AJSM PreView, published on May 6, 2013 as doi:10.1177/0363546513485359

Degenerative Joint Disease of the Acromioclavicular Joint

A Review

Nathan A. Mall,* MD, Emily Foley,† BS, Peter N. Chalmers,† MD, Brian J. Cole,‡§ MD, MBA, Anthony A. Romeo,§ MD, and Bernard R. Bach Jr,§ MD
Investigation performed at Rush University Medical Center, Chicago, Illinois, and the St Louis Center for Cartilage Restoration and Repair, St Louis, Missouri

Osteoarthritis of the acromioclavicular (AC) joint is a common condition causing anterior or superior shoulder pain, especially with overhead and cross-body activities. This most commonly occurs in middle-aged individuals because of degeneration to the fibrocartilaginous disk that cushions the articulations. Diagnosis relies on history, physical examination, imaging, and diagnostic local anesthetic injection. Diagnosis can be challenging given the lack of specificity with positive physical examination findings and the variable nature of AC joint pain. Of note, symptomatic AC osteoarthritis must be differentiated from instability and subtle instability, which may have similar symptoms. Although plain radiographs can reveal degeneration, diagnosis cannot be based on this alone because similar radiographic findings can be seen in asymptomatic individuals. Nonoperative therapy can provide symptomatic relief, whereas patients with persistent symptoms can be considered for resection arthroplasty by open or arthroscopic technique. Both techniques have proven to provide predictable pain relief; however, each has its own unique set of potential complications that may be minimized with an improved understanding of the anatomical and biomechanical characteristics of the joint along with meticulous surgical technique.

Keywords: acromioclavicular; osteoarthritis; degenerative joint disease; shoulder

Osteoarthritis of the acromioclavicular (AC) joint is a common and potentially debilitating condition of the shoulder, resulting in pain and physical limitations with overhead and cross-body movements. Clinically, osteoarthritis is the most common disorder of the AC joint, and it has numerous causes. As such, the ability to recognize, diagnose, and treat osteoarthritis of the AC joint is important when patients present with shoulder pain. Patients who have persistent pain in the absence of instability or infection and have failed nonoperative measures can be considered for surgical resection. Open and arthroscopic techniques are described here. The length of clavicular resection is controversial but critical to avoid potential postoperative complications.

ANATOMY

The AC joint is a planar diarthrodial joint formed by the junction of the anteromedial acromion and lateral clavicle. The clavicle develops from 3 ossification centers, with the lateral aspect forming from a primary intramembranous ossification center[35] beginning at 5 to 6 weeks' gestation, although clavicular ossification often is not complete until 25 years of life. The acromion has 4 ossification centers, with the preacromion, meta-acromion, and mesoacromion fusing together by 18 years of life.[48] Of note, nonfusion of these ossification centers can occur in up to 8% of individuals, and thus surgeons must closely evaluate radiographs for a possible os acromiale, which can be clinically confused with AC abnormality and requires a different treatment algorithm.[48]

Although variable,[13] the acromial articulation is generally concave and the clavicular articulation convex, with a mean size of 9 × 19 mm in adults (Figure 1).[5] Despite having a small articular surface area, the AC joint withstands significant forces during activities of daily living.[14,20] A fibrocartilaginous disk cushions the joint, corrects for incongruencies, and acts in a load-bearing fashion similar to the meniscus in the knee.[8] The disk is

‡Address correspondence to Brian J. Cole, MD, MBA, Division of Sports Medicine, Department of Orthopedic Surgery, Rush University Medical Center, 1611 W Harrison, Suite 300, Chicago, IL 60612 (e-mail: bcole@rushortho.com).
*St Louis Center for Cartilage Restoration and Repair, Regeneration Orthopedics, St Louis, Missouri.
†Rush University Medical Center, Chicago, Illinois.
§Division of Sports Medicine, Department of Orthopedic Surgery, Rush University Medical Center, Chicago, Illinois.
The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

The American Journal of Sports Medicine, Vol. XX, No. X
DOI: 10.1177/0363546513485359

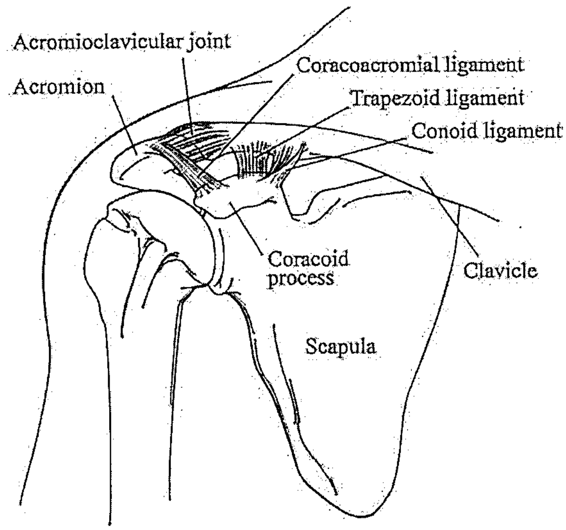

Figure 1. Illustration of the acromioclavicular articulation, acromioclavicular ligaments, and coracoclavicular ligaments. (From Beitzel K, Obopilwe E, Chowaniec DM, et al. Biomechanical comparison of arthroscopic joint instability: suture button systems without biological augmentation. *Am J Sports Med*. 2011;39(10):2218-2225. ©American Orthopaedic Society for Sports Medicine. Reproduced with permission.)

composed of 75% water, 20% collagen (90% of which is type I, with minor contributions from types II, III, and IV), and 5% proteoglycans, elastin, and other cells.[8] Degeneration of the intra-articular meniscus, commonly observed in patients over the age of 50 years, begins as early as the second decade of life and is thought to contribute to osteoarthritis.[18]

