Arthroscopic Excision of the Symptomatic Meso-acromiale of the Shoulder

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William B. Stetson, Brian Chung, Nicole Hung, Samuel Polinsky, and Kristen Reikersdorfer

Abstract

The failed fusion between two acromial apophyses, called an os acromiale, is often asymptomatic and found incidentally during evaluation for unrelated shoulder pathology. There are three different types of os acromiale with the meso-acromial type being the most common. Though this is frequently not the primary pain source, a mobile os acromiale or meso-acromiale fragment can cause inflammation at the pseudoarthrosis site, rotator cuff impingement, or acromioclavicular joint arthritis. Varying operative techniques exist with good to satisfactory results for symptomatic patients. Several operative techniques have been described, including open excision, open reduction–internal fixation (ORIF), arthroscopic acromioplasty or subacromial decompression, and arthroscopic excision. Open excision of a meso-acromion can lead to persistent pain and deltoid weakness and atrophy. The management of a meso-acromial fragment with ORIF can also result in persistent pain, deltoid weakness, and atrophy with nonunion of the fragments. Arthroscopic excision of the meso-acromion is described as a viable alternative for surgical candidates.

Keywords

Shoulder arthroscopy · Os acromiale · Meso-acromion
Surgical technique · Acromion

50.1 Introduction

An os acromiale is usually found incidentally during the evaluation for unrelated shoulder pathology, as most patients are often asymptomatic for this condition [1]. The acromial apophysis develops from four main ossification centers: (1) the pre-acromion, (2) the meso-acromion, (3) the meta-acromion, and (4) the basi-acromion (Fig. 50.1) [2]. The os acromiale represents a failure of fusion between two of these apophyses [2]. The types of os acromiale are defined by the unfused segment immediately anterior to the site of nonunion [3]. For example, a failed fusion between the meta-acromial and meso-acromion ossification centers is called a meso-acromiale [3]. Although the reported prevalence of os acromiale in skeletally mature shoulders has ranged from 1.3% to 30% [2–4], it is not frequently diagnosed as a cause of pain [2, 4, 5]. The great majority of os acromiale are meso-acromions. Pre-acromial fragments occur much less frequently and a meta-acromiale is rare [3].

A meso type of os acromion is an uncommon shoulder pathology. However, when symptomatic, this condition presents the surgeon with a diagnostic dilemma due to varied treatment options and surgical techniques, met with inconsistent outcomes. The meso-acromion is not frequently diagnosed as a source of pain [2, 4, 5], but when factors such as impingement or other shoulder pathology have been ruled out, the optimized treatment option is dependent upon patient age and activity level.

The condition can be symptomatic secondary to pain or inflammation at the pseudarthrosis site from the mobile fragment impinging on the rotator cuff [5, 6] or from arthritic changes of the acromioclavicular (AC) joint due to os hypermobility [2]. The diagnosis of a symptomatic os acromiale

W. B. Stetson (✉) · B. Chung
Stetson Lee Orthopedics and Sports Medicine, Burbank, CA, USA

Department of Orthopaedic Surgery, Keck School of Medicine at the University of Southern California, Los Angeles, CA, USA

N. Hung
Stetson Lee Orthopedics and Sports Medicine, Burbank, CA, USA

Department of Orthopaedic Surgery, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

S. Polinsky
Stetson Lee Orthopedics and Sports Medicine, Burbank, CA, USA

University of California at San Diego School of Medicine, La Jolla, CA, USA

K. Reikersdorfer
Stetson Lee Orthopedics and Sports Medicine, Burbank, CA, USA

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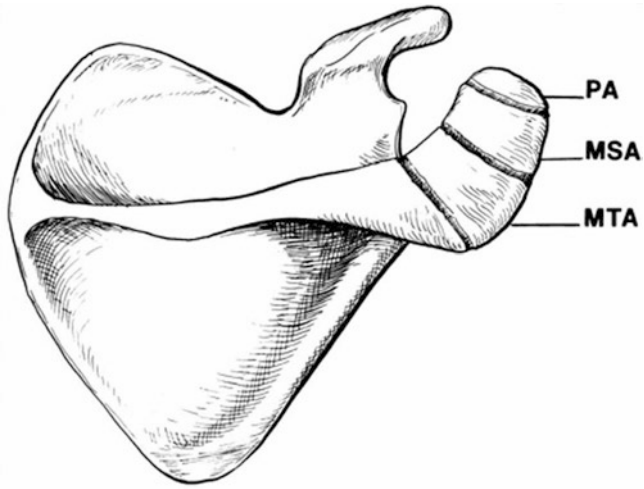

Fig. 50.1 Visual representation of the three possible non-union sites of the acromion: pre-acromion (PA), meso-acromion (MSA), meta-acromion (MTA), and basi-acromion. (Reproduced with permission from Stetson WB, Polinsky S, Chung B, Chen A (2022) Os Acromiale Operative Treatment: A Systematic Review. Acad Orthop Res Rheum 5: 134. https://doi.org/10.29011/2688-9560.100134)

can be difficult. However, it can be made through the presence of pain and local tenderness over the anterior acromion and nonunion site [3, 5], hyper-mobility of an anterior acromion fragment [3], positive impingement signs [5, 7], and positive local injection tests [3].

The area of fibrous union or non-union of the os acromiale fragment may become painful following minor trauma [1] or as a result of repetitive overhead activities of the shoulder. Persistent pain may be due to AC joint arthropathy, resulting from motion at the os acromiale site, or from local inflammation at the non-union site [5]. Because there are multiple potential causes of shoulder pain, it is important to rule out other sources of shoulder pain. A thorough clinical examination is needed to define the source of the pain.

When non-surgical treatment fails, surgical management is warranted. Several surgical techniques have been widely described, including open fragment excision [8], arthroscopic acromioplasty [1, 7, 9, 10], open reduction and internal fixation (ORIF) [2, 3, 5, 6, 11–13], and arthroscopic excision [14–16]. The excision of a pre-acromion, either open or arthroscopically, is usually satisfactory [14, 15]. However, open excision of a symptomatic meso-acromion has led to poor results with residual pain, weakness, and deltoid dysfunction [5, 8, 17]. Arthroscopic subacromial decompression has led to good results in many studies, but satisfaction rates have ranged from 0% to 85% [1, 7, 9, 10]. However, many patients in these studies suffered from subacromial impingement and had an asymptomatic os acromiale. ORIF has additionally led to varied results with a variety of differing surgical techniques described [2, 3, 5, 6, 11–13, 18]. Hardware complications, nonunion, and the need for hardware removal are common after ORIF, even when radiographic union has occurred [1–3, 5, 11, 13].

Some patients are not candidates for ORIF or for arthroscopic subacromial decompression. Some reasons may include concomitant AC joint osteoarthritis, prior history of arthroscopic subacromial decompression with recurrence of pain, or advanced age and the risk of nonunion or unwillingness to undergo a second surgery for hardware removal, which is very common following ORIF. Arthroscopic excision of the meso-acromion is described as a viable alternative for surgical candidates.

