OPEN DISTAL CLAVICLE RESECTION

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Since 1941, resection of the distal clavicle has been a proven treatment for symptomatic acromioclavicular (AC) joint pathology. Although arthroscopic techniques have been well developed, open distal clavicle resection remains the gold standard and in certain patients is the preferred technique for removal of the distal clavicle. A thorough understanding of the historical presentation, physical examination, and radiographic and MRI findings, as well as an appreciation for possible concomitant pathology, is necessary to properly select patients who will benefit from distal clavicle resection. Open distal clavicle resection may be performed expeditiously and at low cost through a cosmetically acceptable small saber-type incision, often in less time than it takes to set up arthroscopic equipment. Results of open distal clavicle resection demonstrate excellent symptomatic relief with low morbidity in properly selected patients. Attention to detail and knowledge of the anatomy of the AC joint is necessary to assure adequate but not excessive bone removal (usually 1 cm), and meticulous preservation of the superior capsule and deltotrapezial fascia allows for an anatomic closure of these stabilizing structures.
KEY WORDS: acromioclavicular joint, resection, biomechanics

HISTORICAL PERSPECTIVE

Since 1941, surgical resection of the distal clavicle has been a treatment option for symptomatic pathologic conditions of the acromioclavicular (AC) joint. Both Mumford[1] and Gurd[2] simultaneously described an open resection of the distal clavicle as surgical treatment of symptomatic AC joint traumatic dislocations. Early mechanical studies identified the importance of the primary and secondary stabilizers of the AC joint.[3] For over 6 decades, open distal clavicle resection has been the "gold standard" for surgical treatment of symptomatic pathologic conditions of the acromioclavicular joint. Advancements in arthroscopic technology in the 1980s allowed the procedure to be performed arthroscopically by surgeons with advanced arthroscopic skills. Short- and long-term results of both open[4-6] and arthroscopic[7] distal clavicle resection have been promising. Despite the widespread use of a well-described arthroscopic technique,[8-10] the open distal clavicle resection technique remains the gold standard treatment of symptomatic conditions of the AC joint which fail conservative treatment. Open resection is a technically simple, rapidly performed procedure which can be performed through a small incision. With careful attention to patient selection and proper surgical technique, this procedure can be performed predictably with low morbidity, excellent patient satisfaction, and cosmetically acceptable results.[4,5] This paper reviews the normal anatomy and biomechanics of the AC joint and discusses the evaluation and treatment of pathologic AC joint conditions.

ANATOMY AND BIOMECHANICS OF THE AC JOINT

An understanding of the normal anatomy and biomechanics of the AC joint allows for an appreciation of the subtleties involved in the evaluation and treatment of pathologic conditions of this joint. The acromioclavicular joint is a diarthrodial joint, containing synovial fluid, lined with synovial membrane, and reinforced by a fibrous capsule and ligaments. At a young age, there exists a meniscal disk which degenerates with time and is usually little more than a remnant by adult age.[11] The joint functions to support the shoulder girdle as a strut. Although the clavicle may rotate up to 45° on its long axis, the majority of this motion occurs at the sternoclavicular joint, and only about 5° of rotation is allowed by an AC joint with intact mechanical stability.

Mechanical stability of the AC joint results from the sum of the joint capsule, a thick *superior* AC ligament, and the deltotrapezial fascia superiorly. Further stability is afforded by the smaller *inferior* AC ligament, which is confluent with the coracoacromial ligament on the undersurface of the AC joint and the medial acromion.[12-14] Klimkiewicz et al demonstrated that the thicker superior AC ligament provides 56% of the resistance to a posteriorly directed force.[15] Although the primary role of these capsular ligaments is to control motion in the AP plane, they have also been shown to prevent up to 68% of the total restraint to vertical displacement at low physiologic loads.[16] When high (traumatic) loads are applied to the joint, the more robust coracoclavicular ligaments restrain the vertical (primarily conoid ligament) and compression (primarily trapezoid ligament) vectors of AC joint relative motion.[17]

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PATHOLOGIC CONDITIONS OF THE AC JOINT

The AC joint is at risk for developing degenerative or inflammatory conditions similar to those seen in other diarthrodial joints. Its superficial location makes it vulnerable to injury, and the small surface area of the articulating surfaces must withstand high loads transmitted through the shoulder girdle, which are often repetitive in nature. In high-demand weight lifters, stresses generated across the AC joint are known to cause osteolysis.[18]

Osteoarthritis of the AC joint is a frequent cause of AC joint pain and is much more common than primary osteoarthritis of the glenohumeral joint.[19,20] However, radiographic evidence of joint degeneration does not correlate well with symptoms, and symptomatic AC joints may appear normal on imaging studies. In 100 asymptomatic shoulders, there was a 75% rate of degenerative changes on MRI.[21] Another study demonstrated that 57% of all elderly patients screened with plain film X-ray were found to have radiographic evidence of degenerative arthritis,[22] but the fact remains that *symptomatic* primary arthritis of the AC joint is much less common.[8]

