Painful Conditions of the Acromioclavicular Joint

Benjamin S. Shaffer, MD

Abstract

The acromioclavicular (AC) joint may be affected by a number of pathologic processes, most commonly osteoarthritis, posttraumatic arthritis, and distal clavicle osteolysis. The correct diagnosis of a problem can usually be deduced from a thorough history, physical examination, and radiologic evaluation. Asymptomatic AC joint degeneration is frequent and does not always correlate with the presence of symptoms. Selective lidocaine injection enhances diagnostic accuracy and may correlate with surgical outcome. Nonoperative treatment is helpful for most patients, although those with osteolysis may have to modify their activities. In appropriately selected patients, open or arthroscopic distal clavicle resection is necessary to relieve symptoms. Recent biomechanical and clinical data emphasize the importance of capsular preservation and minimization of bone resection; however, the optimal amount of distal clavicle resection remains elusive. Patients with AC joint instability have poor results after distal clavicle resection.

J Am Acad Orthop Surg 1999;7:176-188

The acromioclavicular (AC) joint is a relatively frequent source of clinical symptoms, most often due to primary osteoarthritis, posttraumatic arthritis, or distal clavicle osteolysis. These processes disrupt the normal anatomy and functional biomechanics of the AC joint. This article will focus on the specific techniques of evaluation necessary to differentiate symptoms referable to the AC joint from those related to pathologic changes in other areas of the shoulder girdle, as well as specific treatment strategies for management of conditions involving the AC joint.

Functional Anatomy and Biomechanics

The AC joint is a diarthrodial joint, which supports the shoulder girdle through the clavicular "strut." It connects the oval, convex distal clavicle with the somewhat incongruous concave acromial facet. Between the hyaline-cartilage articular surfaces there is a fibrocartilaginous meniscal disk of variable integrity. Degeneration of the AC joint is a natural consequence of the aging process, with disk degeneration occurring as early as the second decade.[1] By early adulthood, most intra-articular disks are little more than fibrocartilaginous remnants.

The capsule surrounding the joint has a synovial lining and is reinforced superiorly by the relatively thick superior AC ligament, and the confluent deltoid and trapezius fasciae. Inferiorly, the coracoacromial ligament blends with the less stout inferior AC ligament (Fig. 1). The AC ligament complex reinforcing the joint capsule plays an important role in maintaining joint stability.[2-5] The AC capsular ligaments are predominantly responsible for maintaining stability in the anteroposterior (AP) plane.[6] These ligaments also provide most (68%) of the restraint to superior translation of the clavicle with small (physiologic) displacements.[6] The AC joint complex is further supported by the conoid and trapezoid ligaments, which extend from the coracoid to the undersurface of the clavicle. During large displacements, the conoid ligament provides the greater portion of superior-inferior stability (62%). The trapezoid serves as the primary restraint (75%) to compression of the AC joint.

Despite the fact that the clavicle rotates as much as 45 degrees about its axis, almost all clavicular motion takes place at the sternoclavicular articulation. Motion at the AC joint is limited to 5 to 8 degrees, predominantly because of synchronous scapuloclavicular motion, in which the clavicle and scapula move as a unit.[7]

Dr. Shaffer is Assistant Professor, Department of Orthopaedic Surgery, Georgetown University Medical Center, Washington, DC.

Reprint requests: Dr. Shaffer, Department of Orthopaedics, Georgetown University Medical Center, 3800 Reservoir Road NW, Washington, DC 20007.

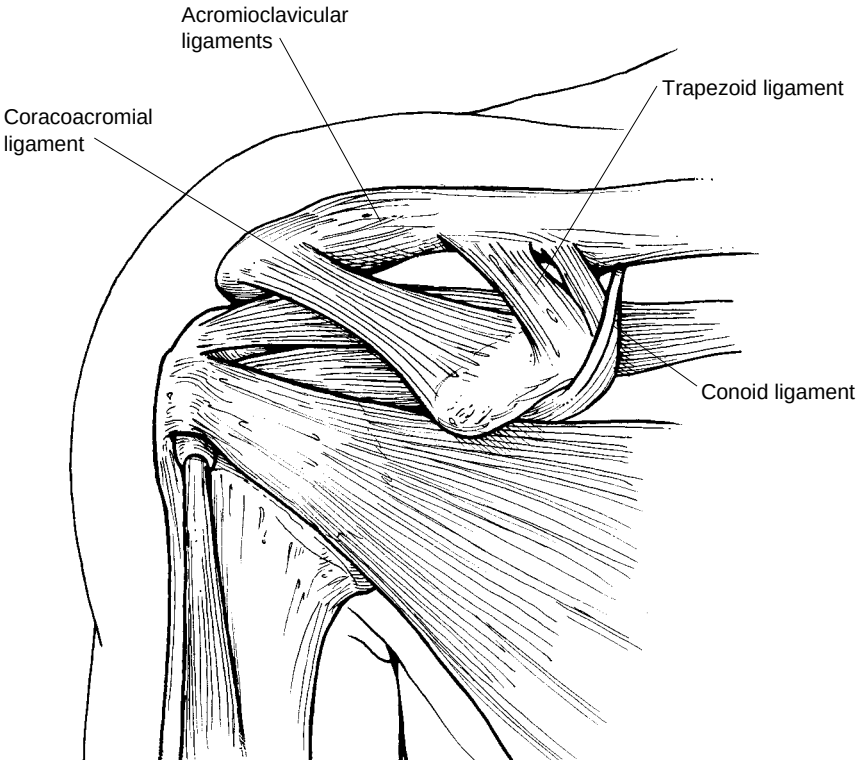

Fig. 1 The acromioclavicular complex is composed of the acromioclavicular ligaments and the coracoclavicular ligaments (conoid and trapezoid).

Common Problems of the Acromioclavicular Joint

The combination of three factors underlies the frequency of problems of the AC joint. First, because it is a diarthrodial joint, it is vulnerable to the same processes affecting other joints in the body, such as degenerative osteoarthritis, infections, and inflammatory and crystalline arthritis. Second, its superficial location and its relationship to the shoulder girdle predispose it to traumatic injury. Third, the biomechanics of the shoulder girdle require the AC joint to transmit large loads across a very small surface area, which can result in failure with repetitive activity or overuse. In addition, the modern emphasis on weight training and upper-extremity strengthening further stresses the AC joint, which, according to Cahill,[8] is often the weak link in the shoulder girdle.

Primary Osteoarthritis

In comparison to the rate of occurrence in the knee and hip, primary osteoarthritis in the shoulder is relatively rare.[9] However, primary involvement of the AC joint is much more common than primary involvement of the glenohumeral joint and is, in fact, the most common cause of pain in the AC joint.[10] The true incidence is unknown, in part because of differences in the criteria used to define arthritis in various studies. Using morphologic criteria, DePalma et al[11] demonstrated degenerative changes by the fourth decade in the majority of AC joint specimens obtained from 151 patients. In one study,[12] 54% to 57% of elderly patients demonstrated radiographic evidence of degenerative arthritis. In another study,[13] magnetic resonance (MR) imaging demonstrated evidence of arthritic changes in 48% of the AC joints in over 300 older asymptomatic patients.[13]

Despite its seeming prevalence by radiologic criteria, symptomatic primary osteoarthritis is a relatively uncommon clinical entity.[14] Osteoarthritis of the AC joint may be associated with other shoulder disorders and must be considered when evaluating any shoulder problem, especially rotator cuff impingement. The proximity of the AC joint to the subacromial space may lead to clinical overlap in the symptom complex.