50.1.1 Diagnostic Imaging

Plain radiographs are the mainstay of diagnostic imaging. An axillary view should be obtained routinely to diagnose and confirm the presence of an os acromiale. More frequently, the diagnosis is made incidentally. Lee and colleagues have described the double-density sign on a standard anteroposterior radiograph of the shoulder and a cortical irregularity on the supraspinatus outlet view which was highly suggestive of an os acromiale [19]. MRI or CT scans can also be used to confirm an os acromiale and to determine if there are any sclerotic or inflammatory changes at the site, which may be indicative of degeneration or symptomatic findings. Bone scans may help to illustrate the inflammatory response at the non-union site [5]. MRI and MR arthrograms are also helpful to determine if there are any intra-articular (SLAP lesion) or other pathologies (partial or full-thickness rotator cuff tear) which may be sources of pain.

50.1.2 Nonsurgical Management

Nonsurgical treatment for an isolated, symptomatic os acromiale is generally recommended as the initial approach [20]. Similar to a typical impingement protocol, rest and activity restriction, accompanied by a structured physical therapy program and a course of nonsteroidal anti-inflammatory medications is a reasonable approach [20]. A subacromial corticosteroid injection can also be administered and may help or eliminate pain due to impingement or subacromial bursitis.

A selective lidocaine test (5 cc's of 1% lidocaine with reexamination 10 min later) or corticosteroid injection into the os acromiale site can be utilized as a diagnostic tool to help determine whether or not the os acromiale is the source of pathology. In addition, these injections may provide symptom relief, at which point surgery may not be necessary.

50.1.3 Surgical Options

Once the os acromiale or, in particular, the meso-acromion, has been identified as the source of pain and non-operative treatment options have failed, there are a number of different surgical options. These options range from acromioplasty to open resection, ORIF, and arthroscopic resection. The results in the literature vary considerably and are controversial. Depending on the type of os acromiale, the age of the patient, and their activity level, the best surgical options vary for each individual patient. For the sake of this discussion and review of surgical options, we will only address the most common type of os acromiale: the meso-acromion.

50.1.3.1 Open Excision

Open fragment excision of the symptomatic meso-acromion has had mixed results in the literature due to residual deltoid weakness and post-operative dysfunction [20]. Mudge and colleagues reported on six patients with an os acromiale who underwent open fragment excision [8]. However, each patient also had an associated rotator cuff tear, which was repaired with an open technique. Four of these patients had excellent results and two had poor outcomes, which may be attributed to rotator cuff tear severity or possibly due to the os acromiale excision. Their research was also unclear as to what type of os acromiale was present in these cases, as the pre-acromion represents only a small portion of the os acromiales, whereas the meso-acromion represents a much larger portion.

The results of an open excision for a meso-acromion from other authors are poor. Armengol and colleagues reported on a case series of 41 patients with an os acromiale in conjunction with rotator cuff tears [21]. Five patients had open fragment excision and all five had poor results. Warner and colleagues reported on three patients who underwent fragment excision [5]. One patient with a pre-acromion had an excellent result, but the other two had openly excised meso-acromions, yielding poor results with persistent weakness and pain. It is likely that their post-operative pain and weakness was due to loss of the normal acromial fulcrum for deltoid function. Open fragment excision has limited indications and is recommended for a symptomatic pre-acromion with a relatively small fragment or as a salvage procedure after a failed ORIF [20].

50.1.3.2 Open Reduction and Internal Fixation

ORIF of symptomatic meso-acromions can be a challenging procedure as evidenced in the literature with poor and unsatisfactory results. There are different techniques that have been reported on including the use of tension-band wires, sutures, and cannulated screws with or without bone graft. The non-union and complication rates are high with most patients requiring hardware removal as a result of hardware irritation post-operatively [12]. Abboud et al. [1] reported a satisfaction rate of only three of eight patients (38%), even though all patients achieved union of the fragments.

Peckett and colleagues achieved a union rate of 96% (25/26 patients) with a 92% satisfactory rate in patients treated with either K-wires or screws and a tension-band technique [13]. Local bone graft was used if available and was placed at the pseudarthrosis site in an unknown number of cases. No objective or subjective scores were reported, and two patients sustained post-operative fractures, while eight patients required hardware removal.

Ryu and colleagues reported on a case series of four patients treated with ORIF using partially threaded, 3.5 mm cannulated screws to achieve compression across the fibrous union site [18]. All patients achieved union of the pseudarthrosis site, regained full range of motion and strength with 35/35 UCLA shoulder rating scores with no complications reported or reoperations needed for symptomatic hardware.

Warner and colleagues [5] reported on two different techniques of ORIF with iliac crest bone grafting. Four patients (five shoulders) underwent ORIF with a tension-band wiring and bone grafting and four (80%) resulted in non-union. Seven other patients underwent ORIF using cannulated screws and 18-gauge wire in a figure of eight fashion through the screws and around the pseudarthrosis site followed by bone grafting. Six of the seven (86%) achieved union of meso-acromion site. Of the 12 patients in the study, nine (75%) required hardware removal, and two failed and required open excision of the unstable meso-acromion fragment.

Hertel and colleagues [22] performed ORIF on 12 patients with 15 shoulders using a tension-band wiring technique in all patients with bone grafting. The surgical approach differed in that eight patients had a trans-acromial approach with preservation of the deltoid origin and seven shoulders the deltoid was peeled off the acromion. The union rate was much higher when the deltoid preserving (trans-acromial) approach was used with seven of eight patients achieving union, whereas only three of seven patients achieved union in the other group. The preservation of the vascularity of the acromial epiphysis was hypothesized as the reason for the high union rate in the deltoid preserving group, most likely because of preservation of the acromiale branch of the thoracoacromial artery.

ORIF of unstable meso-acromions/os acromiale fragments has mixed results depending on the technique that is used. Preservation of the blood supply as demonstrated by Hertel and colleagues [22] appears to give the best results. Even with this technique and others, where union is achieved, the hardware often needs to be removed [20].

50.1.3.3 Arthroscopic Subacromial Decompression/Acromioplasty

The role of arthroscopic subacromial decompression/acromioplasty when an os acromiale is present is controversial. The technique is typically used when the os acromiale or meso-acromion appears to be stable, it is non-tender to palpation on physical exam, and the patient has signs and symptoms consistent with impingement syndrome, with or without a rotator cuff tear [20]. If the os acromiale is stable, it is best to leave it intact and the technique of an arthroscopic subacromial decompression is used without disrupting the pseudarthrosis site. Wright and colleagues [7] performed an arthroscopic subacromial decompression on 13 patients who had a meso-acromion that was deemed stable and asymptomatic. Eleven of 13 patients had good or excellent results with no evidence of any loss of anterior deltoid strength or deltoid detachment with an average UCLA shoulder rating scale of 31 out of 35.