Due to its vulnerable location and biomechanics, acute or repetitive trauma to the AC joint is common and often leads to posttraumatic degenerative changes. Even low-grade AC joint separations have been shown to lead to symptomatic degenerative changes in up to 42% of patients.[23,24] Clavicle fractures are unlikely to result in long-term degenerative changes of the AC joint unless the fracture extends intraarticularly or results in deformity which alters the mechanics of the AC joint.[25]

PRESENTATION AND PATIENT EVALUATION

HISTORY

Patients with a painful acromioclavicular joint generally present in their mid to late 30s and into their early 40s. There is a second subgroup of patients that present to our office in their mid to late 50s and early 60s. Patients may frequently recollect a previous injury to the shoulder, such as a grade 1 AC joint sprain in the remote past. The presentation in the late 50s implies a degenerative process over time. The patient's symptoms are often insidious in nature and diffuse in presentation and become more focal with time. The patient may note that the pain is sharp and/or dull, occasionally burning in nature. Patients can frequently place their finger directly onto the superior aspect of the shoulder directly onto the AC joint when asked to indicate the location of the pain. They may also report that the AC joint has become prominent over time, which is secondary to hypertrophic osteophyte formation. In contrast to subacromial referred pain which is characteristic of bursitis, partial or full thickness rotator cuff tears, and primary or secondary impingement syndrome, the location of the pain from a symptomatic AC joint is characteristically superior. AC joint pain may present in isolation or in combination with other shoulder problems. Patients with isolated AC joint pathology will often complain of pain radiating to the trapezius, the base of the neck, the deltoid, or even the upper arm in addition to being directly over the AC joint.[26] As a result of AC joint discomfort, patients frequently will splint their shoulder and may develop secondary trapezial spasm, which makes the location of pain more diffuse. We have frequently seen patients who have sought an opinion from a neurologist or spine surgeon with the presumed diagnosis of a "pinched nerve." They are often being evaluated and worked up for a herniated disc when, in fact, the radiating neck pain resulting from a trapezial spasm is secondary to the AC joint condition. Activities which require forward flexion or abduction/internal rotation may result in pain and it is critical to differentiate where the pain is localized.

Fig 1. Active cross-arm adduction test of the right shoulder will produce pain due to compression and rotation at the ipsilateral symptomatic AC joint.

Patients will report that symptoms are aggravated by either compression or rotation of the AC joint; most activities of daily living are a combination of theses two vectors. Pure AC joint compression can be caused by lying directly on the shoulder or by active adduction maneuvers across the body (Fig 1). Symptoms from dynamic cross-arm adduction activities may mimic unstable SLAP tears. For example, golfers may have a complaint of AC joint pain with follow-through maneuvers of the golf swing as they adduct, causing compression and rotation of the AC joint. Household activities, such as polishing a car, require repetitive compression and rotational maneuvers in an adducted position which may precipitate symptoms by compressing and rotating the AC joint. Lifting objects two-handed requires compression through the AC joint to stabilize an object and thus potentially aggravates AC joint symptoms. We note with many of our weight lifters that specific activities, such as push-ups, dips, and overhead and inclined presses may aggravate a painful AC joint. Patients may also note that AC joint pain is precipitated by internal rotation maneuvers, such as scratching the back,

or extremes of internal rotation, which rotates the relatively unloaded AC joint.

PHYSICAL EXAMINATION

The hallmarks of a painful AC joint are characterized by localized pain superiorly on the AC joint. Of note is that patients will frequently will place a finger directly on to the AC joint region while verbally describing their symptoms. A symptomatic AC joint is often prominent due to osteophyte formation, but an abnormal physical appearance of the AC joint does not always correlate with symptoms. A passive adduction crossover maneuver, which compresses the joint, generally will precipitate pain. If the patient complains of pain, it is critical to differentiate where the pain is localized as they may have symptoms referred to the coracoid process region or may have posterior shoulder pain when the rotator cuff is stretched. Passive internal rotation, produced by placing a patient's hand on his or her spine, may be limited secondary to pain and frequently may precipitate superior pain. Passive abduction may cause pain directly over the superior aspect of the AC joint as well.