Surrounding the articular margins of the joint is a fibrous capsule. Overlying and confluent with this capsule, the AC ligaments and nearby coracoclavicular (CC) ligaments (conoid and trapezoid) stabilize the joint.[14,16,26,43] The AC ligaments resist 50% of anterior and 90% of posterior displacement, with capsular and capsuloligamentous insertions 2.8 mm and 4.8 mm from the acromial articular surface and 3.5 mm and 6.2 mm from the clavicular articular surface, respectively.[14,26,44] The coracoclavicular ligaments primarily resist superior and axial translation and secondarily resist anterior and posterior translation in the absence of AC ligaments (Figure 1).[9,10] The conoid ligament extends from the posteromedial coracoid to the anterior clavicle, and the trapezoid ligament extends from the anterolateral coracoid to the clavicle, inserting 32.1 mm and 14.7 mm medial to the clavicular articular surface, respectively.[44] The coracoacromial (CA) ligament, which does not play a significant role in AC joint stability, inserts 3.5 mm from the medial acromion, extending from the coracoid process to the acromion.[44]

Dynamic stabilization of the joint is provided by the anterior deltoid, trapezius, and serratus anterior. These muscles help support the weight of the arm, which places significant stresses on the AC joint. The AC joint is

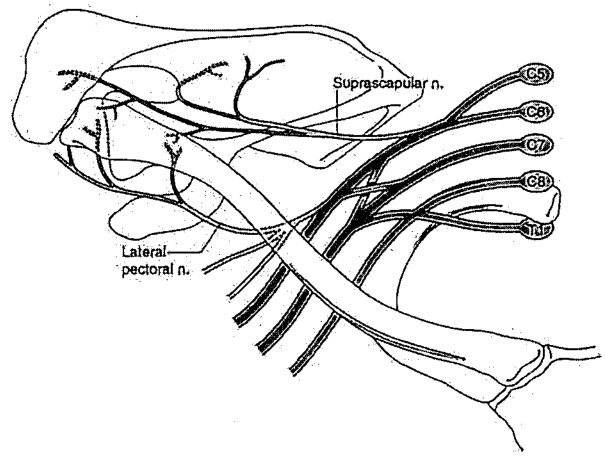

Figure 2. Illustration of the innervation of the acromioclavicular articulation. (Reprinted from the article "Injuries to the Acromioclavicular Joint" by DeLee, Drez, and Miller in the book *Delee & Drez's Orthopaedic Sports Medicine: Principles and Practice*, p. 916, Copyright 2003, with permission from Elsevier.)

supplied by branches of the suprascapular and thoracoacromial arteries. Innervation is provided by branches of the suprascapular nerve, which pass with the suprascapular artery, and branches of the lateral pectoral nerve, which pass with the thoracoacromial artery (Figure 2).[32]

BIOMECHANICS

The AC joint is part of the 6-component superior shoulder suspensory complex, along with the glenoid, coracoid process, coracoclavicular ligament, distal clavicle, and proximal acromion. Although a single disruption to this bony and soft tissue connection between the arm and the body (ie, grade 1 AC joint injury) does not compromise stability, loss of 2 or 3 components (ie, grade 4 AC joint injury) may indicate the need for operative intervention.[30]

Joint motion of the AC plays a role in overall shoulder girdle motion and scapular positioning.[9,49] The clavicle rotates up to 45° relative to the sternum, rib cage, and remainder of the axial skeleton, with 5° to 8° of this rotation occurring at the AC joint and the remainder occurring with coordinated glenohumeral, scapulothoracic, and sternoclavicular motion.[9,32,41] The AC joint is critical for scapular kinesis, coupling clavicular and scapular motion,[6,32] and thus scapular dyskinesis has been associated with AC joint injury.[31] The small articular surface area and high loads experienced with everyday activity result in very high contact stresses within the AC joint.[13,19] Oblique orientation of the articular surfaces, incongruencies of the articular surfaces, and degeneration of the disk can exacerbate these stresses, subjecting local areas of articular cartilage to very high stresses and accelerating osteoarthritic changes.[13,19]

ORIGIN OF DEGENERATION OF THE AC JOINT

Degenerative joint disease of the AC can occur due to age-related degeneration of the intra-articular disk, posttraumatic arthropathy, distal clavicle osteolysis, inflammatory arthropathy, septic arthritis, joint instability, and impingement. Similar to the meniscus of the knee, the intra-articular disk degenerates by fraying, tearing, and forming holes, macerated by defects in the chondral surface. This in turn leads to osteoarthritis.[22,37] However, it remains unclear how often these changes occur in asymptomatic patients, which can complicate diagnosis.[41]

Trauma is also a major contributor to joint-related pain,[41] most commonly occurring as an axial impact on the adducted arm.[32] Repetitive microtrauma can lead to AC joint degeneration through the same mechanism that leads to distal clavicular osteolysis. Occurring most commonly in weight lifters, this mechanism has been observed in other sports as well, such as basketball and swimming.[9,11,41,51]

In addition, inflammatory arthropathies can cause AC joint degeneration.[17,33] Septic arthritis, although rare, must be excluded by joint aspiration in cases with acute onset, fever, significant effusion and limitation to range of motion, pain with short arcs, and elevated systemic inflammatory markers.[4] The most common causes of septic arthritis of the AC joint are trauma, recent surgery, and hematogenous seeding.[4,27] Risk factors include age, history of intravenous drug use, past surgery, prior joint disease, intra-articular injection, rheumatoid arthritis, diabetes, immune deficiency, alcoholism, and sickle cell anemia.[4,27,29]

Last, instability can contribute to joint degeneration due to local elevation of contact stresses, dynamic loss of joint congruity, and alterations in range of motion.[42,43] A spectrum of instability is present that ranges from subtle to gross instability, but even subtle instability must be identified because it can lead to complications following AC joint resection in patients who fail nonoperative measures.