Arthroscopic subacromial decompression can lead to early good results, but longer term follow-up is always needed to make sure that the results are sustained. Hutchinson and colleagues [9] had good or excellent early results in three patients treated with a subacromial decompression and the os acromiale was left in situ. The pain returned in all three patients requiring additional surgery, including excision of the os acromiale in one patient and repeat debridement in the other two cases. The two patients treated with repeat arthroscopic debridement continued to have residual pain even after the second surgery, while the one patient treated with excision did well and made a full recovery.

Arthroscopic subacromial decompression in the presence of an os acromiale or meso-acromion has led to mixed results in the literature. It is recommended that if an arthroscopic acromioplasty is performed, the surgeon needs to make sure pre-operatively that the meso-acromion is stable and asymptomatic, and at the time of surgery, the pseudarthrosis site is not disrupted and the meso-acromion is not destabilized.

50.1.3.4 Arthroscopic Excision

Arthroscopic excision of a meso-acromion is an alternative to open excision and to ORIF with excellent results published in the literature. Both Campbell et al. [14] and Pagnani et al. [15] have reported good-to-excellent results with arthroscopic excision of a meso-acromion. Campbell and colleagues [14] performed arthroscopic excision of a symptomatic meso-acromion or os acromiale on 14 shoulders using a 4.5 mm flat acromionizer burr. This technique preserves the periosteal sleeve and deltoid attachment. Good or excellent results were noted in 89% of patients with little or no difference in deltoid strength or change in the appearance of the contour of the anterior deltoid.

Pagnani and colleagues [12] reported on nine male elite collegiate and professional athletes, between the ages of 18–25 years, treated with arthroscopic excision of a symptomatic meso-acromion. The arthroscopic technique similar to the technique described by Campbell, where the meso-acromial fragment was carefully shelled out preserving the deltoid fascia and attachment. With a minimum follow-up of 2 years and an average follow-up of 3.72 years, all patients made a complete recovery and were able to return play without any limitations. There was no report of any compromise of deltoid function or cosmetic deformity in any of the patients.

The studies of Pagnani [15] and Campbell [14] are the only two reports in the literature dealing with the arthroscopic excision of symptomatic meso-acromions. The technique of arthroscopic surgical excision has been described previously by the senior author (WBS) [16] and is also described in detail later in this chapter. The technique requires no special instrumentation but does require advanced arthroscopic shoulder surgical skills to prevent iatrogenic damage to the deltoid insertion. Using arthroscopy allows faster rehabilitation with improved and faster range of motion and strength compared to an open procedure along with shortened operating room times [12]. Compared to ORIF, arthroscopic excision does not require a second procedure for metal removal for symptomatic hardware. Many orthopaedic surgeons are reluctant to perform an arthroscopic excision despite the favorable results in the literature.

50.2 Indications

When planning surgery, it is imperative that a thorough workup has been completed, including a detailed history, physical examination, and proper diagnostic studies. It is also important that all non-operative means have been exhausted. Proper diagnosis before surgery is key, because not all meso-acromions are symptomatic. Preoperative diagnosis of a meso-acromion is often made incidentally on the axial view of plain radiographs when evaluating for another shoulder condition. Lee et al. [23] described the double-density sign on a supraspinatus outlet view that was highly suggestive of an os acromiale (Fig. 50.2). Other imaging studies should be obtained, including a magnetic resonance imaging study that shows sclerosis and inflammatory changes at the synchondrosis of the meso-acromion (Fig. 50.3). On MRI, a meso-acromion can be diagnosed by transverse orientation and irregular margins with marrow and interface edema. In contrast, in a normally developing acromial ossification center, the developing acromion has an arched interface and lobulated margins with no evidence of marrow or interface edema [24]. Bone scans may also help illustrate the inflammatory response at the nonunion site of a meso-acromion.

The condition can be symptomatic due to inflammation at the pseudarthrosis site, the mobile fragment impinging on

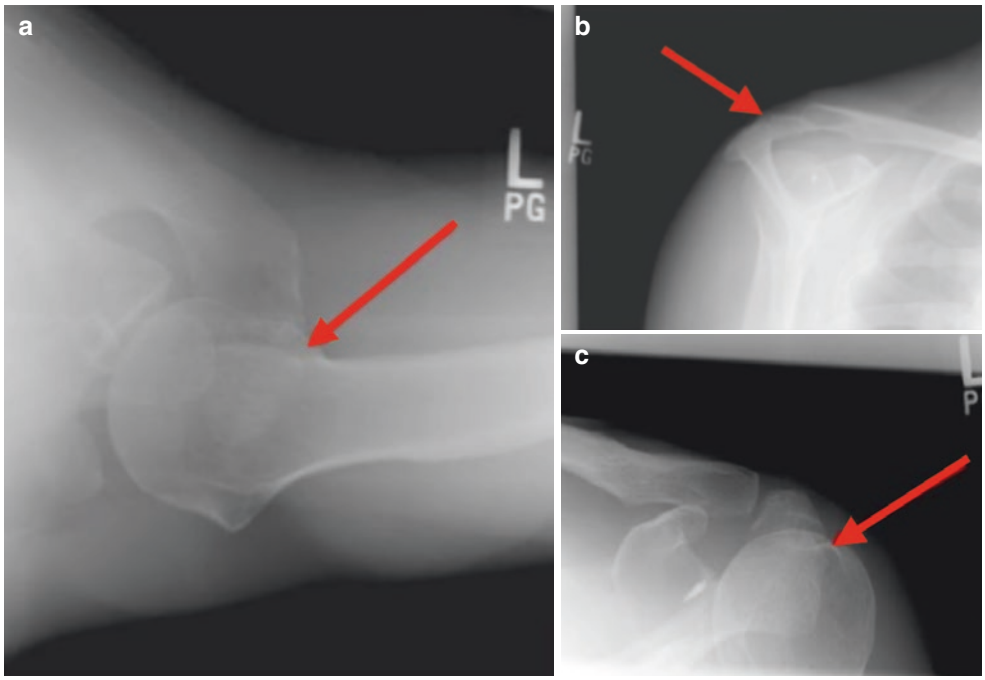

Fig. 50.2 Radiograph views showing a meso-acromion: axillary lateral (**a**), supraspinatus outlet (**b**), and anterior–posterior view of the glenohumeral joint (**c**). (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

