

Distal Clavicular Osteolysis

A Review of the Literature

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Abstract

Acute distal clavicular osteolysis was first described in 1936. Since then, distal clavicular osteolysis (DCO) has been separated into traumatic and atraumatic pathogeneses. In 1982 the first series of male weight trainers who developed ADCO was reported. The association of weightlifting and ADCO is especially important considering how routine a component weights are to the male athlete's training. The pathogenesis of DCO has often been debated. The most widely accepted etiology involves a connection between microfractures of the subchondral bone and subsequent attempts at repair, which is consistent with repetitive microtrauma. Symptoms usually begin with an insidious aching pain in the AC region that is exacerbated by weight training. On examination, patients have point tenderness over the affected AC joint and pain with a cross-body adduction maneuver. Although DCO may seem like an easy and quick diagnosis, one must rule out other possibilities. Avoidance of provocative maneuvers, modification of weight training techniques, ice massage, and nonsteroidal anti-inflammatory drugs (NSAID) constitute the basis of initial treatment. Much of the literature supports the

same general indications for surgery. These include point tenderness of the AC joint, evident abnormal signs with AC joint scintigraphy and AC radiographs, lack of response to conservative treatment, and an unwillingness to give up or modify weight training or manual labor. Distal clavicle resection has provided good results. Distal clavicle osteolysis is a unique disease most likely due to an overuse phenomenon.

Many investigators have credited Dupas and colleagues as first describing, in 1936, osteolysis in the distal clavicle as a result of trauma.¹⁻⁸ Since then, distal clavicular osteolysis (DCO) has been separated into traumatic and atraumatic pathogeneses. Ehrict was first credited with reporting that DCO could present without the "trigger" of acute trauma. In Ehrict's report, an air-hammer operator began to suffer from osteolysis.⁵ Subsequently, the problem was also diagnosed in a judo player, a deliveryman, and a handball player.^{9,10} Atraumatic distal clavicular osteolysis (ADCO) in weight trainers is thought to arise from a stress failure syndrome that involves resorption of the distal clavicle. In 1982, Cahill³ described the first series of male weight trainers who developed ADCO. The association of weightlifting and ADCO, as revealed in Cahill's report, is especially important considering how routine a component weights are to the male athlete's training. Cahill looked at 46 males, none of whom had a history of acute injury to the AC joint area; 45 of them lifted weights, usually at least three times a week, with emphasis on the upper extremities. The average age was 23.3 years.³ Since then, there have been more than 100 cases reported in male weight trainers. In 2001, Sopov and coworkers published a case report also involving a 20-year-old male. In this case, the upper extremity stress came from several months of intensive training and lifting, including carrying a heavy machine gun during soldier/parachutist training.⁸ Like Cahill's patients, there was no history of accidental trauma. As more females are participating in competitive and

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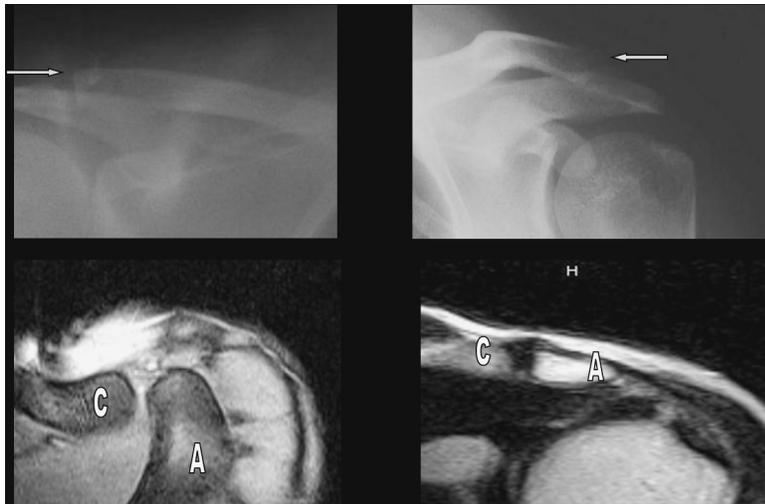


Figure 1 Normal shoulder on plain radiographs and MRI. Top, AP views in slightly different obliquities of two different patients, demonstrating a normal, smooth contour (arrows) to the clavicular articular surface. Bottom right, coronal proton density. Bottom left, axial proton density (A, acromion; C, clavicle).

recreational weight training, ADCO has been reported recently in a female bodybuilder.⁶