Posttraumatic Arthritis

Acromioclavicular arthritis following trauma is even more common than primary osteoarthritis, due to the frequency of injury to this vulnerable joint. The incidence of posttraumatic arthritis symptoms after injury or surgery is highly variable and depends on the degree of injury and the type of operative procedure. Studies of the natural history of grade I and II sprains of the AC joint have demonstrated the development of symptoms in 8% to 42% of patients.[15,16] Arthritis also occurs, although less commonly, after distal clavicle fractures, particularly those with intra-articular extension.[17] Operative procedures for AC joint dislocations in which the AC joint is preserved or transfixed have been associated with a higher incidence of arthritis than those in which the joint is sacrificed (i.e., Weaver-Dunn procedure).

Distal Clavicle Osteolysis

An increasingly recognized but still infrequent entity that causes AC joint symptoms is distal clavicle osteolysis. Osteolysis related to repetitive microtrauma has recently been receiving more attention, particularly among weight-lifting ath-

letes.[8,18] This condition is thought to be growing in frequency due to the popularity of weight-training and its incorporation into fitness programs and training regimens for other sports. The proposed mechanism of this form of osteolysis is that repetitive stresses to the subchondral bone of the distal clavicle lead to fatigue failure, which initiates resorption. The histologic features of microscopic fractures, demineralization, subchondral cysts, and distal clavicle erosion have been described.[19,20]

Evaluation and Diagnosis

Presentation

Acromioclavicular joint problems can present either in isolation or in conjunction with associated pathologic conditions, most commonly rotator cuff impingement. The patient with an isolated AC joint lesion usually notes discomfort or aching over the anterior and/or superior aspect of the shoulder. The pain occasionally radiates into the base of the neck, the trapezius, and the deltoid and down the arm. Hypertonic saline injections in normal volunteers have elicited the sometimes vague and occasionally radicular pain pattern typical of AC joint involvement.[21]

Pain is often brought on by activities of daily living, such as washing the opposite axilla, reaching back to retrieve a wallet, or fastening or unhooking a brassiere. Symptoms are often exacerbated by more demanding activities, such as pushing or overhead work in the case of laborers and weight lifting, golfing, swimming, or throwing in athletes. Among athletes involved in weight training, pain is typically brought on by specific exercises, such as bench presses, dips, and push-ups.[8,18] Patients may note pain at night, with nocturnal awakening when rolling onto the affected shoulder. There may be associated symptoms of popping, catching, or grinding. A history of trauma is important because residual instability following AC joint trauma may complicate treatment.

Physical Examination

Inspection of the affected extremity may reveal joint prominence or asymmetry, and palpation over the AC joint may elicit tenderness. Provocative tests, such as reaching across to touch the opposite shoulder or placing the hand behind the back, may elicit discomfort. Active motion of the shoulder may cause crepitus, which must be localized to differentiate it from subacromial crepitus.

Motion is rarely restricted, although in long-standing cases acquired mild restriction of internal rotation and/or cross-body adduction may develop. Restriction should be documented by comparing motion in both shoulders. More significant restriction in the affected shoulder suggests adhesive capsulitis or glenohumeral osteoarthritis.

The most reliable provocative physical examination is the cross-body adduction test, in which the arm on the affected side is elevated 90 degrees and the examiner then grasps the elbow and adducts the arm across the body (Fig. 2). Reproduction of pain over the AC joint is suggestive of, although not specific for, an AC joint lesion. This test may also be positive in patients with subacromial impingement and may cause discomfort posteriorly in patients with posterior capsular tightness.

Abnormal mobility of the distal clavicle can be elicited by manipulating the distal clavicle with the thumb and index finger while stabilizing the acromion with the other hand. The detection of abnormal translation or provocation of pain during loading may indicate instability or arthritis.

Radiologic Evaluation

Standard AP views of the shoulder are usually inadequate to clearly visualize the AC joint. Zanca[22] described a modified technique that provides a clear, unobstructed view of the distal clavicle and AC joint (Fig. 3). This projection is obtained by angling the x-ray beam 10 to 15 degrees superiorly and decreasing the kilovoltage to about 50% of that used for a standard glenohumeral exposure.

Patients with primary or posttraumatic degenerative arthritis will have findings of arthritic changes seen in other joints, which include sclerosis, osteophyte formation, subchondral cysts, and joint space narrowing (Fig. 4). Narrowing is probably the least significant finding, as progressive narrowing normally occurs due to aging. In younger individuals, the joint is 1 to 3 mm in width, whereas a joint space of 0.5 mm or less is common in patients over the age of 60.[23]

In distal clavicle osteolysis, radiographs show rarefaction or relative osteopenia, loss of subchondral bone detail, tapering or enlargement

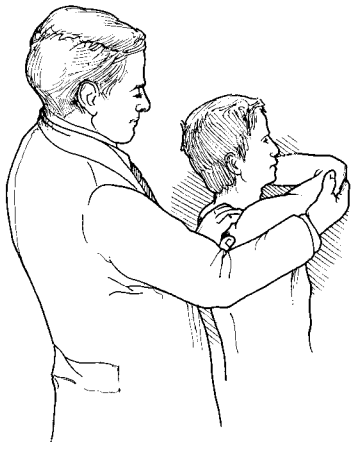

Fig. 2 The cross-body adduction test is performed by elevating the arm 90 degrees, gently grasping the patient's elbow, and adducting the arm across the body. Reproduction of pain over the joint suggests pathologic changes.

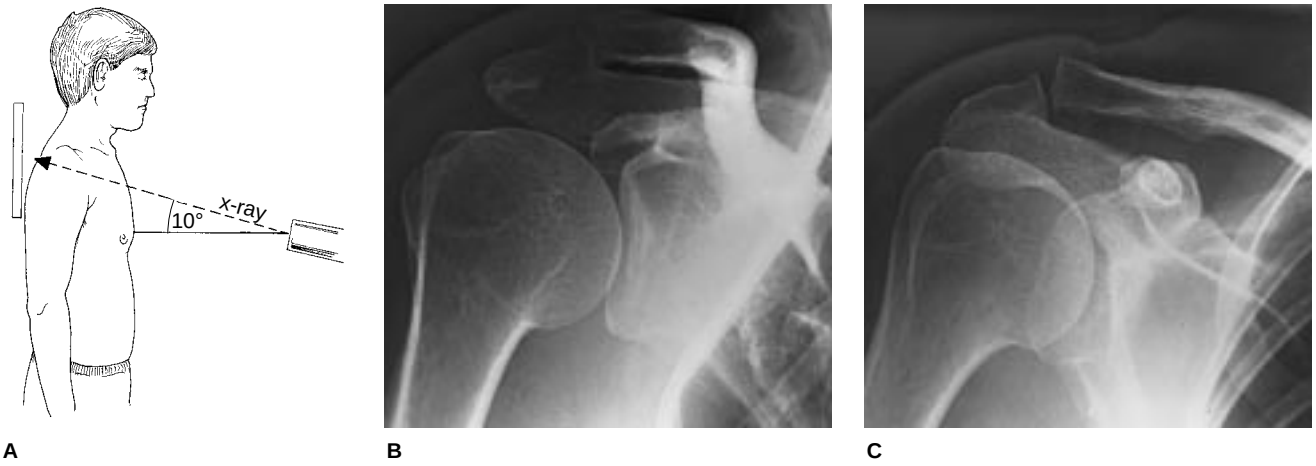

Fig. 3 **A,** The Zanca view of the AC joint is obtained by angling the x-ray beam 10 to 15 degrees in the cephalic direction and decreasing the kilovoltage by half. **B,** This AP view of the shoulder demonstrates the glenohumeral joint anatomy but is overpenetrated and fails to demonstrate the AC joint well. **C,** This Zanca view better depicts the soft-tissue and joint detail of the AC joint; however, the glenohumeral joint is no longer well visualized.