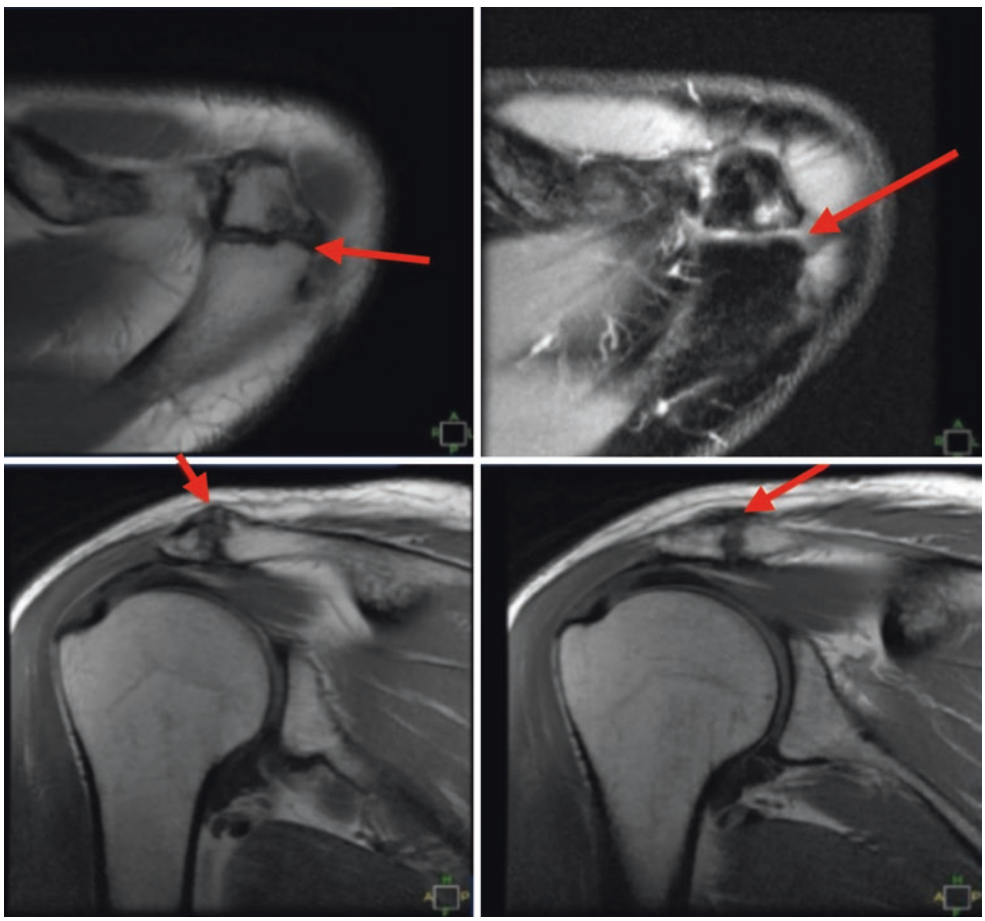

Fig. 50.3 MRI left shoulder that shows an intact rotator cuff, healing of the previous SLAP repair, moderate AC joint osteoarthritis, and a meso-acromion with sclerotic changes and soft tissue swelling at the meso-acromion site. (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

the rotator cuff [5], or arthritic changes of the AC joint due to hypermobility of the os [2]. In cases of a meso-acromion that becomes symptomatic, patients often present with a mobile fragment that results in pain and tenderness at the nonunion site and positive impingement signs. There have also been reports of rotator cuff pathology ranging from tendinitis to full-thickness tearing associated with an os acromiale [20]. As a diagnostic tool, selective injection of 5 mL of 1% lidocaine into the site with re-examination 10 min later can be performed. This diagnostic tool is useful to determine if the meso-acromiale is the source of the pain [25]. If the lidocaine injection does help relieve or reduce pain, it is not unreasonable to then administer a one-time corticosteroid injection into the same region for therapeutic purposes, which may give symptomatic long-term pain relief in some patients.

Failure to diagnose a meso-acromion prior to arthroscopic surgery may lead destabilization at the time of subacromial decompression.

50.3 Contraindications

The majority of os acromiale are asymptomatic and do not require surgical intervention. The primary contraindication for surgical treatment of an os acromiale is that it is not the source of the patient's pain. Careful pre-operative treatment and planning is necessary to determine if the os acromiale is the cause of the patient's complaints or is just an incidental finding on imaging studies.

50.4 Author-Preferred Technique for Arthroscopic Excision

The vast majority of meso-acromions are asymptomatic and are incident findings by X-ray or MRI. A thorough history and physical examination is always important in evaluating any shoulder problem, and by doing this, surgeon can often determine if the meso-acromion is the source of the patient's pain. Physical examination determines if the area of the meso-acromion is tender to palpation or even unstable. By injecting 5 cc's of 1% lidocaine into the area of the synchondrosis and then re-examining the patient 10 min later, one can determine if the meso-acromion is the source of the pain. This can also be followed by a local corticosteroid injection to see if that will give permanent relief of the patient's pain. If the meso-acromion is determined to be the source of the pain and the corticosteroid injection does not provide long-term relief, the meso-acromion can be addressed surgically.

50.4.1 Pre-operative Planning

Once the decision has been made for the patient to undergo surgery with arthroscopic excision of the symptomatic meso-acromion, careful preoperative planning is necessary to ensure a good result. Advanced arthroscopic skills are necessary, and surgeons should be comfortable using shavers, burrs, and radiofrequency devices in the subacromial space. Having a qualified and well-trained assistant, an experienced team of nurses, and a skilled anesthesiologist comfortable with hypotensive anesthesia is critical. Inadequate control of the blood pressure, resulting in excessive bleeding, can lead to poor visualization and make this procedure difficulty, if not impossible, to perform. Finally, the arthroscopic surgeon should have a checklist of all equipment needed. This list should be checked before bringing the patient into the operating room. An index of the recommended equipment for this procedure is shown in Table 50.1.

50.4.2 Patient Positioning

After administration of general endotracheal anesthesia, the patient is placed in the lateral decubitus position with an axillary roll, pillows between the knees, and all bony prominences padded. A beanbag or other device (with posts anterior and posterior, similar to a total hip position) can be used for positioning. Pneumatic compression devices are applied to both lower extremities to reduce the risk of deep venous thrombosis. This procedure can also be performed with the patient in the beach-chair position, but the lateral decubitus position is our preference. The non-operative shoulder is strapped to an arm board at 90° to the operating table for support and stability. The surgeon then performs an examination of the operative shoulder with the patient under general anes-

Table 50.1 Required equipment

Device	Source
STARR sleeve with shoulder suspension device	Arthrex, Naples, FL
Hip positioning device for lateral decubitus position	
Standard 30 arthroscope with monitor and tower	
Crystal smooth cannula, 5.75 mm 7 cm	Arthrex, Naples, FL
Arthroscopic Shaver (Dyonics 4.0-mm full-radius shaver)	Smith & Nephew, Memphis, TN
Radiofrequency Device (ArthroCare 90 wand)	ArthroCare, Austin, TX
4.5-mm oval burr (Dyonics; [16])	Smith & Nephew, Memphis, TN

thesia, noting mobility of the glenohumeral joint and any crepitus related to the meso-acromion or the nearby AC joint. The operative extremity is prepared and draped in a standard fashion. The operative arm is placed in a STARR sleeve (Arthrex, Naples, FL), which is then connected to a suspension device and placed in abduction (utilizing 10 pounds of suspension).