The key to identifying symptomatic AC joint pathology is that if the patient's symptoms are localized superiorly to the AC joint, then most likely the AC joint is the culprit. For example, as previously mentioned, a positive impingement sign in forward flexion and internal rotation is not necessarily reflective of a subacromial process; localization of the pain superiorly implies AC joint pathology. It is critical to assess the patient for rotator cuff pathology as this may in fact coexist with the painful AC joint. Rotator cuff strength assessment includes external rotation, abduction, posterior lift-off, and belly-press testing. In addition, passive and active subacromial impingement testing is an important part of the evaluation of AC joint pathology. Evaluation for scapular dyskinesis should be performed as well. The bicipital groove should be palpated to assess whether there may in fact be localizing symptoms referable to the biceps tendon. Finally, provocative maneuvers for SLAP tears should be performed. Of particular note, the O'Brien test should be performed. In this maneuver, the arm is adducted and the hand hyperpronated to place the long biceps tendon on maximal stretch. A patient with a symptomatic SLAP tear will report pain with resistance to a downward force with the arm held in a forward flexed position. If this pain with resisted downward force is relieved with the shoulder adducted and the palm supinated, this is considered a positive O'Brien test. In our experience, patients with a symptomatic SLAP tear will frequently complain of popping and clicking within the joint and frequently note that the pain is a deeper rather than the more superficial pain associated with a painful AC joint. AC joint stability is an important feature in evaluating the symptomatic AC joint. Horizontal plane instability may be caused by previous surgery. One must also determine whether the patient has had a previous grade 2 or 3 AC joint separation, in which case a distal clavicle resection should not be performed as an isolated procedure, but rather in conjunction with a Weaver-Dunn procedure to provide coracoclavicular stabilization.

A clear understanding of a differential diagnosis for shoulder pain is helpful to avoid missing concomitant pathology. Rotator cuff impingement and intrinsic glenohumeral problems, such as SLAP tears, calcific tendonitis, or capsular tightness, can mimic or superimpose symptoms of AC joint pathology. In addition, inflammatory conditions of the AC joint, including gout, pseudogout, septic arthritis, and rheumatoid arthritis, should be considered and worked up appropriately. Neoplasms of the distal clavicle are rare but could include a myeloma or lymphoma in an adult or Ewing's sarcoma in a child.

IMAGING

Radiographic evaluation of the AC joint remains the gold standard of imaging. Zanca's technique of visualizing the AC joint calls for angling the beam 10 to 15° upward relative to the horizontal and decreasing the kilovoltage by 50%.[27] Reducing the kilovoltage is essential to obtaining accurate detail of the osseous anatomy of the distal clavicle. Radiographic findings of osteoarthritis include sclerosis, osteophytes, periarticular cystic lucencies, and joint space narrowing. Narrowing of the AC joint is normal with age, however; young adults have 1 to 3 mm of joint space, whereas asymptomatic patients over 60 years of age commonly have 0.5 mm of joint space.[28]

Additional radiographic views will provide information about acromion morphology and possible impingement in the supraspinatous outlet. An outlet view is obtained by angling the beam 10° downward relative to the horizontal and centering it over the scapular spine. An axillary view is a standard 90° opposed view which will provide information about possible displacement in the AP plane in a trauma setting or other pathology, such as an os acromiale, which may contribute to the patient's symptoms. Stress view radiographs are not indicated in the evaluation of AC joint degenerative pathology. Frequently, AC degenerative arthrosis may go undetected in the standard AP of the shoulder or AP of the glenohumeral joint radiographic views.

Other modalities of imaging include technetium-99 month bone scanning and MRI, but these modalities are needed only on unusual occasions. In a series of avid weight lifters with symptomatic AC joints, a technetium-99 bone scan was positive in 100% of 46 patients with distal clavicle osteolysis.[17] An MRI scan is very sensitive but not specific for symptomatic AC joint pathology; in one review, 75% of asymptomatic shoulders had "degenerative" changes in the AC joint by MRI.[20] For this reason, MRI is not indicated for routine evaluation of AC joint pathology. The more likely clinical scenario is that an MRI is obtained to evaluate other shoulder pathology and "abnormalities" of the AC joint are noted on MRI. If these MRI findings are asymptomatic they are not treated. MRIs of the AC joint reveal that the posterior aspect of the AC joint is narrower than the anterior. Occasionally, an intra-articular loose body or calcification may be appreciated as well by MRI. Reactive edema of the AC joint may be noted and has been implicated as a positive predictive factor in patients with a painful AC joint.[29]

INJECTION

AC joint injection is helpful in implicating the AC joint as the location of symptomatic pathology of AC joint symptoms.[9,30,31] Overall, our experience has been that although an AC joint injection may be of therapeutic value, it is more consistently helpful as a diagnostic tool. For a diagnostic injection, it is important that the patient is experiencing reproducible provocative AC joint compressive symptoms before administering the injection to allow for postinjection comparison. Tenderness to palpation is not sufficient, as this will not predictably change following AC joint injection. Under sterile conditions, the AC joint is injected with 1 to 2 mL of 1% lidocaine. This is performed from a direct superior approach, and due to the superficial location of the joint, a short 22-gauge needle should be used. Using a longer needle risks penetrating the inferior AC joint capsule, inadvertently infusing lidocaine into the subaromial space, which would confound the diagnostic value of the injection. Quality radiographs and an understanding of the common changes in morphology of the degenerative AC joint will facilitate accurate targeting of the joint space.[32] If the patient's previously reproducible symptoms are eliminated shortly after administering the injection, this is a positive test, implicating the AC joint as the location of the symptomatic pathology. In some series, a properly performed lidocaine injection test was nearly 100% predictive.[28,33]