of the distal clavicle, and actual widening of the joint space (Fig. 5). The findings in one study[23] indicate that enlargement of the joint space beyond 6 mm in women and 7 mm in men may be pathologic.

An axillary lateral view may help identify posterior displacement after a traumatic injury and determine the adequacy of distal clavicle resection postoperatively. An outlet view, taken by angling the beam 10 degrees inferiorly and centering over the scapular spine, has been described for evaluation of patients with impingement. In patients with clinical overlap, this view may help demonstrate outlet compromise due to projection of osteophytes from the distal clavicle or AC joint or attributable to abnormal acromial morphology.

Stress views are not routinely helpful, nor are they indicated in the workup of the patient with AC joint osteoarthritis or osteolysis. However, in patients with a history of trauma and suspected instability, radiographs taken while dynamically stressing the joint may be diagnostic. Superior-inferior instability can be elicited by obtaining a Zanca view while applying inferior traction on the arm. Anterior-posterior laxity can be seen on an axillary view obtained with application of a posteriorly directed force on the distal clavicle. Residual abutment or abnormal medial-lateral excursion may be visualized by having the patient perform an active cross-body adduction maneuver while a Zanca view is obtained. Comparison to the opposite side should help determine the significance of any translation. The detection of such instability is important in treatment planning, so as to avoid surgical procedures that may exacerbate symptoms (i.e., isolated distal clavicle resection).

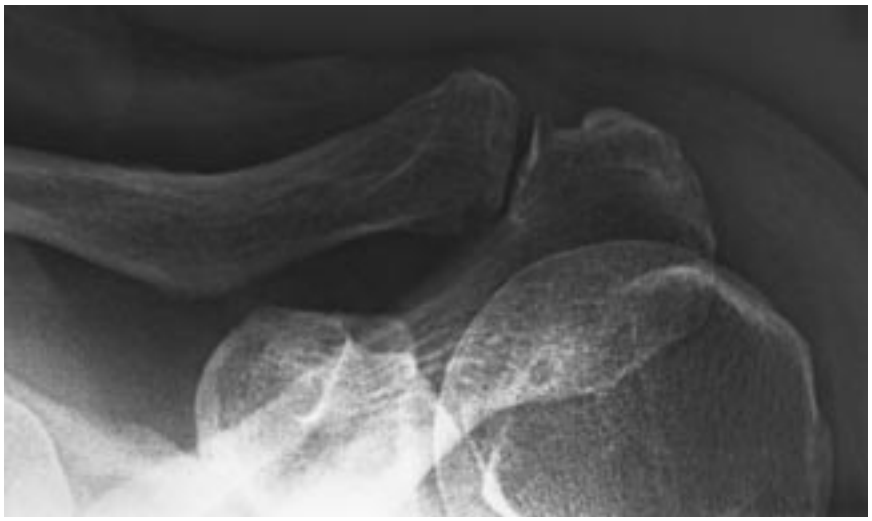

Fig. 4 This Zanca view demonstrates the typical radiographic findings of arthritis, including joint-space irregularity, sclerosis, subchondral cyst formation, and the presence of an osteophyte on the acromial facet.

Fig. 5 The "washed out" appearance typical of the expanded distal clavicle with subchondral osteopenia is seen in this radiograph of a 28-year-old gymnast with distal clavicle osteolysis.

Three-phase technetium-99m bone scanning has proved very helpful in demonstrating AC joint lesions not detected with conventional radiography.[8] Scanning is most commonly indicated for the young to middle-aged active patient whose symptoms and physical findings are not corroborated by plain radiography. In one study of 46 patients with distal clavicle osteolysis, scans were positive in 100%.[8]

Magnetic resonance imaging is very sensitive in identifying abnormalities of the AC joint, but these changes often do not correlate with physical findings. In one study of asymptomatic volunteers, findings indicative of AC joint arthritis were present in 75% of shoulders.[13] The nonspecificity of MR imaging precludes it from being useful in the evaluation of patients with AC joint symptoms.

Joint Injection

Diagnostic uncertainty can be resolved through direct injection of local anesthetic into the AC joint.[20] Elimination of pain within a few minutes of the injection confirms the AC joint as the source of the patient's symptoms and is considered by many authors to be the most valuable diagnostic tool.[24,25] Relief after an injection is also considered the most accurate prognostic indicator of success with distal clavicle resection.[20,26] However, for this test to be effective, the patient must be symptomatic or the symptoms must be elicitable before the injection. Tenderness to palpation as the only physical finding is insufficient. Provocation by cross-body adduction or stress, such as occurs with push-ups, may bring on the pain. If symptoms cannot be generated, the injection test should not be performed, as it will not yield useful information. The patient may need to return when symptomatic or may need to schedule a return appointment that will follow the provocative activity.

After the joint has been palpated and outlined with a marker, the shoulder is prepared, using a broad enough area to permit palpation during the injection. A 23-gauge needle is directed into the joint from a superior approach (Fig. 6), and 1 to 2 mL of 1% lidocaine is instilled. With gentle pressure, a pop or sudden change in resistance is felt as the needle penetrates the capsule. Easy free flow confirms joint entry. Resistance to needle advancement or injection warrants redirection of the needle. Because of the subcutaneous location of the joint, a short needle is usually sufficient to enter the joint. A longer needle may be inadvertently passed through the joint, resulting in injection into the subacromial space, which can cause diagnostic confusion.

Persistence of symptoms after injection suggests the presence of alternative or additional pathologic changes or failure to target the joint. The most common alternative to consider is rotator cuff impingement. A second injection directed into the subacromial space may help clarify the role of the rotator cuff in the patient's symptoms.

Injection into the AC joint may be unsuccessful due to difficulty in targeting. Variability in the obliquity of the joint, sometimes combined with substantial narrowing and osteophyte formation, can make targeting challenging. Most joints are inclined from superolateral to inferomedial in the coronal plane. A smaller number are vertically oriented, and even fewer are incongruent, with the clavicle either superior or inferior to the acromion.[27] Having the radiographs available during the injection optimizes the likelihood of successful joint entry.