CLINICAL PRESENTATION OF AC JOINT OSTEOARTHRITIS

Clinical diagnosis of AC osteoarthritis can be challenging. Common symptoms include pain with passive and active motion of the shoulder joint, most notable with overhead and cross-body athletic or occupational activities.[42,43] Pain is predominantly referred to the superior or anterior aspect of the shoulder but can also be referred to the anterolateral neck, anterolateral deltoid, and trapezius.[32,41] Similar symptoms can be observed with cervical spine disorders, symptomatic os acromiale, rotator cuff injury, and subacromial impingement, and thus the examiner must be meticulous in the physical examination and imaging review to eliminate other possible causes. Mechanical symptoms such as popping, catching, or grinding within the joint can be present as well.[41]

Physical Examination

Because of commonly concomitant rotator cuff tears, labral injury, and biceps tendon tendinitis,[7,41] determining the contribution of the AC joint to the patient's pain requires careful examination.[12,41] A careful examination of the entire shoulder girdle, including scapular kinetics, is essential and should be combined with a cervical spine examination to rule out any contributions from cervical lesions.

On visual inspection, swelling, deformity, or prominence of the lateral clavicle may suggest AC joint instability.[12] Palpation frequently yields tenderness, which is anecdotally sensitive but nonspecific.[28] Dynamic stability can be assessed with the patient supine and the affected arm flexed to 90°. With one hand on the affected AC joint, the examiner assesses for movement of the clavicle with respect to the acromion while applying downward force to the patient's flexed arm.

Specific provocative tests include the cross-body adduction test, the AC resisted extension test, and the O'Brien active compression test.[12,32] In the cross-body adduction test, the shoulder is brought into 90° of forward flexion and maximal adduction of the shoulder; pain with this maneuver is considered a positive test.[12] In the AC resisted extension test, the shoulder is brought into 90° of forward flexion and the patient actively extends against resistance; pain with this maneuver is considered a positive test. In the O'Brien active compression test, the shoulder is brought to 90° of forward flexion and 10° of adduction. The patient performs resisted shoulder flexion with the arm in maximal internal rotation and then again in maximal supination; pain with the former maneuver is consistent with a superior labrum anterior-posterior (SLAP) lesion, and pain with the latter maneuver is consistent with AC joint abnormality (Figure 3, A-C).[12,34] Although the cross-body adduction stress test has been found to be the most sensitive test at 77%, the O'Brien active compression test is the most specific at 95% (Table 1).[12,34]

Imaging

Although the AC joint can be seen on anteroposterior views of the chest and anteroposterior and Grashey views of the shoulder, the joint is best visualized on the Zanca view with 10° to 15° of cephalad tilt to the beam and 50% exposure penetration with respect to an anteroposterior view of the shoulder.[32,41,43,50] Radiographic findings suggestive of degenerative osteoarthritis include joint space narrowing, subchondral cysts, osteophytes, and subchondral sclerosis, although radiographs should be closely evaluated for adjacent lesions such as subacromial impingement, os acromiale, instability, and fracture.[23,41] However, these findings must be interpreted in light of the history and physical examination given the frequency of asymptomatic AC osteoarthritis findings. An axillary lateral radiograph should be part of the radiographic evaluation as this may reveal subtle or gross anterior to posterior instability.

Although plain films are sufficient to diagnose AC degenerative joint disease, patients often undergo advanced imaging as part of an evaluation for concomitant injuries. Computed tomography (CT) allows superior osseous visualization,[23] whereas magnetic resonance imaging (MRI) provides superior visualization of soft tissue lesions,

TABLE 1
Sensitivity and Specificity of a Variety of Physical Examination Maneuvers for Acromioclavicular Degenerative Joint Disease[a]

Test	Sensitivity, %	Specificity, %	Accuracy, %
Cross-body adduction stress test	77	79	79
Acromioclavicular resisted extension test	72	85	84
O'Brien active compression test	41	95	92
Positive in the above 3 tests	25	97	93
Neer impingement sign	57	41	59
Painful arc sign	50	47	47
Drop arm sign	35	72	70

[a]From Chronopoulos E, Kim TK, Park HB, Ashenbrenner D, McFarland EG. Diagnostic value of physical tests for isolated chronic acromioclavicular lesions. *Am J Sports Med.* 2004;32(3):655-661. ©American Orthopaedic Society for Sports Medicine. Reproduced with permission.

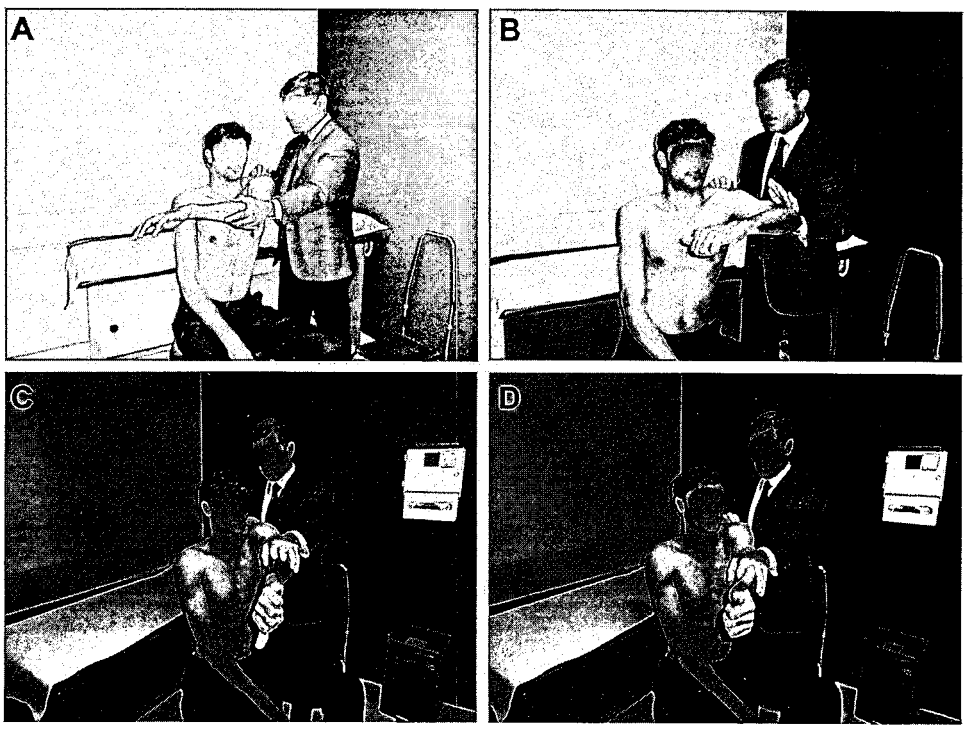

Figure 3. Clinical photographs of the physical examination maneuvers used in the diagnosis of acromioclavicular degenerative joint disease. (A) Cross-body adduction stress test. (B) AC resisted extension test. (C) The O'Brien active compression test. (D) This maneuver is repeated with the arm in maximal external rotation.