TREATMENT OPTIONS

NON-OPERATIVE

Although there have been reports of improving AC joint symptoms with stretching and rotator cuff strengthening,[34] these techniques have not been reproduced and there is little evidence to support the use of formalized physical therapy to treat isolated AC joint arthritis. Cortisone injections have been reported to be effective, at least for a short while.[29,35,36] The same technique described to deliver a diagnostic lidocaine injection is used to deliver 1 mL of cortisone to the AC joint space. As with the diagnostic injection, a short needle is utilized to prevent inadvertent penetration of the subacromial space. In addition, caution must be used when injecting the AC joint with cortisone, because the superficial location of the joint may result in fat atrophy or depigmentation of the skin if the cortisone is injected before entering the joint. Ice, antiinflammatory medication, and activity modification are other basic tenets of nonoperative treatment. These nonoperative techniques are often effective, but occasionally surgical excision of the distal clavicle is necessary. Typically, if a patient has persistent symptoms which are consistent with AC joint pathology for greater than 6 months despite compliance with appropriate nonoperative treatment outlined above, surgical excision of the distal clavicle is recommended.

RATIONALE FOR OPEN SURGICAL TREATMENT

An open distal clavicle resection can be performed in a relaxed beach chair position, for example, at 20 to 30° of head elevation. For medically unstable patients or patients who become hypotensive in a standard elevated beach chair position due to cardiac conditions, an open distal clavicle resection may be preferable to arthroscopic resection. An open distal clavicle resection can be performed in an expedited fashion, often in less time than it takes to set up arthroscopy instrumentation and perform a diagnostic glenohumeral shoulder arthroscopy. OR charges related to an isolated open distal clavicle resection will be significantly less than those for an arthroscopically performed procedure.

Although when we perform AC joint resections arthroscopically we recognize that these patients are more comfortable in the early postoperative course, an open distal clavicle resection can easily be performed on an outpatient basis. In our experience, patients undergoing open distal clavicle resection frequently are able to sense a marked difference in the character of pain by the time the sutures are removed at 7 to 10 days postoperatively, and many patients have excellent active shoulder motion at that time. A 1- to 1.5-in. Saber incision directly over the AC joint is very cosmetically acceptable and it has been rare for patients to complain about the cosmetic aspects of their surgical scar. Unless the deltotrapezial fascia dehisces, it is extremely unusual to see a defect in the AC joint interval provided appropriate surgical closure is performed. In fact, if one sums the multiple puncture incisions placed for an arthroscopic distal clavicle excision, they approach and, in some situations, may even exceed the length of a single incision made over the superior aspect of the AC joint.

Performing an open distal clavicle resection obviates the need for performing an acromioplasty with every distal clavicle resection. Arthroscopic acromioplasty performed routinely with arthroscopic distal clavicle resection is not without a potential for morbidity, as it causes subacromial bleeding and may result in adhesions and postoperative adhesive capsulitis. In addition, use of multiple arthroscopic penetrations causes surgical trauma to the pericapsular tissues. It has been extremely rare following an open distal clavicle resection to see any significant loss of motion. As discussed above, the superior AC joint ligaments have been implicated as the primary restraints to AP translation. A carefully performed open distal clavicle resection repairs the tissues that have been sharply dissected and reflected. We do not violate the inferior capsular structures and perform a subcapsular and subperiosteal dissection to mobilize and expose the distal clavicle. While performing an arthroscopic distal clavicle resection, the inferior capsular structures are removed, and it is occasionally necessary to establish multiple portals to address the arthroscopic distal clavicle resection. A modified Neviser approach, a modified anterosuperior portal, and occasionally a direct superior portal are used, which result in perforation through the capsular structures.

OPERATIVE: OPEN DISTAL CLAVICLE RESECTION

Surgical Technique

This is routinely performed as an outpatient procedure. The patient is positioned initially supine on the table and

Fig 2. A Saber incision 1 to 1.5 in. in length is made directly over the AC joint region.