Differential Diagnosis

The differential diagnosis of an AC joint disorder includes a number of conditions specific to the AC joint and other conditions that can refer pain to the area. The most common condition in the differential diagno-

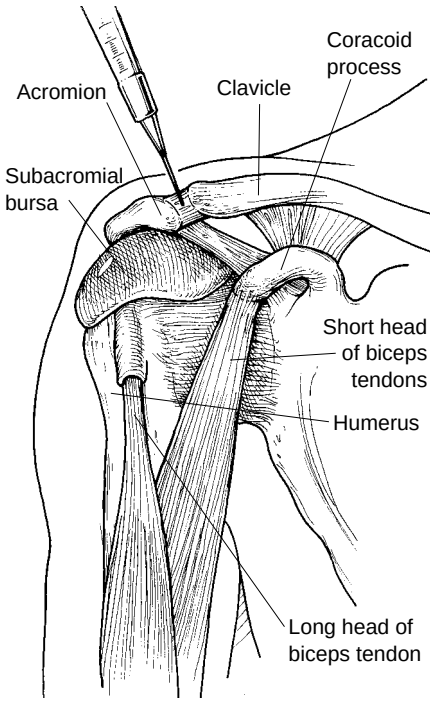

Fig. 6 Direct injection into the AC joint through a superior approach.

sis is another intrinsic shoulder problem, such as rotator cuff impingement. The location of the AC joint immediately above the subacromial space explains its contribution to impingement due to joint hypertrophy or osteophyte formation. Not surprisingly, this leads to clinical overlap in presentation and diagnostic difficulty in distinguishing the contribution of the AC joint from that attributable to the subacromial space.[20] Physical examination, radiography, and the lidocaine injection test, when necessary, can usually help differentiate these conditions.

Common intrinsic shoulder problems include calcific tendinitis, early adhesive capsulitis, and glenohumeral arthritis. Other conditions that can specifically affect the AC joint include rheumatoid arthritis, crystal-induced arthritis (gout and pseudogout), septic arthritis, and (uncommonly) hyperparathyroidism. Ganglia and cysts of the AC joint have also been described, with visible and palpable masses protruding above the joint. These are often in association with large rotator cuff tears and necessitate appropriate evaluation rather than routine resection.

Musculoskeletal tumors of the distal clavicle and proximal acromion are uncommon but must be considered in the differential diagnosis, particularly in the patient with night pain or pain at rest and systemic symptoms. Examples of such neoplasms include Ewing's sarcoma in a child and myeloma or lymphoma in an adult patient.

The differential must also include extrinsic conditions that can mimic shoulder lesions. Referred symptoms may be attributable to a cervical spine disorder (e.g., disk disease, spondylosis) or visceral afferent stimulation due to cardiac, pulmonary, or gastrointestinal disorders.

Treatment Options

Treatment of AC joint arthritis or osteolysis depends more on the particular patient than on the specific diagnosis. As with any medical condition, treatment decision making must incorporate many factors, including the patient's age, activity level, shoulder dominance, occupation, degree of activity restriction and/or athletic disability, and goals. For example, what is tolerable to an older patient with mild degenerative osteoarthritis of the nondominant AC joint may be perceived as crippling by a young athlete with AC joint osteolysis. Treatment options available are similar for patients with osteoarthritis, posttraumatic arthritis, and distal clavicle osteolysis.

Nonoperative Treatment

Initial treatment of the painful osteoarthritic or osteolytic AC joint is nonoperative. Options include activity modification, moist heat, nonsteroidal anti-inflammatory medications, corticosteroid injections, and physical therapy.

Activity modification involves avoidance of inciting activities. For younger patients, this usually involves at least a temporary change in exercise routine, eliminating bench presses, dips, flies, and push-ups. Sometimes, merely changing the grip distance on the bar during bench pressing is sufficient to permanently relieve symptoms.[8]

For the few patients with restricted motion or concomitant impingement, physical therapy may have a role. Restoring normal flexibility and strengthening the cuff have been reported to eliminate symptoms in the AC joint.[28] However, there is little evidence to support the role of formal therapy in most cases of isolated AC arthritis or osteolysis.

Many authors have found intra-articular injections of cortisone effective.[25,29,30] After carefully palpating and marking the joint line, the area is thoroughly prepared, and a combination of 1 mL of lidocaine and 1 mL of intermediate- or long-acting betamethasone is infiltrated into the AC joint. Patients are cautioned to avoid provocative activity for 1 week. Most authors recommend a total of no more than three injections over a 3- to 6-month period, although such recommendations remain empiric.

Nonoperative treatment is usually effective, but such an approach may require an extended period of time for complete resolution of symptoms. The duration of nonoperative treatment varies. Although some authors have suggested a minimum of 6 months before considering surgical intervention,[10,14,31] such a protracted period of relative disability may be intolerable to some patients, particularly laborers and athletes. With the exception of two retrospective reports on pa-

tients with distal clavicle osteolysis,[3,8] there are virtually no studies of the natural history of these conditions in the literature. In the two studies available, the athletes treated successfully without surgery did so by stopping the causative activities.

Surgical Options

Surgery is considered for a patient with appropriate clinical symptoms, AC joint tenderness, a positive cross-body adduction sign, and radiographic evidence of pathologic changes. The patient should exhibit pain relief after injection of local anesthetic and should have undergone a course of nonoperative treatment.

Open resection of the distal clavicle for painful conditions of the AC joint was first reported independently by Mumford[32] and Gurd[33] in 1941. The advantages of this approach are the relative ease and speed with which it can be performed, the ability to directly visualize the remaining clavicle and ensure adequate bone removal, and the generally favorable results reported in the literature (Table 1). Disadvantages include the potential for injury and weakness in the reattached deltoid and trapezius and the obligatory delay in returning to active function while awaiting muscle healing.

Arthroscopic resection has been performed since 1986, when Johnson[38] reported the potential for arthroscopic resection of the outer end of the clavicle. Theoretical advantages include avoidance of detachment, reattachment, and consequent potential weakness of the deltoid and trapezius; shorter duration of postoperative protection; and quicker recovery. Two surgical approaches have evolved: a subacromial (indirect) approach and a superior (direct) approach.

Technique for Open Distal Clavicle Resection

A strap incision is centered over the AC joint, and the deltotrapezial fascia is split in line with its fibers directly over the superior joint capsule (Fig. 7). The meniscus is excised, and the distal clavicle is elevated subperiosteally along its superior border to visualize its distal articular surface. Use of a burr facilitates removal of the distal clavicle without requiring unnecessary subperiosteal dissection and capsular release. Alternatively, a sagittal saw can be used for resection. The joint is inspected while adducting the arm to ensure the presence of smooth surfaces and the absence of abutment. The capsule and deltotrapezial fascia are reapproximated by using nonabsorbable sutures, and the skin is closed with a subcuticular suture.

A sling is used for the first day or two for patient comfort. Active shoulder flexion, elevation, and abduction are discouraged for the first 3 weeks to allow healing of the deltotrapezial fascia. Progressive resistance is begun at 6 weeks, with a return to overhead activity occurring, on average, at 3 months.