50.4.3 Portal Design/Placement

With the arm supported in suspension and prior to making any incisions, the surface anatomy is outlined with a sterile marking pen. The supraclavicular fossa is first outlined: it is bordered anteriorly by the clavicle and the AC joint, laterally by the acromion, and posteriorly by the spine of the scapula. Next, the most outer or inferior edges of the clavicle, acromion, and spine of the scapula are palpated, and "dots" are used as reference points. Connect the dots to define the most lateral acromial border, the S-shaped anterior edge of the clavicle to its midpoint and posteriorly the scapular spine. Then, by palpating the most lateral aspect of the supraclavicular fossa, the AC joint is located at a 45° angle anteriorly. Though in most patients, it can be palpated, and this allows a reliable estimate of the AC joint location in heavier patients.

The lateral orientation line is drawn next. At the posterior aspect of the AC joint (i.e., the anterior edge of the supraclavicular fossa, where it intersects the AC joint), a line is drawn out laterally that crosses perpendicular to the lateral border of the acromion and extends distally 4 cm down the arm. This reference line divides the acromion into an anterior two-fifths and posterior three-fifths (Fig. 50.4). The orientation line is helpful as a reference when creating the lateral subacromial portal for decompression and arthroscopic rotator cuff repair procedures [1].

The first step in performing an arthroscopic evaluation of the glenohumeral joint is to create the posterior superior portal and to introduce the posterior cannula. In an average-sized individual, the entry point is approximately 2 cm inferior and 1 cm medial from the posterolateral acromial edge (Fig. 50.5). For patients with thicker tissue or larger bony structures, the point is further inferior and medial [26]. A 1 cm or less incision is made through the skin only with a number 11 blade. The arthroscopic metal cannula with a blunt-tipped obturator is inserted through the posterior skin incision through the muscle until the posterior humeral head is palpated. With the opposite hand palpating the anterior surface of the shoulder joint, the humeral head is gently balloted back and forth. If in the correct position, the surgeon's opposite hand, which is placed anteriorly, can feel the movement of the humeral head. This additionally allows one to assess the location of the joint line. The cannula is then directed medially and slightly inferior (by slightly raising the surgeon's hand) to slide medially off the humeral head. Aiming toward the coracoids can be helpful in orientation when establishing this portal. Working the cannula through the capsule, one usually feels a definite pop as the joint is entered. The arthroscope should then be placed into the cannula after the obturator. This avoids making multiple holes in the posterior capsule with repetitive attempts, which can lead to increased fluid extravasation. A common error in making

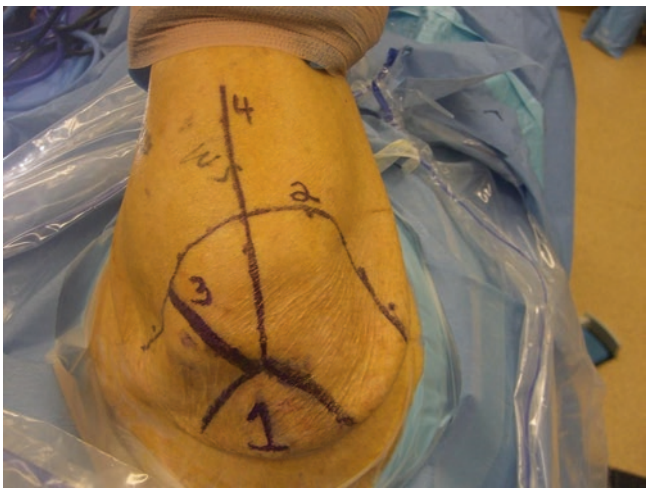

Fig. 50.4 Surface anatomy of the shoulder is drawn before any portals are made. In this right shoulder, the supraclavicular fossa (1) is drawn first, followed by outlining the entire lateral edge of the acromion from anterior to posterior (2). The AC joint is at a 45° angle from the most lateral aspect of the supraclavicular fossa (3). The lateral orientation line is then drawn from the posterior aspect of the AC joint out laterally, perpendicular to the lateral edge of the acromion (4). The posterior portal is created 2 cm inferior and 1 cm medial from the posterolateral edge of the acromion

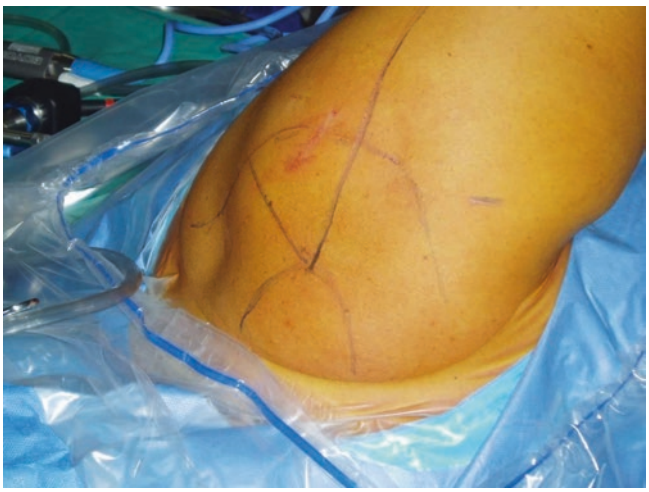

Fig. 50.5 First step in performing an arthroscopic evaluation of the glenohumeral joint is to create the posterior superior portal and to introduce the posterior cannula. In an average-sized individual, the entry point is approximately 2 cm inferior and 1 cm medial from the posterolateral acromial edge

the posterior superior portal is in placing it too laterally or proximally. The joint line is located inferior and medial to the posterolateral acromial corner [26]. If difficulties are encountered in entering the glenohumeral joint, especially in larger patients, it is helpful to place five more pounds of suspension on the arm (for a total of 15 pounds). This provides more distraction and makes it easier to palpate the step-off between the humeral head and the glenoid with the tip of the blunt obturator. Never use excessive pressure or employ a sharp trocar in the cannula, as penetration of the humeral head or scraping and damaging the articular surface can occur. After the capsule is punctured, the arthroscope is inserted to ensure that the cannula is truly in the joint and not in the subacromial space [26]. If an extra 5 pounds of suspension had been added, removal at this time helps avoid inadvertent neurovascular compromise.

The anterior portal must then be created, prior to performing the diagnostic glenohumeral arthroscopy. The anterior portal is needed not only to provide controlled outflow and lavage of the joint, but also to complete the second part of the diagnostic arthroscopy of the glenohumeral joint. In addition, this portal can be utilized to palpate anatomy using the tip of the cannula. If the cannula has a diaphragm, an arthroscopic probe can be inserted for further palpation.

When the arthroscope is inserted into the posterior cannula, the joint is distended with the use of an arthroscopic pump, and the biceps tendon is visualized. The anterior portal can be created using an inside-out or outside-in technique. We prefer using an inside-out technique, as it is quick, easy, and reproducible. We prefer the anterior portal to be created in an anterior superior position in the rotator interval between the anterior edge of the supraspinatus and the subscapularis tendons. We routinely create this portal high enough, so that superior (SLAP) labral pathology can be addressed, and a superior glenoid anchor can be inserted. This location also ensures a suitable viewing portal for visualizing anterior labral anatomy and pathology. It further ensures adequate space for a second anterior mid-glenoid portal, which is made at the leading edge of the subscapularis tendon and is used as a working portal when addressing anterior labral or SLAP tears.