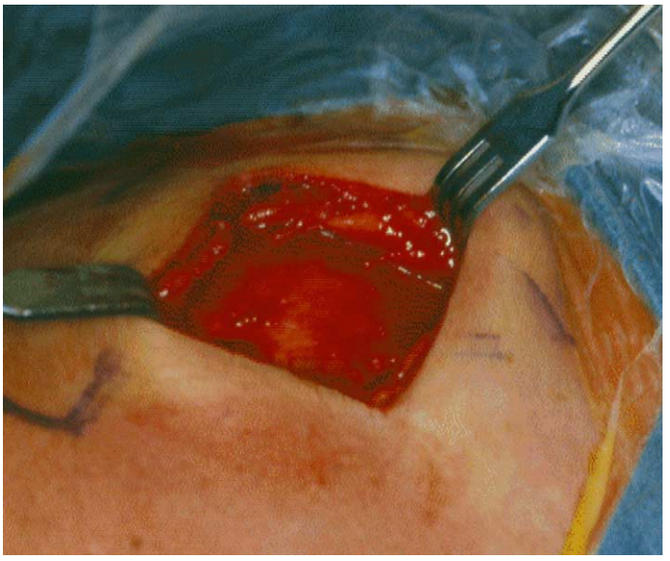

Fig 3. The subcutaneous tissues over the AC joint of a right shoulder are elevated and small rake retractors are used to retract the skin edges.

examination under anesthesia is performed to assess for adhesive capsulitis or occult shoulder instability. The patient is then carefully positioned in a modified beach chair position. SCD boots are applied on the lower legs for deep vein thrombosis prophylaxis. The waist and foot of the table are slightly flexed. The torso is brought to the edge of the OR table and stabilized with a lateral post. The head is secured on a foam donut, stabilized with a towel, and secured with tape over the forehead region. The patient's back is elevated to between 20 and 30°. The anatomic landmarks are marked with a sterile marking pen. Preoperative prophylactic antibiotics are administered intravenously before skin incision. Generally 1 g of Cephalosporin is used unless the patient is penicillin- or Cephalosporin-sensitive, in which case an adult receives 600 mg of Clindamycin. A Saber incision, 1 to 1.5 in. in length, is made directly over the AC joint region (Fig 2). Transverse incisions, in our opinion, should not be performed as this does not provide any advantage and the cosmetic aspect of the scar is significantly worse. The skin is incised and infiltrated with a dilute epinephrine–Marcaine solution. The subcutaneous tissues are dissected and elevated and small rake retractors are used to retract the skin edges (Fig 3). The dissection is carried directly down to the AC joint, which is identified by finger palpation and then confirmed with placement of a needle into the AC joint. Electrocautery is then used to incise the periosteum and capsule directly in the midplane of the clavicle. A technical error is to perform this too far anterior or posterior, where the tissues appear to be thinner and are more difficult to repair at closure. The periosteal incision is performed 1 in. medial to the AC joint and a subperiosteal and subcapsular reflection is performed with electrocautery. This, therefore, creates anterior and posterior deltotrapezial tissue flaps. The AC joint is entered and, after mobilization of the periosteal and capsular tissue, small Homan retractors are placed anterior and posterior to protect the inferior aspect of the AC joint region. A No. 238 oscillating saw blade is then used. This blade is 10 mm wide and can be helpful in estimating the amount of resection. Although the classic descriptions of distal clavicle resection by Mumford[1] and Gurd[2] in 1941 recommended a 1-in. resection, we generally perform a 0.5-in. resection. This approximates a 12- to 14-mm resection. As is discussed below, the trend arthroscopically has been to resect increasingly smaller amounts of clavicle. However, we have had a number of patients referred to our office after failed arthroscopic distal clavicle resections who have had incomplete AC joint resection, particularly posteriorly and superiorly. A distal clavicle resection is performed with the oscillating saw blade (Fig 4), and the resected specimen is then grasped with a

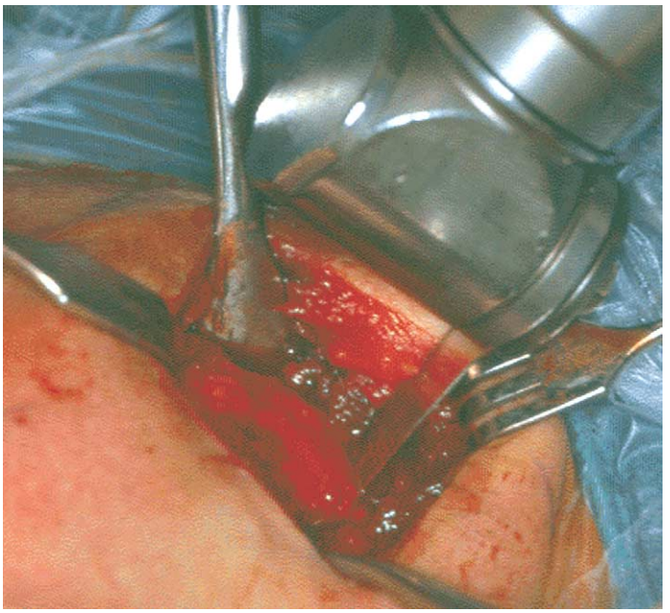

Fig 4. A distal clavicle resection in the right shoulder is shown being performed with a 10-mm No. 238 oscillating saw blade.