such as capsular hypertrophy, effusions, and subchondral edema.[19,23] Three-dimensional imaging of the AC joint is best viewed in the coronal oblique plane.[23] Caudal osteophytes and capsular hypertrophy identified on MRI are predictive of increased pain relief with intra-articular injection (Figure 4).[46] An MRI can also be useful when there is an acute injury, because edema can help localize the zone of injury and involved structures. Ultrasound can be used to assess joint space and detect osteophytes or other bony erosions, although the usefulness of this technique is dependent on the skill of the technician and is limited to superficial soft tissues.[19,23]

Diagnostic Injection

Joint injection can be used both diagnostically and therapeutically.[9,19,41] We typically use an admixture of short- and long-acting local anesthetic and corticosteroid. After palpation of the bony landmarks and marking of the site of injection, the skin should be prepared so as to inject using sterile technique. The clinician then slowly advances the needle perpendicular to the articulation while palpating for a tactile "pop" through the capsule, after which the mixture can be injected and noted to flow freely into the joint. Despite the subcutaneous nature of the joint,

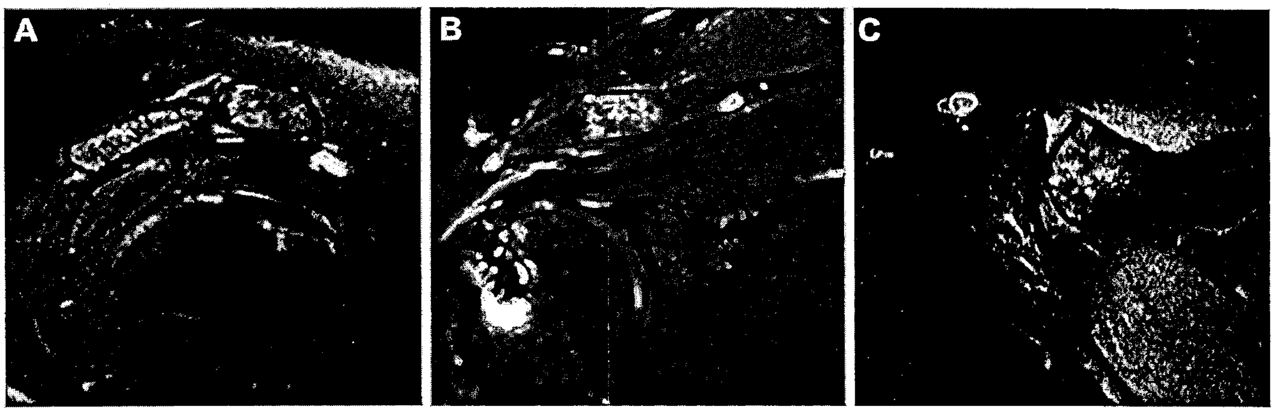

Figure 4. (A) Magnetic resonance T2-weighted fat-suppressed image demonstrating end-stage degenerative joint disease of the acromioclavicular joint with osseous edema of the distal clavicle, a small joint effusion, osteophyte formation, diminishment of the joint space, and no appreciable cartilage or intra-articular meniscus remaining. (A) Sagittal slice. (B) Coronal slice. This patient has had prior rotator cuff repair, and metallic anchors can be seen at the articular margin. (C) Axial slice.

these injections can be deceptively difficult and in some cases the accuracy of injection can be questionable.[15] The accuracy of intra-articular injection is improved, however, with the use of ultrasound guidance, which yields an increased frequency of reaching the intra-articular space (Figure 5).[3,15] Upon follow-up, patients should be asked whether the local anesthetic portion of the injection provided any relief for the hours following the injection as well as whether the corticosteroid portion of the injection provided any relief for the weeks following the injection, as patients with symptomatic AC degeneration can experience the former without the latter. Only 28% of patients report resolved symptoms at 4 weeks after injection and 64% of patients fail to improve after an injection.[47]

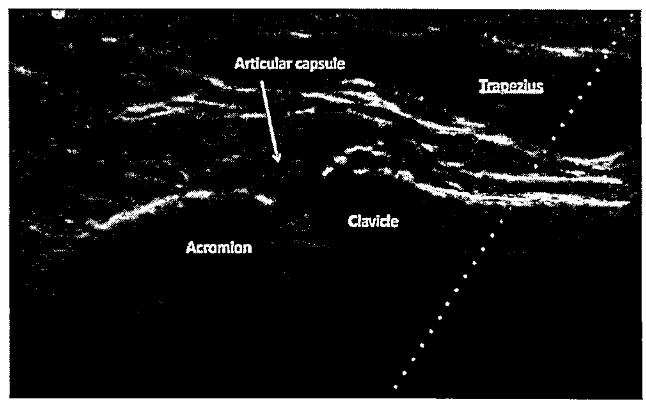

Figure 5. Sonographic image of a right acromioclavicular joint. The acromion can be seen on the left and the clavicle on the right. The joint can be injected under sonographic guidance using this view.

NONOPERATIVE TREATMENT

The most common modes of nonoperative treatment are physical therapy, activity modification, immobilization, nonsteroidal anti-inflammatory medications, and intra-articular injection therapy.[38,39] Physical therapy, although often ineffective in relieving osteoarthritic pain, can increase range of motion, flexibility, and strength, specifically within the periscapular musculature and rotator cuff.[19,41] Avoidance of repetitive, aggravating overhead and cross-body motions, such as pushing, weight lifting, throwing, or overhead work, can also relieve pain.[19,41] A 3- to 7-day period of sling immobilization with ice to the joint may reduce inflammation with acute exacerbations.[32] Patients whose condition fails a trial of other nonoperative measures can be considered for intra-articular injection.