The arthroscope is then gently "driven" across the glenoid, just below the biceps tendon, and then up into the rotator interval by gently dropping the surgeon's hand and driving the tip of the scope upward against the anterior capsule. The arthroscope is removed and a blunt switching stick or Wissinger rod is inserted through the cannula, tenting the skin anteriorly. This should not take a great deal of force. If significant resistance is met, the switching stick may have migrated too superiorly into the supraspinatus tendon, which will damage this tendon. The tip of the guide rod should be near the anterior aspect of the acromion, within 2 cm, and lateral to the AC joint. A small stab incision is then made at the tip of the rod and the rod is passed through the skin incision. A metal or plastic cannula is then inserted over the guide rod and gently twisted in until a pop is felt, and the capsule is penetrated. We prefer a metal cannula, similar to the one used for the posterior portal. This metal cannula eases anterior capsule penetration and is interchangeable, so that the arthroscope can be easily switched between the posterior and anterior positions during the diagnostic arthroscopy. If a plastic cannula is used, a metal cannulated obturator can be utilized for anterior introduction. This helps prevent damage to the leading edge of the cannula, which comes into contact with all suture material. Fretting of the cannula edge can compromise suture strength. When the arthroscope is switched from posterior to anterior, it is necessary to use a switching stick to place the posterior metal cannula anteriorly and the plastic cannula posteriorly. Use of the switching stick technique maintains the portal and prevents multiple holes in the capsule and surrounding soft tissues.

After the anterior superior portal is established, an outflow drainage tube is attached. This outflow is very important and should be attached only to gravity outflow. The outflow can be controlled with a clamp. Periodically releasing the clamp helps evacuate air bubbles or blood. Once the posterior and the anterior superior portals are established, a complete diagnostic arthroscopy is performed [26].

50.4.4 Step-by-Step Technique Description

The importance of a systematic and complete diagnostic arthroscopy of the shoulder cannot be over emphasized. Snyder, one of the pioneers of shoulder arthroscopy, described the 15-point glenohumeral exam at the time of diagnostic arthroscopy [26]. We prefer the lateral decubitus position, as it allows better access to the anterior aspect of the shoulder joint if a labral repair is necessary. We also use a shoulder suspension device to hold and position the arm in abduction and forward flexion in order to enter into the glenohumeral joint. Using a two-portal technique, the standard posterior portal and an anterior superior portal in the rotator interval are both established. The entire glenohumeral joint is examined both viewing from posterior portal anteriorly and also viewing from the anterior portal posteriorly using interchangeable arthroscopic cannulas in both portals. Intra-articular pathology can be addressed after the diagnostic arthroscopy is performed and can include loose body removal, labral debridement or repair, capsular release, debridement of partial rotator cuff tears and addressing any other pathology which may be present. Partial rotator cuff tears are debrided and then using the suture marker technique described by Snyder [26], an absorbable suture is placed via a spinal needle into the glenohumeral joint in order to find the bursal side of the cuff in the subacromial space to determine the extent of the damage.

The arthroscope is removed from the glenohumeral joint, and the arm is repositioned via the shoulder holder suspension device into adduction. This positions the humeral head away from the acromion and opens up the subacromial space. Using the same posterior portal that was used for the glenohumeral joint, the arthroscope is inserted into the subacromial space. An arthroscopic shaver is introduced anteriorly through the same anterior portal, and if bursitis is present, it is debrided to create a "room with a view." After adequate bursectomy has been performed, the bursal side of the rotator cuff can be inspected. The arm can be internally and externally rotated to get a complete view of the rotator cuff. If a marker suture has been placed, it is now localized on the bursal side of the rotator cuff and is inspected for any tearing or fraying.

After debriding the bursal tissue and adequate visualization is obtained, a lateral portal is then established 2.5–3 cm from the lateral edge of the acromion in line with the posterior aspect of the AC joint. A 5.75 mm × 7 cm clear, smooth cannula (Crystal Cannula/Arthrex) is placed through this latera portal. It is important to maintain all portals once they are established to avoid iatrogenic damage to the deltoid and surrounding musculature by multiple attempts to pass instruments through the soft tissues. Because of the significant vascularity in the subacromial space, it is important to have hypotensive anesthesia (systolic blood pressure 90 mm or lower) in order to have adequate visualization. With the arthroscope in the posterior portal, a radiofrequency device is inserted through the lateral portal and all soft tissues are taken off the undersurface of the acromion and the coracoacromial ligament is released but not cut. The acromion is then identified anteriorly and laterally with all soft tissues removed. The pseudoarthrosis or synchondrosis site of the meso-acromion is then identified and outlined using the radiofrequency device. A radiofrequency device causes less bleeding and allows better visualization versus a shaver which can cause more bleeding (Fig. 50.6). The radiofrequency device is used to strip as much of the soft tissue off the meso-acromion without disrupting the deltoid fibers (Fig. 50.7).

After all of the soft tissues have been debrided from the undersurface of the meso-acromion, a 4.5 mm oval burr (Dyonics/Smith & Nephew) is inserted through the lateral portal. The synchondrosis site is identified and arthroscopic excision is done using the burr in a sweeping type of fashion. Working from posterior to anterior, the burr is used to sweep the undersurface of the meso-acromion and shell it out. Careful attention is needed not to disrupt or damage the deltoid fibers which are attached to the remaining portion of the acromion (Fig. 50.8). After the meso-acromion has been resected, co-planning of the distal aspect of the clavicle is done, as there are often osteoarthritic changes of the AC joint. The arthroscopic shaver is then reinserted to debride any residual soft tissue and to ensure complete removal of the meso-acromion (Fig. 50.9). A list of key points to perform the described procedure is found in Table 50.2 [16].

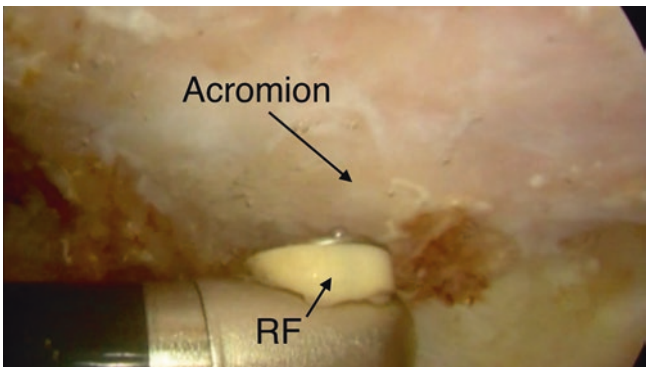

Fig. 50.6 Viewing anteriorly from the posterior portal in a left shoulder in the lateral decubitus position, the radiofrequency device (RF) (ArthroCare 90 wand) is inserted into the subacromial space through a lateral portal. This device is used to strip all soft tissues from the undersurface of the acromion. (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

