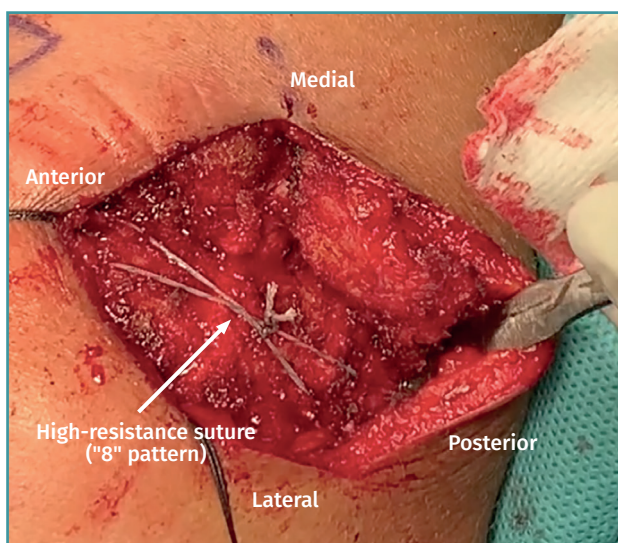


Figure 9. Final "8" pattern configuration, which is knotted and manually adjusted until no loss of tension is noted.

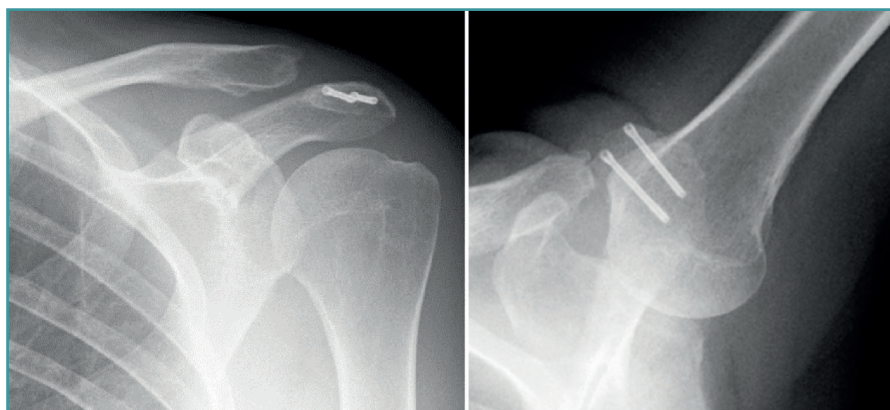


Figure 10. Control at the end of the procedure. Posteroanterior and axillary view of the left shoulder.

miale. Our preferred treatment strategy in such cases is the use of cannulated screws reinforced by a high-resistance suture tension band distributed in an "8" pattern, without added bone grafting and employing a transacromial medial to lateral surgical approach with minimum disinsertion of the deltoid muscle from the anterior margin of the acromion.

A number of techniques have been described for those cases in which conservative management fails: open or arthroscopic excision, acromioplasty or subacromial decompression, open reduction and internal fixation (ORIF).

Wright *et al.*⁽¹⁶⁾ reported good outcomes with subacromial decompression in 13 patients after one year of follow-up. Campbell *et al.*⁽¹⁷⁾ in turn performed arthroscopic excision of *os acromiale* in 31 shoulders. Complete pain relief was achieved in 20 of the shoulders, with improvement in 9. However, the appearance of deltoid dysfunction

on resecting large fragments remains a cause of concern.

If ORIF of the symptomatic mesoacromion is decided to be performed, a number of options are available^(11,18). The best results were recorded with the use of K-wires or compression cannulated screws, usually combined with a tension band (metallic in most cases)⁽²⁰⁻²²⁾.

In a descriptive series of 15 cases of *os acromiale* published by Warner *et al.*⁽²⁰⁾, the patients were subjected to three surgical techniques: pre- and mesoacromion exeresis; ORIF with K-wire and cerclage; and ORIF with cannulated screws, cerclage and iliac crest autologous bone grafting. The best clinical outcomes were obtained with the consolidation of *os acromiale* and exeresis of the preacromion - the consolidation index being greater in the group subjected to osteosynthesis with screws, cerclage and grafting.