OPERATIVE TREATMENT

Indications for operative treatment in AC degenerative joint disease include continued pain and loss of shoulder function despite a full course of nonoperative treatment. Contraindications to resection arthroplasty include active infection, neuroarthropathy, instability, and medical comorbidities that could prohibitively increase the risk of postoperative complications. Both open and arthroscopic approaches have been advocated. Of note, associated lesions are frequent: Rotator cuff tears occur in up to 81% of patients, labral tears occur in up to 33%, and biceps tendon abnormailities occur in up to 22%.[7] As a result, it behooves the surgeon to closely investigate every patient considered for distal clavicular excision via physical examination, advanced imaging, and concomitantly performed glenohumeral arthroscopy to ensure that these associated lesions are adequately addressed. For instance, in the patient with acromioclavicular degenerative cyst formation and rotator cuff injury, cyst resection and distal clavicle excision alone will likely provide inadequate symptomatic relief.

Open Distal Clavicular Excision

After administration of general and regional anesthetic, position the patient in the beach-chair position and prepare and drape the arm in the usual sterile fashion. An articulated arm holder can assist with intraoperative positioning (Figure 6). Often this procedure is preceded by an arthroscopy, performed either diagnostically or to address concomitant injury. If prior arthroscopy is performed, landmark skin markings can be altered as a result of edema and fluid extravasation and should be reevaluated before skin incision. We commonly use a 2- to 4-cm saber (anterior-to-posterior) incision overlying the AC joint because this provides improved cosmesis. The incision is carried through skin and subcutaneous tissues to the level of the deltotrapezial fascia, and large skin flaps are created. To facilitate later repair of the superior capsule, we typically split the deltotrapezial fascia longitudinally in line with the capsular incision for a robust closure. The superior capsular split extends to the level of the periosteum perpendicular to the plane of the joint (ie, transversely). Needle localization can assist in cases with unclear location of the articulation. Subperiosteal flaps are raised. Osseous resection can be performed with an osteotome, oscillating sagittal saw, bur, or rongeur. The extent of resection is discussed in a later section of this article. An angled resection from superomedial to inferolateral better parallels the natural joint surface and generally parallels the lateral border of the acromion, although considerable variability exists in the morphological features of the joint lines, especially in advanced degeneration. Anecdotally, the medial acromial border is more easily identified and can be used intraoperatively as a guide to resection orientation. After removal of the resected fragment, perform a flexion and adduction maneuver while palpating for residual bony contact with a finger in the joint space created by the resection. With the open technique, it is not uncommon to leave a small portion of bone inferiorly or the resection width can taper inferiorly. Careful examination for this potential cause of residual pain and abutment must be performed. Hemostasis can be obtained with bone wax and electrocautery, followed by thorough irrigation. The capsular and deltotrapezial closure is often thought to be the most important portion of the procedure and is essential for avoidance of subtle instability after resection. We typically use a large tapered needle with a nonabsorbable braided suture, such as No. 2 or 5 Ethibond (Ethicon Inc, Somerville, New Jersey). We attempt to capture each tissue layer from periosteum to the deltotrapezial fascia in a single suture pass, tying on top of the fascia. Typically, 3 to 4 sutures are placed, and any remaining rents in the fascia or concurrent damage to the deltoid insertion can be either primarily closed or imbricated with 0-Vicryl sutures (Ethicon Inc). Augmenting this repair may include performing a pants-over repair over the distal clavicle and acromion incorporating the deltotrapezial fascia.

Arthroscopic Distal Clavicular Excision

For the arthroscopic approach, lateral decubitus or beach-chair positioning can be used depending on the surgeon's preference. Because the procedure involves exposing cancellous osseous surfaces, we use hypotensive anesthetic technique, an arthroscopic pump with pressure control, and irrigation fluid with dilute epinephrine to maintain arthroscopic visualization.

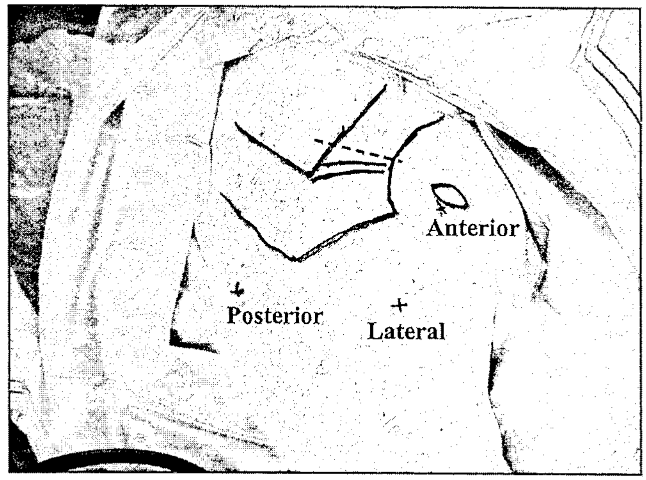

Figure 6. Clinical photograph of a patient in the beach chair position with the palpable landmarks and location for arthroscopic portals (labeled anterior, lateral, and posterior) outlined with a skin marker. The incision for open distal clavicle excision is marked with a dashed black line.

Establish posterior and anterolateral portals using the standard techniques (Figure 6). Complete a thorough diagnostic arthroscopy. Two arthroscopic approaches to the acromioclavicular joint have been described: the "indirect" transbursal approach and the "direct" bursal-sparing approach.