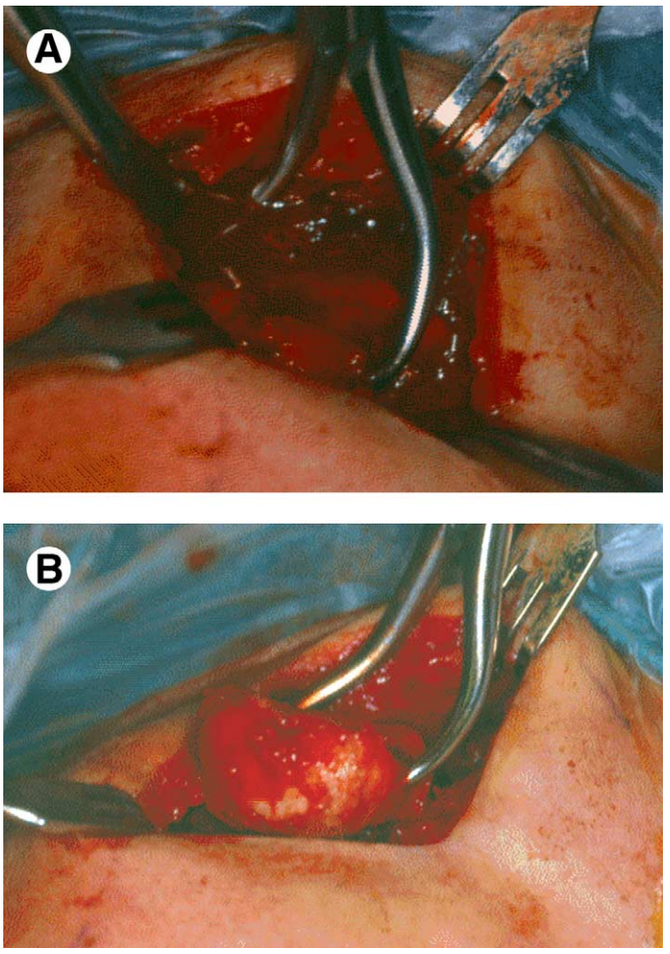

Fig 5. The resected specimen is grasped with a towel clip (A) and removed in its entirety from the right shoulder (B).

towel clip and removed in its entirety (Fig 5A,B). Traction is placed on this while electrocautery is then used to reflect the remaining inferior capsular tissues. The specimen is inspected and measured in the mediolateral, AP, and caudal cephalad directions. The articular surface is inspected and palpated for articular degeneration and is sent to pathology. A measurement is made of the resulting gap in the AC joint, and a cross-arm adduction maneuver is performed while inspecting the AC joint for residual impingement. Direct palpation of the anterior and posterior edges of the clavicle through the resulting gap will assure that no residual impingement remains (Fig 6A,B). Some surgeons[37] perform the procedure under local anesthetic, so that the patient may perform an active dynamic loading of the joint before completion of the case. The wounds are irrigated and a small amount of sterile bone wax is placed on the distal clavicle resection margin.

Attention to detail is important during fascia and wound closure. A No. 2 braided nonabsorbable suture is placed in a figure-of-eight fashion, with multiple stitches placed in the deltotrapezial capsular tissues. This is tied at the conclusion of placement of sutures rather than individually. The arm is forward elevated and this helps takes tension off the deltotrapezial capsular closure. Any defect in the fascia should be closed at this point. Some surgeons prefer incorporating the AC joint meniscus, if present, into this repair as a soft tissue bumper. The subcutaneous tissue is closed with a nonabsorbable suture and the skin is closed with a running subcuticular nylon suture. Marcaine is injected into the subacromial space and surgical wound region. Sterile dressings are applied and the patient is placed in a sling. The senior author has performed this operation for over 17 years on an outpatient basis.

There may be occasions when the patient has a combination of subacromial and AC joint symptoms. In these situations, an arthroscopic acromioplasty and arthroscopic distal clavicle resection are performed. If patients have a rotator cuff tear that requires repair, we will frequently perform the acromioplasty and distal clavicle resection arthroscopically and perform the rotator cuff repair as a miniopen technique. If the tear is extremely small, then we may reverse our treatment algorithm and repair the rotator cuff reconstruction arthroscopically along with an arthroscopic acromioplasty and perform an open distal clavicle resection. Specifically, distal clavicle resections in patients who have wide clavicles in the AP plane exceeding 25 mm or patients with significant medical issues will likely be performed as open procedures.