Technique for Arthroscopic Resection With Use of the Subacromial (Indirect) Approach

Esch et al[39] described distal clavicle resection from a subacromial

Table 1
Results After Open Distal Clavicle Resection*

Study	Year	No. of Patients	Diagnosis	Mean Follow-up, yr	Good/ Excellent Results, %	Amount Resected
Worcester and Green[26]	1968	56	OA	4.5	100	<2.5 cm
Cahill[8]	1982	21	DCO	> 2	74	"Outer end"
Petersson and Redlund-Johnell[23]	1983	50	OA, PTA, DCO	7	62	1.0-2.0 cm
Cook and Tibone[34]	1988	23	PTA	3.7	96	1.9 cm
Worland[35]	1992	38	PTA	3.4	70	1.0 cm
Bassett[36]	1994	40	OA	NA	98	"Enough to eliminate abutment"
Slawski and Cahill[18]	1994	17	DCO	2.5	100	1.0-2.0 cm
Novak et al[31]	1995	21	OA, PTA, DCO	2.7	78	1.5-1.7 cm
Eskola et al[37]	1996	73	OA, PTA	9	69	1.6 cm (0.5-3.7 cm)

* Abbreviations: DCO = distal clavicle osteolysis; NA = not available; OA = osteoarthritis, PTA = posttraumatic arthritis.

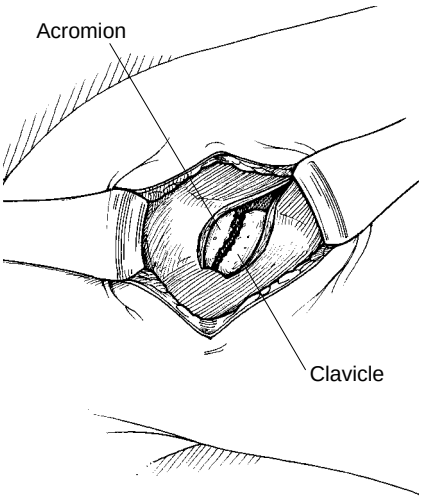

Fig. 7 Open resection relies on a small anterior "strap" incision, subperiosteal elevation of the deltotrapezial fascia in line with the fibers, and resection of the distal clavicle with use of a burr.

(indirect) approach performed arthroscopically in patients undergoing subacromial decompression for impingement. Many authors have reported various adaptations of this approach.[30,40-42]

The patient may be positioned in the lateral decubitus or beach-chair position, depending on surgeon preference. After the landmarks have been established, the glenohumeral joint is inspected through a traditional posterior portal. The scope is redirected into the subacromial space, which is inspected and, if seen to be contributing to impingement, decompressed. Attention is then directed to the AC joint, the undersurface of which is often obscured by soft tissue. Eighteen-gauge 1½-in-long (or spinal) needles can be placed at the anterior and posterior joint margins for orientation. With the scope placed posteriorly, ablation of the soft tissue and fat pad beneath the AC joint is carried out with electrocautery through an anterolateral working portal. This step is helpful in preventing bleeding, which can obscure visualization. Efforts to maintain the patient's diastolic blood pressure below 100 mm Hg are helpful (if not medically contraindicated). Use of a pump maintains distention but can cause soft-tissue extravasation if not monitored. Adding epinephrine (1 ampule of 1:1,000 concentration per 3-L bag of saline) helps maintain visual clarity. A third portal established just anterior and inferior to the AC joint allows direct debridement of soft tissue and bone.

If the joint is oblique and cannot be delineated, removal of the undersurface of the medial acromial facet may facilitate visualization of the joint and the distal clavicle. A 5.5-mm round or oval burr inserted through the anterior portal allows resection of the distal clavicle in a systematic manner. Better access is obtained by depressing the clavicle inferiorly and delivering it into the operative field (Fig. 8). One should begin at the distal clavicle inferiorly and work from front to back. By working from the inferior to the superior surface and continuing debridement medially, the entire distal clavicle can be easily shelled out of the periosteal tube with little difficulty. Visualization is enhanced by changing the scope to a lateral portal, which provides an "end on" view of the distal clavicle.

After completing the resection, the scope can be placed in the anterior portal, so as to directly visualize the joint. An effort should be made to resect enough bone so that there is no longer any impingement. If there is any question about the adequacy of the resection, a radiograph should be obtained. The amount resected can be estimated by comparison to the known dimensions of the arthroscopic instruments. Alternatively, needles can be positioned at the resected end of the clavicle and proximal acromion, and the distance can then be measured with a ruler.

The joint is thoroughly irrigated to eliminate any osseous debris. Bupivacaine (or similar long-acting local anesthetic) is infiltrated into the joint and surrounding soft tissues, and the scope portals are closed with simple interrupted sutures. A sling is used for comfort for the first few days as necessary, and the patient is encouraged to use the arm for activities of daily living. Overhead activities are avoided for the first few weeks until the patient is comfortable. Most patients are able to return to work promptly, and a return to full activity is possible after 4 to 8 weeks.

Arthroscopic resection of the distal clavicle through a superior or direct approach has been advocated to avoid disturbing the subacromial anatomy and to preserve normal capsular anatomy.[24,25,43,44] The principal disadvantages of both arthroscopic techniques are that

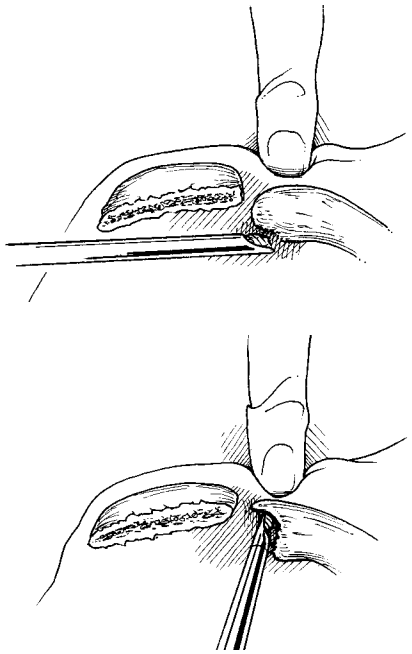

Fig. 8 By pushing inferiorly, the distal clavicle can be delivered into the subacromial field, allowing resection through a subacromial (indirect) approach.

they are technically demanding and often take longer to perform than the open procedure. Both have somewhat higher risks of inadequate resection.[30,41]

Technique for Arthroscopic Resection With Use of the Superior Approach

After anesthetic induction and placement of the patient in the beach-chair position, a few milliliters of local anesthetic (e.g., 0.25% bupivacaine with epinephrine) is infiltrated into the joint. Having the patient's radiographs in the operating room facilitates joint targeting and instrumentation. A small incision is made over the superoposterior aspect of the joint, and the obturator and sheath for a small (2.7-mm) scope are inserted. Fluid extravasation through the sheath confirms joint entry. Inflow using an arthroscopic pump is connected to the scope sheath, and a second percutaneous incision is made, anteriorly directed into the anterior aspect of the AC joint. Under direct visualization, the working portal sheath and obturator are introduced, followed by connection of a small (2.0-mm) soft-tissue shaver. The joint is easily visualized in most cases, allowing direct appreciation of the degree of degenerative change (Fig. 9).