In the transbursal approach, the arthroscope is directed into the subacromial space. Establish a lateral portal and perform a thorough subacromial bursectomy. If indicated, perform an acromioplasty. Identify the acromioclavicular joint at the anterior subacromial space, just medial and superior to the acromial attachment of the CA ligament. The distal clavicle can often be localized by pressing down on the clavicle while visualizing the anterior subacromial space; however, in questionable cases needle localization can be used. Using a combination of the arthroscopic shaver and the radiofrequency device, expose the articular portion of the distal clavicle by resecting the inferior joint capsule, taking care to preserve the posterior and superior joint capsule. If any intra-articular meniscus remains, this is resected. Then, using a 4- or 5.5-mm bur, remove 3 to 10 mm of the distal clavicle using a "windshield wiper" style motion progressing from anterior to posterior and inferior to superior. The extent of resection is discussed in a later section. A minimal amount of medial acromion resection is almost always required to improve visualization. Some surgeons routinely remove 2 to 3 mm of the medial acromion because this widens the space between the acromion and clavicle without violating as much of the insertion of the AC ligaments and the trapezoid ligament. Ensure that the osseous resection of the posterior and superior portions of the clavicle is sufficient, as these portions are often poorly visualized. Often, this requires moving the arthroscope into the anterior portal with direct visualization into the AC joint. Too wide of a resection must be avoided because this can release the acromioclavicular and even coracoclavicular ligaments. Placing a downward displacement force on the clavicle can improve arthroscopic orientation and deliver the distal clavicle to the bur. Accessory portals, such as a portal placed directly into the superior AC, can be used to obtain the appropriate orientation of the bur, although this portal violates the superior acromioclavicular ligaments.[21,40] The width of resection should be confirmed with a calibrated probe or with the width of the bur.[25,39] An alternative method involves needle localization of the ends of the resection with measurement of the distance between the needles on the overlying skin.[41] Reevaluate from both the anterior and lateral portals and by bringing the arm into flexion and adduction to observe for residual contact. The resected surfaces can be smoothed with an arthroscopic rasp if needed. After ensuring that hemostasis has been obtained, perform closure in the usual fashion.

In the bursal-sparing approach, the AC joint is directly entered. First, identify the location and angulation of the AC joint with multiple needle localization and create 2 direct superior portals, one anteriorly and one posteriorly. Incise the skin, taking care not to violate the capsule with the incision, instead bluntly entering the joint with an obturator to minimize capsular damage. Introduce a 2.7-mm arthroscope into the posterior portal. Use a shaver (2.0 mm) or radiofrequency device to debride the meniscal remnant and a curette to resect remaining articular cartilage. The radiofrequency device can be used to subperiosteally dissect the distal clavicle. Once the osseous surfaces are cleared of soft tissue, perform a measured resection of the distal clavicle and medial acromion as described in the transbursal approach. Given limited space, it may be necessary to begin with a 2-mm bur, switching to a full-size bur and standard 4-mm arthroscope once sufficient bone has been resected. As in the transbursal approach, visualizing the resection from the anterior portal can be helpful to determine the adequacy of the resection. The extent of resection is discussed in a later section. Although technically challenging, this approach may provide superior capsular and ligamentous preservation.[24]

POSTOPERATIVE REHABILITATION

Postoperative rehabilitation is often dictated by concomitantly performed procedures. If distal clavicular excision is performed in isolation, patients are immobilized in a simple sling initially and allowed to perform pendulums immediately. Passive and active assisted range of motion exercises begin at 2 weeks postoperatively. By 4 weeks immobilization is discontinued and full active range of motion is permitted. Our postoperative protocol does not differ between the open and arthroscopic approaches, with one exception: If the dissection involves extensive detachment of the deltoid origin, active forward elevation and abduction are limited for 4 to 6 weeks.

OPEN VERSUS ARTHROSCOPIC DISTAL CLAVICLE RESECTION

Although open distal clavicle resection techniques traditionally have been used with success,[36] arthroscopic techniques are used with increasing frequency given the potential for accelerated recovery and improved ability to preserve the AC ligaments, joint capsule, and deltotrapezial fascia.[21,25,36,39,44,45] The open technique may require deltoid disruption and may compromise the integrity of the superior AC ligaments, possibly increasing the risk of instability and residual pain.[14,26,39] However, repair of the superior ligaments may be possible with the open technique, whereas compromise of the inferior ligaments cannot be repaired with the arthroscopic technique. The arthroscopic approach also improves one's ability to treat concomitant intra-articular glenohumeral or subacromial lesions.[21,25,39,45]

Both open and arthroscopic techniques exhibit mostly positive outcomes.[21,36,38] Significant improvements have been demonstrated in visual analog scale (VAS) pain scores and Short Form–36 (SF-36) quality of life scores for both the open and arthroscopic techniques.[25] However, arthroscopic distal clavicular resection may require less rehabilitation, provide increased pain relief at 3 months, and allow an accelerated return to function or athletic activities.[11,20,21,25,45] In addition, arthroscopic techniques are associated with a higher proportion of good or excellent results after distal clavicle excision in several retrospective cohort studies.[36,38] The direct arthroscopic approach can be considered for competitive athletes for whom the length of rehabilitation and time to return to sport are important factors.[11]

Resection Length

Among the most challenging portions of the procedure is determination of the depth and length of resection. Inadequate resection can result in continued pain due to residual contact between the clavicle and acromion, whereas excess resection can result in instability due to ligamentous detachment. Most authors agree that resection length should not exceed 10 mm.[14,37] A resection length of less than 10 mm is associated with decreased pain.[14] Resection length also varies with gender, with some authors recommending a resection length of less than 8 mm in female patients and less than 10 mm in male patients.[2] Other authors have recommended that resection length not exceed 5 mm.[1] In some patients, removing as little as 2.3 mm in women and 2.6 mm in men is enough to disrupt the ligament insertions on the clavicle.[20] A resection length of 2.5 mm may be feasible so long as the inferior-posterior quadrant of the clavicle, best visualized from the anterolateral portal, is resected to ensure that no bony contact remains between the clavicle and acromion.[20] Alternatively, a 3- to 4-mm resection of the distal clavicle can be supplemented with a 2- to 3-mm resection of the medial acromion to achieve the needed resection length while preserving the AC ligament attachments and joint capsule.[44] Although much of the literature to date has focused on the length of clavicle resected, the degree of acromioclavicular gap achieved by the resection is the more clinically relevant determinant of residual acromioclavicular contact, and this gap can be achieved with either medial acromial resection or lateral clavicular resection. No exact resection length can be definitively recommended, because the ideal resection length likely depends on the patient in question; therefore, it is crucial to recognize the importance of maintaining a conservative resection length to best preserve the AC joint capsule and minimize postoperative instability.