Similar results were reported by Peckett *et al.*⁽²¹⁾, achieving consolidation of *os acromiale* within an average of four months in 25 out of 26 patients (96%) treated with tension bands and K-wires or cannulated screws. In the same way as the previous authors, Boehm *et al.*⁽²²⁾ recorded successful outcomes in 15 out of 22 patients (68%) subjected to fusion of *os acromiale* with isolated tension bands over a mean follow-up of 41 months.

A factor that may also favour successful ORIF is the use of autologous bone grafts^(20,23), though this does not seem mandatory for achieving correct consolidation, provided stable fixation with acceptable compression is secured, as evidenced by the results published by Atoun *et al.*⁽¹³⁾. These authors recorded radiographic consolidation in 6 out of 8 patients treated via arthroscopy with resorbable cannulated screws.

The vascularization of the unstable fragment would also play an important role in defining the outcome of osteosynthesis. It is believed that preserving the insertion of the deltoid muscle anterior to the *os acromiale* fragment (as recommended in the description of our surgical technique) would help preserve the acromial branch of the thoracoacromial artery. This, associated to fixation with cannulated screws and a tension band, appears to increase the percentage of consolidation. In this regard, Hertel *et al.*⁽¹⁹⁾ documented a variable mesoacromion consolidation rate that appeared to depend on the surgical approach used. Fusion occurred in 43% of their patients subjected to a trans-deltoid approach versus in 88% of the cases when a transacromial approach was used.

A significant problem is the high incidence of intolerance and extraction of the implanted material following ORIF - a circumstance that may lessen the favourable opinion of the

patient regarding the outcome of surgery. These figures are much higher with the combination of K-wires and cerclage than when using the cannulated screw and tension band technique, as reported by Warner *et al.*, Hertel *et al.* and Peckett *et al.*, with percentages of between 86-100%^(15,19,20).

This high implant intolerance rate reflects the potential advantage of a fixation method with a lower profile, such as the combination of a tension band using high-resistance sutures together with cannulated screws^(14,24), as described in the present technical note. Such a combination would afford biomechanical resistance similar to that of stainless steel wire cerclage, according to the data published by Shui *et al.*⁽²⁵⁾ in a study in cadavers.

Our study shows that the fixation of symptomatic *os acromiale* using cannulated screws and tension bands with high-resistance sutures allows consolidation of the mesoacromion without the need for secondary procedures (material ablation), and without complications.

The optimum results recorded define this surgical technique as a reproducible alternative to be taken into account in infrequent cases of symptomatic *os acromiale*.

Ethical responsibilities

Conflicts of interest. The authors state that they have no conflicts of interest.

Financial support. This study has received no financial support.

Protection of people and animals. The authors declare that this research has not involved human or animal experimentation.

Data confidentiality. The authors declare that the protocols of their centre referred to the publication of patient information have been followed.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