Joint debris is removed, followed by introduction of a small burr to open the joint. Small amounts of proximal acromion and distal clavicle are removed. When access permits, the scope and shaver are replaced by larger versions (5.5-mm sheath with 4.0-mm arthroscope, 4.2-mm shaver, 5.5-mm burr). After resection of the anterior portion of the joint, the instrumentation should be exchanged, placing the scope anteriorly and the shaver or burr posteriorly to ensure smooth and adequate posterior resection. With the scope placed posteriorly, gentle cross-body adduction allows inspection of the joint surfaces to ensure that no contact occurs. If there is any question, an intraoperative radiograph should be obtained.

Simple sutures are used to close the two scope portals. A sling is used for comfort for the first day or two. The patient is allowed to use the arm ad libitum, although athletic and overhead activities are discouraged for 2 to 3 weeks. Most patients are able to rehabilitate their shoulders independently without the need for formal therapy, although some will benefit from a structured exercise program. The majority will be able to resume full activity 1 to 2 months postoperatively.

Surgical Outcomes

Outcomes after distal clavicle resection have been generally satisfactory. However, a review of the literature shows considerable variation in study design, including the number of patients studied, the diagnoses, the presence of associated conditions, the specific surgical indications and procedure performed, the amount of clavicle resected, the duration of follow-up, and the methods of subjective and objective evaluation.

Published results after open resection of the distal clavicle have been largely favorable, with 62% to 100% good to excellent results (Table 1). The results seem not to correlate with the specific diagnosis, although patients with posttraumatic arthritis, if in unstable condition, may have a poorer prognosis.

Outcomes after arthroscopic distal clavicle resection have paralleled those reported for open procedures. Most authors report high overall success rates, ranging from 83% to 100% good and excellent results. The majority of their patients were able to return to activity after resection (Table 2).

No prospective comparisons of open and arthroscopic distal clavicle resection have been reported. However, several researchers retrospectively compared the two approaches and reported an earlier return to activity for arthroscopically treated patients but comparable long-term outcomes.[43,46] However, considerably longer-term outcome data are available for studies reporting open resection (in some cases, more than twice the length of follow-up) (Tables 1 and 2). Because results seem to deteriorate with time, the outcome with arthroscopic resection should be reevaluated with longer follow-up to assess whether the early good results hold up over time.

Complications of Surgical Resection

Intraoperative complications of distal clavicle resection are relatively uncommon and are usually limited to technical difficulties during arthroscopic resection. Postoperative complications, however, are

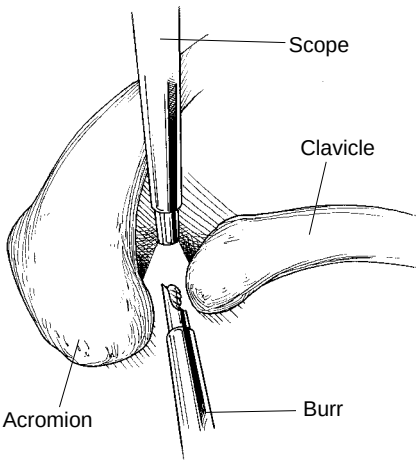

Fig. 9 With the 2.7-mm arthroscope angled from the superior-posterior portal and the burr anterior, the AC joint is debrided and the distal clavicle is resected through the superior (direct) approach.

Table 2
Results After Arthroscopic Distal Clavicle Resection

Study	Year	No. of Patients	Diagnosis*	Mean Follow-up	Good/Excellent Results, %	Amount Resected, cm
Flatow et al[43]	1992	4	DCO	>12 mo	100	1.8
Gartsman[14]	1993	20	OA	29 mo	85	Acromion, 0.5; clavicle, 1.0-1.5
Jerosch et al[41]	1993	65	OA, PTA	>6 mo	86	1.74 (mean)
Tolin and Snyder[30]	1993	23	OA, PTA	25 mo	87	1.4 (mean)
Kay et al[40]	1994	10	OA, DCO	14 mo	100	1.0-1.5
Snyder et al[42]	1995	46	OA, PTA, DCO	24 mo	94	1.5
Flatow et al[25]	1995	41	OA, PTA, DCO	31 mo	83	0.5-0.7
Martin et al[45]	1996	29	OA, PTA DCO	3.8 yr	93	0.8-1.0
Auge and Fischer[44]	1998	8	DCO	8 mo	100	0.4

*Abbreviations: DCO = distal clavicle osteolysis; OA = osteoarthritis; PTA = posttraumatic arthritis.

not infrequent and are found in both open and arthroscopic series. Basamania et al[47] evaluated their experience managing failed open distal clavicle resections in 42 patients and classified the complications encountered as being due to diagnostic error, inadequate resection, joint instability, weakness, or miscellaneous factors. These kinds of complications have all been reported regardless of the surgical technique.

Persistent pain as a consequence of diagnostic error probably accounts for many open or arthroscopic resection "failures." Diagnostic error can be minimized by obtaining a careful history and physical and radiographic examinations and by judicious use of the lidocaine injection test, which, according to several accounts,[20,26] is nearly 100% predictive.

Persistent pain due to inadequate resection is probably the most common technical cause of surgical failure. It is usually ascribed to inadequate resection of the posterior aspect of the distal clavicle, which predisposes to posterior abutment against the acromion (Fig. 10).[20] Rockwood et al[7] caution against excision, noting that they have seen patients who continued to have pain in the joint after excision of 1 cm of the distal clavicle. Inadequate resection more commonly occurs with arthroscopic techniques, due to retained posterior cortical ridges or uneven resection.[30,41]

Instability of the AC joint has been reported after both arthroscopic and open resections.[30,41] Cook and Tibone[34] were the first to note this complication, having found increased horizontal clavicular motion in 10 of 23 athletes who had undergone an average 1.9-cm open distal clavicle resection for posttraumatic arthritis following grade I and II injuries.[34] They theorized that loss of normal AC ligament integrity subtly affects normal joint stability, which can lead to both increased clavicular motion and potential weakness.

Blazar et al[2] demonstrated radiographically abnormal postoperative motion following distal clavicle resection in a group of 17 patients with atraumatic AC joint problems, who had been treated with an open technique (8 patients) or arthroscopy (9 patients). Total anterior-posterior motion was increased by an average of 5.5 mm compared with the normal shoulder. Visual analog pain scale scores correlated with the magnitude of translation. There was no difference in the results obtained with the two techniques. The authors speculated that instability explains postoperative failures in some patients.

Laboratory evidence suggests the possibility of iatrogenic instability.[4-6] Using cadaveric sectioning techniques, Fukuda et al[6] demonstrated convincingly the importance of the AC ligaments to normal joint stability, especially during

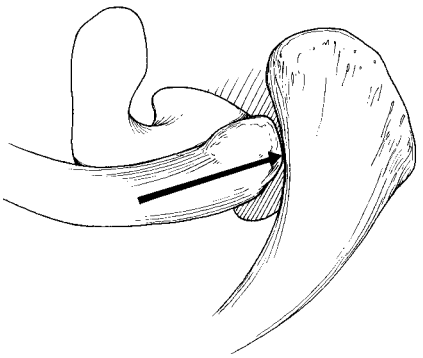

Fig. 10 Despite seemingly adequate resection, residual posterior bone may predispose to posterior cortical abutment (arrow) and persistent or recurrent symptoms.

physiologic loading. The conoid has been shown to be particularly important in controlling axial compression. Its release during distal clavicle resection may allow greater potential medial-lateral play of the distal clavicle, thereby predisposing it to joint abutment and persistent postoperative symptoms, despite an otherwise seemingly adequate resection.