Complications

The most common complication of a distal clavicle resection is persistent pain, which can result from over- or under-resection.[41] Incomplete resection can occur because of poor visualization.[45] To prevent under-resection, the AC joint should be viewed via an anterior and lateral portal.[45] Overexuberant resection of the clavicle or disruption of the AC and coracoclavicular ligamentous system can result in iatrogenic instability of the AC joint.[16] Posterior translation of the AC is increased by 32% after a distal clavicle resection with an AC capsular incision.[14] Similarly, AC joint resection alone should be cautioned in patients with prior AC joint instability injuries, because a prior capsular or ligamentous disruption may lead to greater instability after AC joint resection. In these cases, AC resection combined with AC ligament reconstruction may be needed. Posterior translation can be reduced to 13% if the distal clavicle resection is completed with a coracoacromial ligament augmentation procedure, restoring the integrity of the ligamentous system.[14] Postoperative iatrogenic instability may require revision surgery or coracoclavicular ligament reconstruction.[45] Other complications include infection, stiffness, fracture, spontaneous fusion, and complex regional pain syndrome.[45]

CONCLUSION

Degenerative joint disease of the AC joint is common yet often difficult to diagnose. Diagnosis relies on clinical history and physical examination in coordination with imaging findings. A variety of approaches have been described for resection arthroplasty, each with associated advantages and disadvantages. Length of resection must be carefully monitored to avoid residual bony contact or iatrogenic instability.

REFERENCES

1. Beitzel K, Sablan N, Chowaniec DM, et al. Sequential resection of the distal clavicle and its effects on horizontal acromioclavicular joint translation. *Am J Sports Med*. 2012;40(3):681-685.
2. Boehm TD, Kirschner S, Fischer A, Gohlke F. The relation of the coracoclavicular ligament insertion to the acromioclavicular joint: a cadaver study of relevance to lateral clavicle resection. *Acta Orthop Scand*. 2003;74(6):718-721.
3. Borbas P, Kraus T, Clement H, et al. The influence of ultrasound guidance in the rate of success of acromioclavicular joint injection: an experimental study on human cadavers. *J Shoulder Elbow Surg*. 2012;21(12):1694-1697.
4. Bossert M, Prati C, Bertolini E, Toussirot E, Wendling D. Septic arthritis of the acromioclavicular joint. *Joint Bone Spine*. 2010;77(5):466-469.
5. Bosworth BM. Complete acromioclavicular dislocation. *N Engl J Med*. 1949;241(6):221-225.
6. Branch TP, Burdette HL, Shahriari AS, Carter FM II, Hutton WC. The role of the acromioclavicular ligaments and the effect of distal clavicle resection. *Am J Sports Med*. 1996;24(3):293-297.
7. Brown JN, Roberts SN, Hayes MG, Sales AD. Shoulder pathology associated with symptomatic acromioclavicular joint degeneration. *J Shoulder Elbow Surg*. 2000;9(3):173-176.
8. Brys P, Geusens E, Scapular, clavicular, acromioclavicular and sternoclavicular joint injuries. In: Vanhoenacker FN, Maas M, Gielen JL, eds. *Imaging of Orthopedic Sports Injuries*. Berlin, Germany: Springer-Verlag; 2007:169-182.
9. Cadet E, Ahmad CS, Levine WN. The management of acromioclavicular joint osteoarthrosis: debride, resect, or leave it alone. *Instr Course Lect*. 2006;55:75-83.
10. Carofino BC, Mazzocca AD. The anatomic coracoclavicular ligament reconstruction: surgical technique and indications. *J Shoulder Elbow Surg*. 2010;19(2 suppl):37-46.
11. Charron KM, Schepsis AA, Voloshin I. Arthroscopic distal clavicle resection in athletes: a prospective comparison of the direct and indirect approach. *Am J Sports Med*. 2007;35(1):53-58.
12. Chronopoulos E, Kim TK, Park HB, Ashenbrenner D, McFarland EG. Diagnostic value of physical tests for isolated chronic acromioclavicular lesions. *Am J Sports Med*. 2004;32(3):655-661.
13. Colegate-Stone T, Allom R, Singh R, et al. Classification of the morphology of the acromioclavicular joint using cadaveric and radiological analysis. *J Bone Joint Surg Br*. 2010;92(5):743-746.
14. Corteen DP, Teitge RA. Stabilization of the clavicle after distal resection: a biomechanical study. *Am J Sports Med*. 2005;33(1):61-67.
15. Daley EL, Bajaj S, Bisson LJ, Cole BJ. Improving injection accuracy of the elbow, knee, and shoulder: does injection site and imaging make a difference? A systematic review. *Am J Sports Med*. 2011; 39(3):656-662.
16. Dawson PA, Adamson GJ, Pink MM, et al. Relative contribution of acromioclavicular joint capsule and coracoclavicular ligaments to acromioclavicular stability. *J Shoulder Elbow Surg*. 2009;18(2):237-244.
17. Day MS, Nam D, Goodman S, Su EP, Figgie M. Psoriatic arthritis. *J Am Acad Orthop Surg*. 2012;20(1):28-37.
18. DePalma AF. The role of the discs of the sternoclavicular and acromioclavicular joints. *Clin Orthop Relat Res*. 1959;13:7-12.
19. Docimo S Jr, Kornitsky D, Futterman B, Elkowitz DE. Surgical treatment for acromioclavicular joint osteoarthritis: patient selection, surgical options, complications, and outcome. *Curr Rev Musculoskelet Med*. 2008;1(2):154-160.
20. Edwards SL, Wilson NA, Flores SE, Koh JL, Zhang LQ. Arthroscopic distal clavicle resection: a biomechanical analysis of resection length and joint compliance in a cadaveric model. *Arthroscopy*. 2007;23(12): 1278-1284.
21. Elhassan B, Ozbaydar M, Diller D, et al. Open versus arthroscopic acromioclavicular joint resection: a retrospective comparison study. *Arthroscopy*. 2009;25(11):1224-1232.
22. Englund M, Lohmander LS. Risk factors for symptomatic knee osteoarthritis fifteen to twenty-two years after meniscectomy. *Arthritis Rheum*. 2004;50(9):2811-2819.
23. Ernberg LA, Potter HG. Radiographic evaluation of the acromioclavicular and sternoclavicular joints. *Clin Sports Med*. 2003;22(2):255-275.
24. Flatow EL, Cordasco FA, Bigliani LU. Arthroscopic resection of the outer end of the clavicle from a superior approach: a critical, quantitative, radiographic assessment of bone removal. *Arthroscopy*. 1992;8(1):55-64.
25. Freedman BA, Javernick MA, O'Brien FP, Ross AE, Doukas WC. Arthroscopic versus open distal clavicle excision: comparative