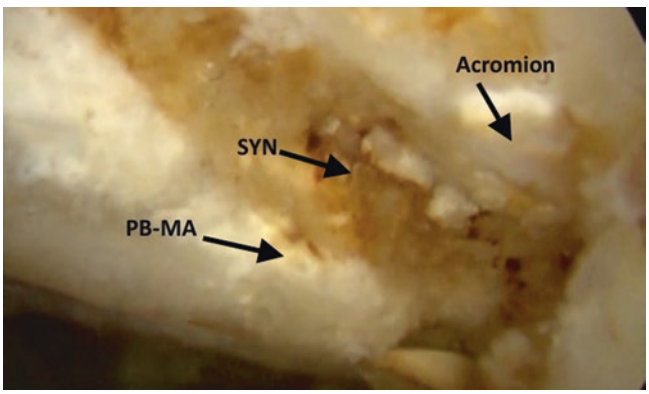

Fig. 50.7 Viewing the subacromial space anteriorly from the posterior portal in a left shoulder in the lateral decubitus position, the meso-acromion (PB-MA) can be visualized along with the synchrondosis (SYN) and the acromion. (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

50.4.5 Complications and Management

The risk of postoperative pain, weakness, and deltoid atrophy or dysfunction is reduced with the arthroscopic tech-

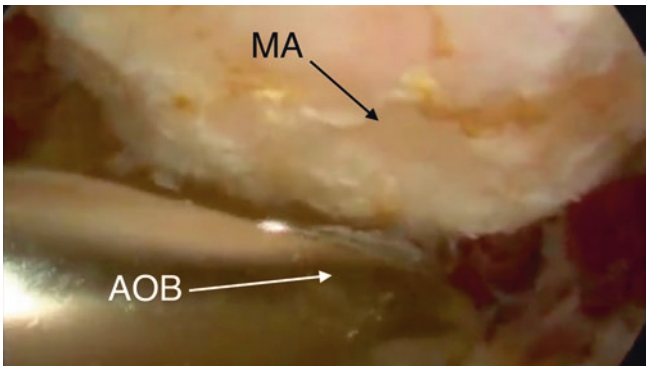

Fig. 50.8 Viewing the subacromial space anteriorly from the posterior portal in a left shoulder in the lateral decubitus position with the burr in the lateral portal, arthroscopic burring is performed by sweeping the arthroscopic oval burr (AOB) along the undersurface of the meso-acromion (MA) from posterior to anterior with meticulous technique to prevent disruption of the deltoid fibers. (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

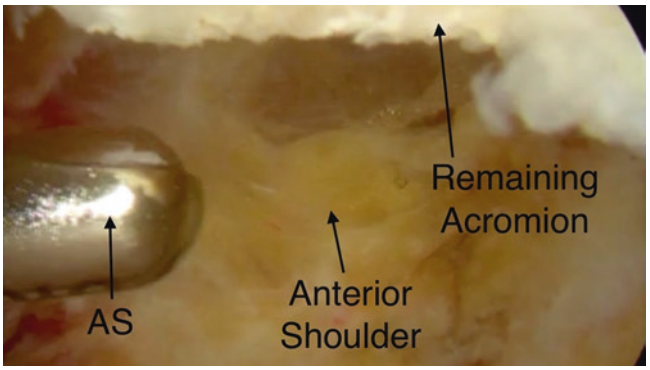

Fig. 50.9 Viewing the subacromial space anteriorly from the posterior portal in a left shoulder in the lateral decubitus position, the arthroscopic shaver (AS) is introduced through the lateral portal to remove any residual soft tissues from the remainder of the acromion and to make sure that the entire meso-acromion has been removed. The remaining acromion can be visualized superiorly. (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

nique, but not completely eliminated. Iatrogenic damage to the deltoid can occur if the technique is performed improperly, with deltoid stripping off the acromion, leading to deltoid weakness and dysfunction. Iatrogenic damage to the spine of the scapula and to the remainder of the acromion can also occur, leading to fracture.

Table 50.2 Key points

Key considerations
An extensive preoperative evaluation is necessary to determine that the meso-acromion is the source of the patient's symptoms.
The surgeon should perform precise portal placement in the subacromial space with the lateral portal placed 2.5 cm off the lateral edge of the acromion in line with the posterior aspect of the acromioclavicular joint.
The surgeon should perform subperiosteal dissection of all soft tissues of the undersurface of the acromion with a radiofrequency device outlining the lateral, medial, and anterior aspects of the mesoacromion.
Hypotensive anesthesia should be used to ensure adequate visualization.
The surgeon should perform meticulous use of a burr to excise the meso-acromion but not disrupt the deltoid periosteal sleeve to the remainder of the acromion [16].

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50.4.6 Post-operative Care

Postoperatively, radiographs should be obtained to assure adequate resection of the meso-acromial fragment (Fig. 50.10). Patients should be placed into a sling for 2 weeks to allow the incisions to heal. They are instructed to perform active elbow flexion and extension exercises, active gripping exercises of a small exercise ball, and gentle pendulum exercises. After 2 weeks, the patient's sling use should be discontinued, and an aggressive physical therapy program is initiated for active-assisted range of motion, followed by a strengthening program beginning at 6 weeks. Full range of motion is typically achieved at approximately 6–8 weeks. Post-operative visits should be regularly scheduled, assessing improvement in range of motion and strength. Particular attention should be focused on the deltoid, looking for evidence of weakness or atrophy. After the patient has fully recovered, the cosmetic appearance of the shoulder should not be appreciably different (Fig. 50.11).

Patients typically return to full activities 3–4 months postoperatively. In our experience, we have not seen any evidence of deltoid weakness or atrophy in the patients we have treated with arthroscopic excision. All have been able to resume normal overhead activities with virtually no pain and no subjective or objective evidence of weakness.

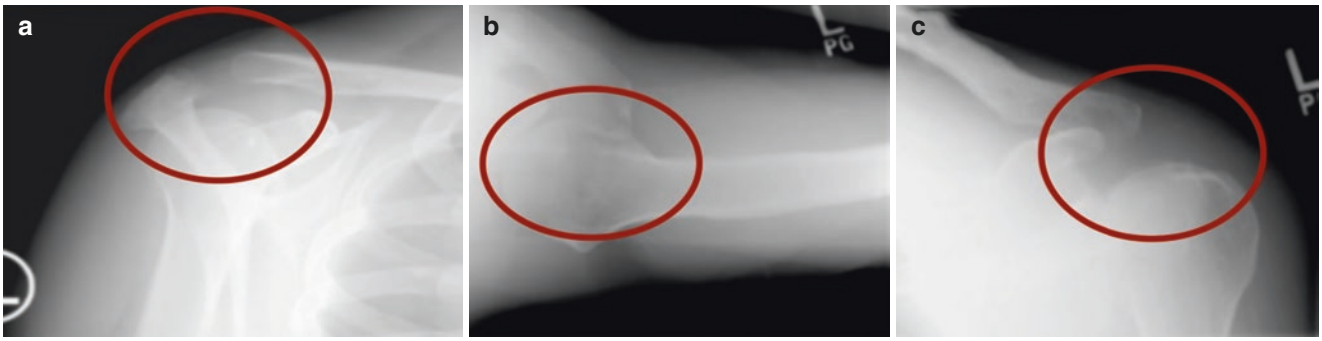

Fig. 50.10 Post-operative X-rays showing complete excision of the meso-acromion: supraspinatus outlet (**a**), axillary lateral (**b**), and AP of the glenohumeral joint (**c**). (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