Klimkiewicz et al[5] examined the specific contributions of each individual part of the AC joint capsule and found that the thicker superior ligament provides 56% of the resistance to a posteriorly directed force. They suggested that preferential ligament preservation during distal clavicle resection may be important.

Several authors have reported failures due to inability to return to the previous level of activity, particularly in heavy laborers and those involved in weight-lifting activities. This has been reported following both open[8,34,35,37,48] and arthroscopic[40,48] procedures.

In the previously mentioned study of 23 athletes with posttraumatic arthritis following grade I and II AC joint injuries, Cook and Tibone[34] found objective weakness by isokinetic strength testing in flexion and extension at low speeds (60 degrees per second) but not at higher speeds or in other planes. The authors attributed the weakness to "subtle instability" of the AC joint due to AC ligament injury, which was unmasked during maximal bench-press effort. They stressed the diagnostic importance of a decrease in maximal bench-press strength.

In the only other study in which isokinetic strength testing was performed, Martin et al[45] found no weakness in any of the 29 shoulders examined after arthroscopic distal clavicle resection performed with an indirect subacromial approach. Of the 25 patients who participated in sports (4 at a professional level), 22 returned to their previous level of performance.

Other complications have been reported after both open and arthroscopic procedures, including superficial wound infections,[14,34,41,47] painful scar formation,[47,48] and distal clavicle regeneration or heterotopic ossification at the site of resection.[8,34,42,45,47-49] Heterotopic ossification is a recognized sequela of AC joint trauma, although it is rarely clinically relevant. Symptomatic ossification or calcification is much less common, but has been recently reported as a cause of postresection failure after use of both the open and the arthroscopic technique.[42,48,49]

Guidelines for Amount of Resection

Relatively generous resection, averaging 1.5 to 2.5 cm, has historically been advocated.[7,8,19,20,26,29,30,32-34,36,37,48,49] Recent clinical and biomechanical evidence emphasizing AC joint preservation has led to a trend toward resection of less of the distal clavicle, with some authors suggesting removal of as little as 4 mm.[24,25,44,50]

The relationship between the amount of bone resected and the clinical outcome remains unproved. The amount of bone resection required is that necessary to avoid any contact between the remnant bone ends during motion. In general, most authors consider 1 cm of space between the distal clavicle and the proximal acromion a reasonable goal.

Regardless of the technique, special attention is required to ensure an even, smooth cut from front to back with no residual abutment. Bassett[36] has described performing these procedures with use of a local anesthetic so that the patient can dynamically load the joint with the cross-body adduction test at the completion of the procedure to verify adequate bone removal. Whether tested dynamically in this manner by the patient or passively by the surgeon, absence of contact should be confirmed intraoperatively.

Contraindications

Distal clavicle excision by itself is contraindicated in the patient with chronic symptoms after an injury classified as grade III or higher, in which case coracoclavicular ligament reconstruction is more appropriate.[7,51] Several authors have also recommended against excising the distal clavicle in patients with grade II injuries and in patients with AC joint hypermobility.[14,25] Novak et al[31] emphasized the importance of careful patient selection, noting that four of five treatment failures occurred in patients involved in workmen's compensation arbitration or litigation.

Summary

Often overlooked, the acromioclavicular joint is a relatively frequent source of clinical symptoms. Primary osteoarthritis, posttraumatic degenerative arthritis, and osteolysis are the most common problems affecting the AC joint. A careful history, physical examination, and radiographic evaluation will permit diagnosis in most cases. Radiographic changes must be correlated with clinical findings because of the prevalence of asymptomatic age-related degenerative changes in the AC joint. The lidocaine injection test affords diagnostic accuracy in equivocal cases and is the most accurate predictor of success after surgical resection of the distal clavicle.

Nonoperative management is effective in most cases, although osteolysis may be refractory to treat-

ment when patients are unwilling to modify activities. Operative treatment by distal clavicle resection, through open or arthroscopic methods, achieves good results in most cases. A successful operative outcome depends on careful patient selection and competent surgical resection. The amount of resection remains controversial.

The direct arthroscopic technique offers distinct advantages over the open and indirect subacromial approaches. It avoids compromise of the deltotrapezial fascia and AC joint capsule. Because the joint space in patients with distal clavicle osteolysis usually affords easy entry, the direct approach is preferred. This procedure should permit the earliest return to activity with the least "downtime." Using this technique has fewer advantages in treating patients with posttraumatic and degenerative osteoarthritis and occasionally is technically impossible when the joint space is considerably narrowed.

The indirect subacromial approach is technically somewhat easier than the direct approach and does not require small instrumentation (2.7-mm arthroscope, 2.0-mm shaver). It is preferable to the direct approach in patients with coexistent subacromial lesions in whom subacromial arthroscopy is already being carried out. Troublesome bleeding with this approach can make it a frustrating endeavor, however, and this technique usually takes longer than an open procedure. Furthermore, the technique may be difficult when the joint orientation is very oblique and access is blocked by the acromial undersurface.

The open approach is the technique of choice in cases of isolated arthritis in which the joint is too narrow to enter arthroscopically, as well as in cases in which associated rotator cuff lesions will be treated by open means. The open method is appropriate for most patients because it is easy and quick and offers predictably good results.