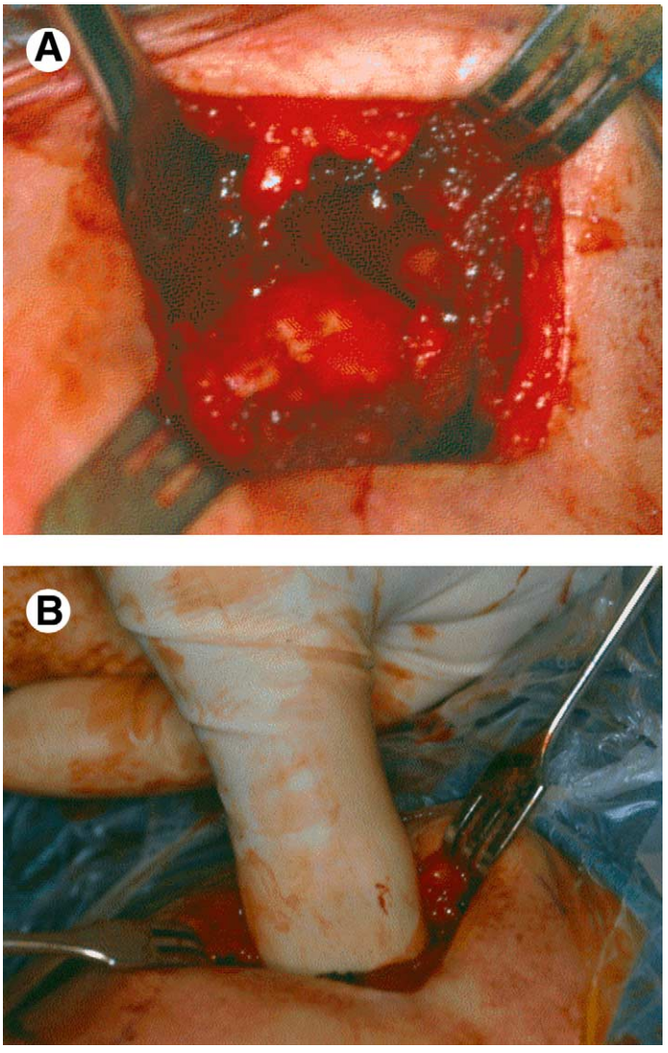

Fig 6. Through the resulting gap (A), direct palpation of the anterior and posterior edges of the distal right clavicle will assure that no residual impingement remains (B).

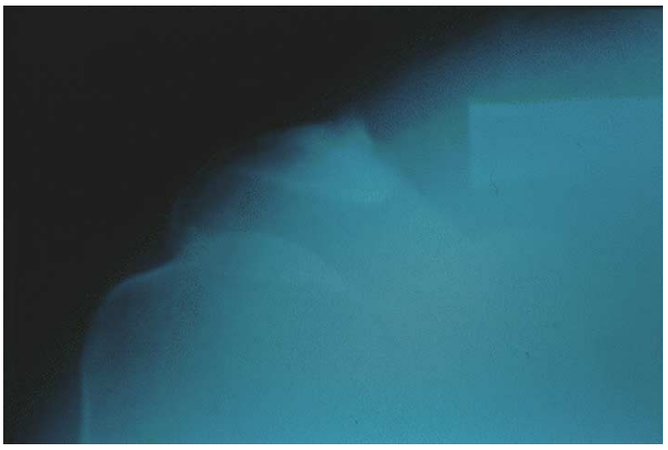

Fig 7. Zanca view of the right shoulder, obtained by angling the beam 10 to 15° upward relative to the horizontal and decreasing the kilovoltage by 50%.

POSTOPERATIVE MANAGEMENT

An isolated distal clavicle resection is treated symptomatically postoperatively with antiinflammatory medications, a short course of narcotic medications, and ice. These procedures are performed on an outpatient basis, and patients are advised that they will be more comfortable if they sleep in a recliner type of chair or in a bed with their shoulder propped up with pillows. They begin pendulum activities the day after surgery along with assisted supine elevation and assisted external rotation exercises. We use pain symptoms as a guideline for progression to active range of motion. Sutures are removed 10 days postoperatively and a Zanca view (Fig 7) is obtained to assess the adequacy of the distal clavicle resection. Patients are progressed to active range of motion as tolerated and referred to supervised physical therapy. Postoperative rehabilitation is directed toward recovery of passive and active range of motion followed by closed chain and scapular strengthening exercises and rotator cuff strengthening exercises utilizing Theraband (The Hygenic Corporation, Akron, OH) type devices. A frequent observation is that the patient's symptoms are significantly improved compared with their preoperative condition 10 days postoperatively. Additionally, those patients who had associated trapezial spasm frequently indicate that those symptoms are resolved as well. Depending on the sports or work activity, patients may return to athletics between 6 and 8 weeks. A 3-month time interval is generally used for "maximum medical improvement" in the Worker's Compensation subgroup.