results at six months and one year from a randomized, prospective clinical trial. *J Shoulder Elbow Surg*. 2007;16(4):413-418.
26. Fukuda K, Craig EV, An KN, Cofield RH, Chao EY. Biomechanical study of the ligamentous system of the acromioclavicular joint. *J Bone Joint Surg Am*. 1986;68(3):434-440.
27. Hammel JM, Kwon N. Septic arthritis of the acromioclavicular joint. *J Emerg Med*. 2005;29(4):425-427.
28. Hegedus EJ, Goode A, Campbell S, et al. Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. *Br J Sports Med*. 2008;42(2):80-92; discussion 92.
29. Hernigou P, Daltro G, Flouzat-Lachaniette CH, Roussignol X, Poignard A. Septic arthritis in adults with sickle cell disease often is associated with osteomyelitis or osteonecrosis. *Clin Orthop Relat Res*. 2010;468(6):1676-1681.
30. Herrera DA, Anavian J, Tarkin IS, et al. Delayed operative management of fractures of the scapula. *J Bone Joint Surg Br*. 2009;91(5): 619-626.
31. Kibler WB, Sciascia A, Wilkes T. Scapular dyskinesis and its relation to shoulder injury. *J Am Acad Orthop Surg*. 2012;20(6):364-372.
32. Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. *Am J Sports Med*. 2007;35(2):316-329.
33. Mease PJ. Disease-modifying antirheumatic drug therapy for spondyloarthropathies: advances in treatment. *Curr Opin Rheumatol*. 2003;15(3):205-212.
34. O'Brien SJ, Pagnani MJ, Fealy S, McGlynn ST, Wilson JB. The active compression test: a new and effective test for diagnosing labral tears and acromioclavicular joint abnormality. *Am J Sports Med*. 1998;26(5):610-613.
35. Ogata S, Uhthoff HK. The early development and ossification of the human clavicle—an embryologic study. *Acta Orthop Scand*. 1990; 61(4):330-334.
36. Pensak M, Grumet RC, Slabaugh MA, Bach BR Jr. Open versus arthroscopic distal clavicle resection. *Arthroscopy*. 2010;26(5):697-704.
37. Petersson CJ. Degeneration of the acromioclavicular joint: a morphological study. *Acta Orthop Scand*. 1983;54(3):434-438.
38. Rabalais RD, McCarty E. Surgical treatment of symptomatic acromioclavicular joint problems: a systematic review. *Clin Orthop Relat Res*. 2007;455:30-37.
39. Robertson WJ, Griffith MH, Carroll K, O'Donnell T, Gill TJ. Arthroscopic versus open distal clavicle excision: a comparative assessment at intermediate-term follow-up. *Am J Sports Med*. 2011;39(11):2415-2420.
40. Sellards R, Nicholson GP. Arthroscopic distal clavicle resection. *Oper Tech Sports Med*. 2004;12:18-26.
41. Shaffer BS. Painful conditions of the acromioclavicular joint. *J Am Acad Orthop Surg*. 1999;7(3):176-188.
42. Shu B, Johnston T, Lindsey DP, McAdams TR. Biomechanical evaluation of a novel reverse coracoacromial ligament reconstruction for acromioclavicular joint separation. *Am J Sports Med*. 2012;40(2):440-446.
43. Simovitch R, Sanders B, Ozbaydar M, Lavery K, Warner JJ. Acromioclavicular joint injuries: diagnosis and management. *J Am Acad Orthop Surg*. 2009;17(4):207-219.
44. Stine IA, Vangsness CT Jr. Analysis of the capsule and ligament insertions about the acromioclavicular joint: a cadaveric study. *Arthroscopy*. 2009;25(9):968-974.
45. Strauss EJ, Barker JU, McGill K, Verma NN.: The evaluation and management of failed distal clavicle excision. *Sports Med Arthrosc*. 2010;18(3):213-219.
46. Strobel K, Pfirrmann CW, Zanetti M, Nagy L, Hodler J. MRI features of the acromioclavicular joint that predict pain relief from intraarticular injection. *AJR Am J Roentgenol*. 2003;181(3):755-760.
47. van Riet RP, Goehre T, Bell SN. The long term effect of an intraarticular injection of corticosteroids in the acromioclavicular joint. *J Shoulder Elbow Surg*. 2012;21(3):376-379.
48. Warner JJP, Beim GM, Higgins L. The treatment of symptomatic os acromiale. *J Bone Joint Surg Am*. 1998;80(9):1320-1326.
49. Worcester JN Jr, Green DP. Osteoarthritis of the acromioclavicular joint. *Clin Orthop Relat Res*. 1968;58:69-73.
50. Zanca P. Shoulder pain: involvement of the acromioclavicular joint (analysis of 1,000 cases). *Am J Roentgenol Radium Ther Nucl Med*. 1971;112(3):493-506.
51. Zawadsky M, Marra G, Wiater JM, et al. Osteolysis of the distal clavicle: long-term results of arthroscopic resection. *Arthroscopy*. 2000;16(6):600-605.