References

1. DePalma AF: The role of the disks of the sternoclavicular and the acromioclavicular joints. *Clin Orthop* 1959;13: 222-233.
2. Blazar PE, Iannotti JP, Williams GR: Anteroposterior instability of the distal clavicle after distal clavicle resection. *Clin Orthop* 1998;348:114-120.
3. Scavenius M, Iversen BF: Nontraumatic clavicular osteolysis in weight lifters. *Am J Sports Med* 1992;20:463-467.
4. 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;24:293-297.
5. Klimkiewicz JJ, Williams GR, Sher JS, Karduna AR, DesJardins JD, Iannotti JP: The acromioclavicular capsule as a restraint to posterior translation of the clavicle: A biomechanical analysis. *J Shoulder Elbow Surg* 1999;8: 119-124.
6. Fukuda K, Craig EV, An KN, Cofield RH, Chao EYS: Biomechanical study of the ligamentous system of the acromioclavicular joint. *J Bone Joint Surg Am* 1986;68:434-440.
7. Rockwood CA Jr, Williams GR, Young DC: Injuries to the acromioclavicular joint, in Rockwood CA Jr, Bucholz RW, Green DP, Heckman JD (eds): *Fractures in Adults*, 4th ed. Philadelphia: Lippincott-Raven, 1996, vol 2, pp 1341-1413.
8. Cahill BR: Osteolysis of the distal part of the clavicle in male athletes. *J Bone Joint Surg Am* 1982;64:1053-1058.
9. Peyron JG: Osteoarthritis: The epidemiologic viewpoint. *Clin Orthop* 1986;213:13-19.
10. Henry MH, Liu SH, Loffredo AJ: Arthroscopic management of the acromioclavicular joint disorder: A review. *Clin Orthop* 1995;316:276-283.
11. DePalma AF, Callery G, Bennett GA: Variational anatomy and degenerative lesions of the shoulder joint. *Instr Course Lect* 1949;6:255-281.
12. Horvath F, Kery L: Degenerative deformations of the acromioclavicular joint in the elderly. *Arch Gerontol Geriatr* 1984;3:259-265.
13. Needell SD, Zlatkin MB, Sher JS, Murphy BJ, Uribe JW: MR imaging of the rotator cuff: Peritendinous and bone abnormalities in an asymptomatic population. *AJR Am J Roentgenol* 1996;166:863-867.
14. Gartsman GM: Arthroscopic resection of the acromioclavicular joint. *Am J Sports Med* 1993;21:71-77.
15. Taft TN, Wilson FC, Oglesby JW: Dislocation of the acromioclavicular joint: An end-result study. *J Bone Joint Surg Am* 1987;69:1045-1051.
16. Bergfeld JA, Andrish JT, Clancy WG: Evaluation of the acromioclavicular joint following first- and second-degree sprains. *Am J Sports Med* 1978; 6:153-159.
17. Rockwood CA Jr, Young C: Disorders of the acromioclavicular joint, in Rockwood CA Jr, Matsen FA III (eds): *The Shoulder*. Philadelphia: WB Saunders, 1990, vol 1, pp 483-553.
18. Slawski DP, Cahill BR: Atraumatic osteolysis of the distal clavicle: Results of open surgical excision. *Am J Sports Med* 1994;22:267-271.
19. Murphy OB, Bellamy R, Wheeler W, Brower TD: Post-traumatic osteolysis of the distal clavicle. *Clin Orthop* 1975; 109:108-114.
20. Neer CS II: *Shoulder Reconstruction*. Philadelphia: WB Saunders, 1990, pp 433-436.
21. Gerber C, Galantay RV, Hersche O: The pattern of pain produced by irritation of the acromioclavicular joint and the subacromial space. *J Shoulder Elbow Surg* 1998;7:352-355.
22. Zanca P: Shoulder pain: Involvement of the acromioclavicular joint (analysis of 1,000 cases). *AJR Am J Roentgenol* 1971;112:493-506.
23. Petersson CJ, Redlund-Johnell I: Radiographic joint space in normal acromioclavicular joints. *Acta Orthop Scand* 1983;53:431-433.
24. Bigliani LU, Nicholson GP, Flatow EL: Arthroscopic resection of the distal clavicle. *Orthop Clin North Am* 1993;24: 33-141.
25. Flatow EL, Duralde XA, Nicholson GP, Pollock RG, Bigliani LU: Arthro-

scopic resection of the distal clavicle with a superior approach. *J Shoulder Elbow Surg* 1995;4:41-50.
26. Worcester JN Jr, Green DP: Osteoarthritis of the acromioclavicular joint. *Clin Orthop* 1968;58:69-73.
27. Edelson JG: Patterns of degenerative change in the acromioclavicular joint. *J Bone Joint Surg Br* 1996;78:242-243.
28. Cibulka MT, Hunter HC: Acromioclavicular joint arthritis treated by mobilizing the glenohumeral joint: A case report. *Phys Ther* 1985;65:1514-1516.
29. Meyers JF: Arthroscopic débridement of the acromioclavicular joint and distal clavicle resection, in McGinty JB, Caspari RB, Jackson RW, Poehling GG (eds): *Operative Arthroscopy*. New York: Raven Press, 1991, pp 557-560.
30. Tolin BS, Snyder SJ: Our technique for the arthroscopic Mumford procedure. *Orthop Clin North Am* 1993;24:143-151.
31. Novak PJ, Bach BR Jr, Romeo AA, Hager CA: Surgical resection of the distal clavicle. *J Shoulder Elbow Surg* 1995;4:35-40.
32. Mumford EB: Acromioclavicular dislocation: A new operative treatment. *J Bone Joint Surg Am* 1941;23:799-802.
33. Gurd FB: The treatment of complete dislocation of the outer end of the clavicle: An hitherto undescribed operation. *Ann Surg* 1941;113:1094-1098.
34. Cook FF, Tibone JE: The Mumford procedure in athletes: An objective analysis of function. *Am J Sports Med* 1988;16:97-100.
35. Worland RL: Resection arthroplasty of the acromial clavicular joint. *Va Med Q* 1992;119:258-259.
36. Bassett FH III: Distal clavicle resection under local anesthesia. *Orthop Trans* 1994;18:766.
37. Eskola A, Santavirta S, Viljakka T, Wirta J, Partio E, Hoikka V: The results of operative resection of the lateral end of the clavicle. *J Bone Joint Surg Am* 1996;78:584-587.
38. Johnson LL: *Arthroscopic Surgery: Principles and Practice*, 3rd ed. St Louis: CV Mosby, 1986, vol 2, pp 1356-1404.
39. Esch JC, Ozerkis LR, Helgager JA, Kane N, Lilliott N: Arthroscopic subacromial decompression: Results according to the degree of rotator cuff tear. *Arthroscopy* 1988;4:241-249.
40. Kay SP, Ellman H, Harris E: Arthroscopic distal clavicle excision: Technique and early results. *Clin Orthop* 1994;301:181-184.
41. Jerosch J, Steinbeck J, Schröder M, Castro WHM: Arthroscopic resection of the acromioclavicular joint (ARAC). *Knee Surg Sports Traumatol Arthrosc* 1993;1:209-215.
42. Snyder SJ, Banas MP, Karzel RP: The arthroscopic Mumford procedure: An analysis of results. *Arthroscopy* 1995; 11:157-164.
43. 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;1:55-64.
44. Auge WK II, Fischer RA: Arthroscopic distal clavicle resection for isolated atraumatic osteolysis in weight lifters. *Am J Sports Med* 1998;2:189-192.
45. Martin SD, Baumgarten TE, Andrews JR: Arthroscopic resection of the distal clavicle with simultaneous subacromial decompression. *Orthop Trans* 1996; 20:19-20.
46. Gaenslen ES, Satterlee CC, Schlehr FJ: Comparison of open versus arthroscopic distal clavicle excision with acromioplasty. *Orthop Trans* 1995-1996;19:258.
47. Basamania CJ, Wirth MA, Rockwood CA Jr, Moya D: Failed distal clavicle resections. *Orthop Trans* 1995-1996;19:355.
48. Petersson CJ: Resection of the lateral end of the clavicle: A 3 to 30-year follow-up. *Acta Orthop Scand* 1983;54:904-907.
49. Berg EE, Ciullo JV: Heterotopic ossification after acromioplasty and distal clavicle resection. *J Shoulder Elbow Surg* 1995;3:188-193.
50. Matthews LS, Parks BG, Pavlovich LJ Jr, Giudice MA: Arthroscopic versus open distal clavicle resection: A biomechanical analysis on a cadaver model. *Arthroscopy* 1999;15:237-240.
51. Wirth MA, Rockwood CA Jr: Complications of treatment of injuries to the shoulder, in Epps CH Jr (ed): *Complications in Orthopaedic Surgery*, 3rd ed. Philadelphia: Lippincott, 1994, vol 1, pp 242-254.