OUTCOMES FROM OPEN DCR

Outcomes following distal clavicle resection demonstrate a predictable benefit to properly selected patients, when proper surgical technique is followed. Early results raised concerns of loss of strength with disruption of the AC joint following trauma to the joint[38] or postsurgical excision of the distal clavicle.[4] Walsh and coworkers examined shoulder strength following grade II AC joint injuries and found weakness in abduction at 240°/s. In 1988, Cook and coworkers evaluated 23 athletes an average of 3.7 years following open distal clavicle excision and demonstrated weakness in extension and flexion at 60°/s, but not at 240°/s. In this group, after an average of 1.9 cm of bone was removed by X-ray, 70% (16/23) returned to the preoperative level of athletic participation, with the most common complaint being a loss of bench-press strength.[35] Peterson found no weakness to manual muscle testing in a 3- to 30- year follow-up.[39]

In 1995, Novak et al[5] published the results of 23 open distal clavicle resections in 21 patients at an average of 30 months following surgery. In this series, cybex testing demonstrated no significant difference in the strength of the operative side compared with the nonoperative side in any direction at any rate of motion. They found a highly variable time to return to work (1 to 365 days). Workman's Compensation patients and patients whose case was involved in litigation had longer delays to return to work and lower HSS shoulder scores. The subgroup with a traumatic etiology of AC joint pathology had poorer postoperative results, but when patients with Workman's Compensation were removed from the traumatic group, the remaining traumatic group was not statistically different from the atraumatic group. In their series, there were no patients with cephalad migration of the distal clavicle relative to the medial acromion. They identified the crucial importance of a secure, anatomic closure of the deltotrapezial fascia. They concluded that good to excellent results can be routinely achieved following open distal clavicle excision in properly selected patients by following proper surgical technique.

In 1997, Eskola and coworkers[6] reviewed 73 patients following open distal clavicle resection for indications ranging from primary osteoarthritis of the AC joint to traumatic separation and AC joint pain following healed lateral one-third clavicle fractures. In this series, patients were evaluated at an average of 9 years, and the results were 29% (21/73) good, 39% (29/73) satisfactory, and 31% (23/73) poor. Poor results were statistically more common in the fracture group, and there were higher pain ratings and poorer outcomes if more than 10 mm of bone was resected from the distal clavicle. From their findings they recommended carefully identifying the etiology of the AC joint symptoms when selecting patients for distal clavicle resection and not resecting more than 10 mm of bone from the distal clavicle from those patients requiring surgery.

Poorer results following distal clavicle resection have been associated with destabilization of the AC joint.[40] Cadaver studies have implicated both the superior AC ligament[14] and the trapezoid coracoclavicular ligament[15,41] as the primary restraints to both axial posterior and superior instability and the deltotrapezial fascia and a secondary restraint.[3,42] The destabilization effect is eliminated or minimized if these structures are respected and repaired anatomically.[5,39] In addition, there is more recent evidence[43] that adequate acromioclavicular joint decompression can be performed with only 5 mm of distal clavicle excision, and this small amount of bone removal minimizes destabilization of the acromioclavicular joint.

Causes for failure or suboptimal outcomes are no doubt related to proper patient selection, as outlined above. Other complications which have been reported after open and arthroscopic distal clavicle resection include superficial wound infections,[4,8,44] painful scar formation,[37,42] and distal clavicle regeneration.[44] Another sequela seen in association with distal clavicle resection is heterotopic ossification at the site of the resection.[45] Symptomatic heterotopic ossification is less common, but has been reported as a cause of failure after both open and arthroscopic procedures.[39,42,46]

In addition, careful technique is required to avoid inadvertently leaving bone impacting the AC joint. It has been demonstrated that as little as 4 mm of bone may allow for decompression of the joint,[17,20,35] but most authors recommend 1 cm as a guideline to adequately decompress the joint while minimizing the risk of destabilizing the joint. Regardless of whether the distal clavicle excision is performed open or arthroscopically, attention must be paid to assuring that an even, smooth cut is made from anterior to posterior, with no residual abutment. Inadequate resection more often occurs when the procedure is performed arthroscopically by less experienced surgeons. This is usually due to retained posterior cortical ridges or uneven resection.[34,47]

In summary, symptomatic relief of AC pathology and return to preoperative functional levels is consistently possible in properly selected patients following open distal clavicle resection. This requires adequate and complete but not excessive distal clavicle excision to decompress the acromioclavicular joint while preserving its primary and secondary stabilizers during the surgical exposure and anatomic closure.

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