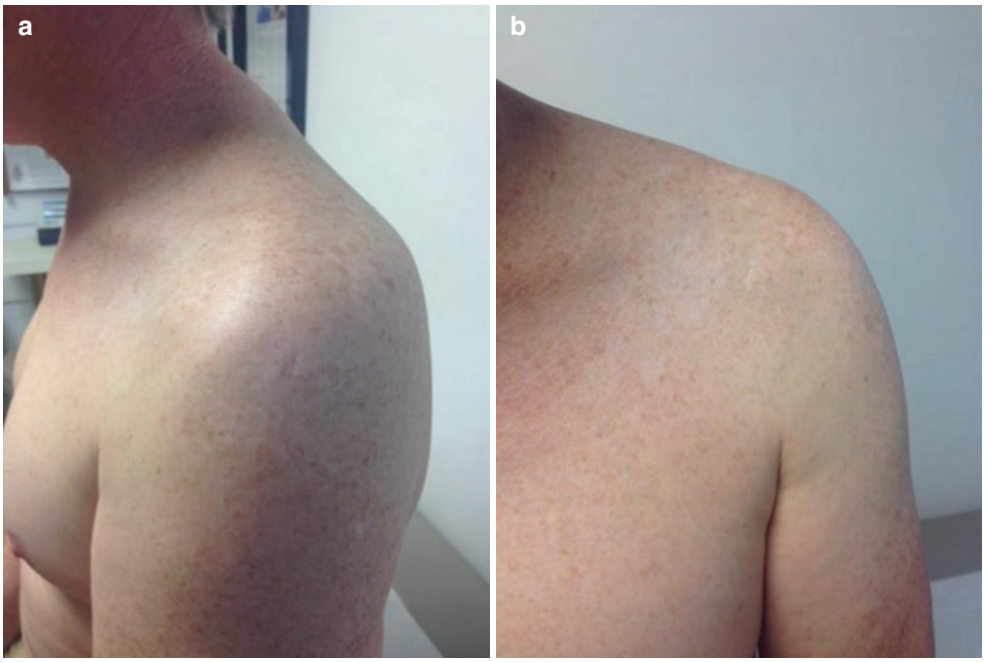

Fig. 50.11 Figure (**a**) left and (**b**) right shows no evidence of cosmetic deformity from resection of the meso-acromion. (Reproduced with permission from Stetson, W. B., Morgan, S., Chung, B., Hung, N., Mazza, G., McIntyre, A. Diagnosis and Treatment of the Meso-Acromion of the Shoulder. In: Amarasekera, H. W., editor. Recent Advances in Arthroscopic Surgery [Internet]. London: IntechOpen; 2018. Available from: https://www.intechopen.com/chapters/60890. https://doi.org/10.5772/intechopen.76267)

50.5 Summary

The majority of meso-acromions are asymptomatic. However, a symptomatic meso-acromion can be a challenging clinical problem and the literature is unclear as to the best way to handle these surgically. Various surgical techniques have been described with mixed results. Open excision of the symptomatic meso-acromion has led to mixed results with residual deltoid weakness and atrophy in the post-operative period [3, 27, 28]. ORIF using various techniques of cannulated screws, tension-band wiring, and other combinations has led to high non-union rates and high complication rates. The hardware often causes irritation and must be removed later in a second procedure [1, 25, 27]. Maintaining the vascularity of the fragments by not stripping the deltoid off the meso-acromion has shown higher union rates but still often requires hardware removal.

When the meso-acromion appears stable and the patient presents with impingement-like symptoms with or without a rotator cuff tear, an arthroscopic subacromial decompression/acromioplasty can be performed [20, 27]. This can lead to destabilization of the meso-acromial fragments with residual pain and associated weakness [28].

Arthroscopic excision is an excellent alternative and the studies of Pagnani et al. [15], and Campbell et al. [14] dem-

onstrated excellent results even in an athletic population as did Kawaguchi et al. [29] in a case report. The surgical techniques used in these series were not well-described by the authors. We have described the arthroscopic surgical technique of the resection of a symptomatic meso-acromion in detail in this chapter. It is a safe and effective procedure and requires no special instrumentation. However, it does require advanced arthroscopic surgical skills which only comes with experience and attention to detail.

The advantages of the arthroscopic excision technique include more rapid rehabilitation, better range of motion, and decreased surgical time. There is additionally no need for a second operation for symptomatic metal removal, which is common following ORIF (Table 50.3).

The disadvantage of the arthroscopic surgical technique for the resection of the symptomatic meso-acromion is the advanced arthroscopic surgical skills that are necessary to perform the procedure. If the arthroscopist does not know his landmarks, iatrogenic damage can occur to the acromion and the spine of the scapula leading to fracture. There is also a risk of stripping the deltoid aponeurosis off the remained of the acromion which can lead to muscle weakness and atrophy.

Despite the excellent results reported in the literature by both Pagnani et al. [15] and Campbell et al. [14], the technique of arthroscopic excision has not been popularized. Many surgeons are reluctant to perform the procedure because of the risk of muscle weakness, cosmetic deformity, and the technical difficulty performing the procedure. With proper surgical techniques, the deltoid aponeurosis and periosteal sleeve can be preserved, minimizing weakness, deformity, and pain. It is our opinion that arthroscopic resection of a symptomatic meso-acromion is a better option than open excision and also ORIF.

Table 50.3 Advantages and risks of arthroscopic resection

Advantages	Risks
The risk of postoperative pain, weakness, and deltoid atrophy and dysfunction is reduced.	Iatrogenic damage to the deltoid can occur if the technique is performed improperly with deltoid stripping off the acromion, leading to deltoid weakness and dysfunction.
The technique allows rapid rehabilitation, better range of motion, and a shorter surgical time.	Iatrogenic damage to the spine of the scapula and to the remainder of the acromion can occur, leading to fracture
There is no need for a second operation for symptomatic metal removal as is seen when open reduction and internal fixation is performed.	

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Meso-acromions are uncommon and are usually asymptomatic. When they are symptomatic, several surgical options are available open excision, arthroscopic subacromial decompression/acromioplasty, ORIF, and arthroscopic excision. ORIF of the symptomatic meso-acromial fragments has a high failure rate and a high complication rate [1, 2, 5, 13]. It is also not a good option for patients with concomitant AC joint osteoarthritis which is not uncommon in many patients. We believe that the technique of arthroscopic excision which we have described [16] is a reliable technique that yields good long-term results and high patient satisfaction. Future prospective studies are needed to increase our understanding of this challenging clinical shoulder problem.

Conflicts of Interest The authors have no conflicts of interest to report.

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