References

- McClure JG, Raney RB. Anomalies of the scapula. *Clin Orthop Relat Res.* 1975;110:22-31.
- Kurtz CA, Humble BJ, Rodosky MW, Sekiya JK. Symptomatic *os acromiale*. *J Am Acad Orthop Surg.* 2006;14:12-9.
- Sammarco VJ. *Os acromiale*: Frequency, anatomy, and clinical implications. *J Bone Joint Surg Am.* 2000;82:394-400.
- Burbank KM, Lemos MJ, Bell G, Lemos DW. Incidence of *os acromiale* in patients with shoulder pain. *Am J Orthop (Belle Mead NJ).* 2007;36:153-55.
- Arenas-Miquélez A, Hertel R. The unstable *os acromiale*: a cause of pain in the young athlete. *JSES Int.* 2020 May 18;4(3):559-63.
- Ouellette H, Thomas BJ, Kassarian A, et al. Re-examining the association of *os acromiale* with supraspinatus and infraspinatus tears. *Skeletal Radiol.* 2007 Sep;36(9):835-9.
- Mudge MK, Wood VE, Frykman GK. Rotator cuff tears associated with *os acromiale*. *J Bone Joint Surg Am.* 1984;66:427-9.
- Lee DH, Lee KH, López-Ben R, Bradley EL. The double-density sign: a radiographic finding suggestive of an *os acromiale*. *J Bone Joint Surg Am.* 2004;86:2666-70.
- Rovesta C, Marongiu MC, Corradini A, Torricelli P, Ligabue G. *Os acromiale*: frequency and a review of 726 shoulder MRI. *Musculoskelet Surg.* 2017;101:201-5.
- You T, Frostick S, Zhang WT, Yin Q. *Os Acromiale*: Reviews and Current Perspectives. *Orthop Surg.* 2019 Oct;11(5):738-44.
- Viner GC, He JK, Brabston EW, Momaya A, Ponce BA. *Os acromiale*: systematic review of surgical outcomes. *J Shoulder Elbow Surg.* 2020 Feb;29(2):402-10.
- Horton S, Smuda MP, Jauregui JJ, et al. Management of symptomatic *os acromiale*: a survey of the American shoulder and elbow surgeons. *Int Orthop.* 2019 Nov;43(11):2569-78.
- Atoun E, van Tongel A, Narvani A, Rath E, Sforza G, Levy O. Arthroscopically assisted internal fixation of the symptomatic unstable *os acromiale* with absorbable screws. *J Shoulder Elbow Surg.* 2012 Dec;21(12):1740-5.
- Harris JD, Griesser MJ, Jones GL. Systematic review of the surgical treatment for symptomatic *os acromiale*. *Int J Shoulder Surg.* 2011 Jan;5(1):9-16.
- Peckett WRC, Gunther SB, Harper GD, Hughes JS, Sonnabend DH. Internal fixation of symptomatic *os acromiale*: a series of twenty-six cases. *J Shoulder Elbow Surg.* 2004;13:381-5.
- Wright RW, Heller MA, Quick DC, Buss DD. Arthroscopic decompression for impingement syndrome secondary to an unstable *os acromiale*. *Arthroscopy.* 2000;16:595-9.
- Campbell PT, Nizlan NM, Skirving AP. Arthroscopic excision of *os acromiale*: effects on deltoid function and strength. *Orthopaedics.* 2012;35:e1601-5.
- Lebus GF, Fritz EM, Hussain ZB, Pogorzelski J, Millett PJ. Operative Treatment of Symptomatic Meso-Type *Os Acromiale*. *Arthrosc Tech.* 2017 Jul 24;6(4):e1093-e1099.
- Hertel R, Windisch W, Schuster A, Ballmer FT. Transacromial approach to obtain fusion of unstable *os acromiale*. *J Shoulder Elbow Surg.* 1998;7:606-9.
- Warner JJ, Beim GM, Higgins L. The treatment of symptomatic *os acromiale*. *J Bone Joint Surg Am.* 1998;80:1320-6.
- Peckett WR, Gunther SB, Harper GD, Hughes JS, Sonnabend DH. Internal fixation of symptomatic *os acromiale*: a series of twenty-six cases. *J Shoulder Elbow Surg.* 2004;13:381-5.
- Boehm TD, Matzer M, Brazda D, Gohlke FE. *Os acromiale* associated with tear of the rotator cuff treated operatively. Review of 33 patients. *J Bone Joint Surg Br.* 2003;85:545-9.
- Atinga M, Gregor R, Selvaraj KM, Hong TF. *Os acromiale* open reduction and internal fixation: a review of iliac crest autogenous bone grafting and local bone grafting. *J Shoulder Elbow Surg.* 2018 Jun;27(6):1030-6.
- Hasan SA, Shiu B, Jauregui JJ. Symptomatic, Unstable *Os Acromiale*. *J Am Acad Orthop Surg.* 2018 Nov 15;26(22):789-97.
- Shiu B, Song X, Iacangelo A, et al. *Os acromiale* fixation: a biomechanical comparison of polyethylene suture versus stainless steel wire tension band. *J Shoulder Elbow Surg.* 2016 Dec;25(12):2034-9.