Acromioclavicular Joint Anatomy

The acromioclavicular joint (AC) is a diarthrodial joint, stabilized by the coracoclavicular ligaments (conoid and trapezoid), the superior and inferior AC ligaments, and the AC capsule (Fig. 1). A fibrocartilaginous meniscal disc is present between the convex distal clavicle and the flat acromion. The coracoclavicular ligaments provide vertical stability to the AC joint, while the AC ligaments confer horizontal stability. Urist demonstrated the variability of the AC joint's orientation.¹¹

Pathogenesis

The pathogenesis of DCO has often been debated. The first etiology proposed involved a connection between microfractures of the subchondral bone and subsequent attempts at repair, which is consistent with repetitive microtrauma. Hyperextension of the shoulder during bench press or chest flies exercises (i.e., dropping the elbows below or behind the plane of the body during the eccentric phase of the press) places excessive traction on the AC joints and may contribute to ADCO pathogenesis. Cahill found microfractures in the subchondral bone in 50% of the surgical specimens in his series and proposed that repetitive microtrauma caused subchondral stress fractures and remodeling.^{2,3} Furthermore, intense osteoblastic activity of the subchondral bone was discovered in all of the surgical specimens of osteolytic patients. This appeared to be predominantly an active repair process. The articular cartilage of the lateral end of the clavicle exhibited fissuring, degeneration, and areas of complete absence. This is in contrast to the tissue of asymptomatic shoulders belonging to 20- to 30-year-old males, in which osteoblastic activity, although possibly present, is not predominant.³ Brunet described synovial invasion of the subchondral bone as a possible cause of osteolysis,² and MRI findings have been reported to be similar to synovial proliferation. In one of the few case reports of DCO occurring in a female patient, Matthews and associates pointed out that microscopic examination of a distal clavicle

resection specimen revealed subchondral microcysts, disruption of the articular cartilage, and metaplastic bone formation with increased osteoclastic activity,⁶ again consistent with a repetitive stress phenomenon. Of all the proposed etiologies, Cahill's is the most accepted.

Pathology

Examination of resected sections may reveal fragments of weakly mineralized trabecular bone proximally, dense scar tissue distally, and a thin, unorganized hyperplastic fibrocartilaginous layer. The tissue is often morphologically villous and hypertrophic, with occasional multinuclear giant cells. Both active and inactive resorptive surfaces can be observed. Occasionally, active osteoblastic surfaces are seen with abnormally large osteoid seams. Where the bone has been resorbed, hypervascular connective tissue will be laid down. Overall, the specimens will consistently demonstrate articular degeneration, chronic inflammation, fibrosis, loss of trabecular structure, and osteoblastic activity. In addition, studies have shown contrasting evidence, demonstrating the presence of synovial hypertrophy and invasion of the underlying bone, resulting in a synovial pathogenesis.^{2,3,7} Proponents for a synovial pathogenesis have shown evidence of hypertrophic synovial tissue migrating across the cartilaginous surface, leaving chronic degeneration of the joint. Finally, it has been suggested that a direct communication between the lesion and the AC joint is a distinguishing pathological feature.^{2,12}

Symptoms

Symptoms usually begin with an insidious aching pain in the AC region that is exacerbated by weight training (e.g., bench presses, push-ups, dips on the parallel bars,³ overhead activities, and horizontal adduction). The power clean exercise, which demands controlled use of the elbows, back, and shoulders to heist a bar, can precipitate the pain as well, as it puts significant stress on the AC joint.¹³ In certain cases, as symptoms progress, any throwing motion may cause pain. The athlete's muscle tone can remain developed. In addition, there is no sign of subluxation.³ Occasionally, the pain may

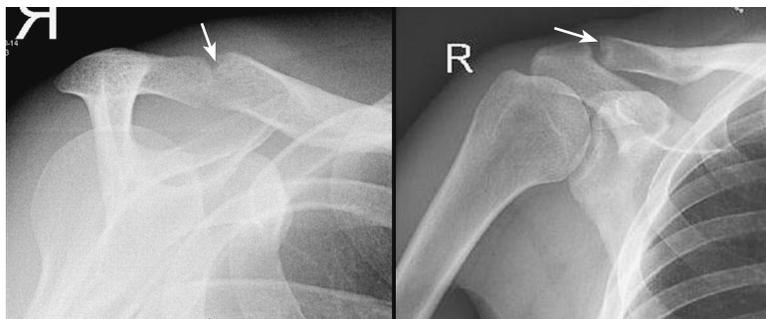


Figure 2 Scapular Y-lateral (left) and AP (right) views of the right acromioclavicular joint, demonstrating subtle erosions (arrows) along the clavicular side of the AC joint.

radiate to the surrounding deltoid or trapezium and is relieved by prolonged rest. Frequently, patients report difficulty sleeping on the affected side. Haupt has referred to ADCO as “weightlifter’s shoulder.”¹³ In his experience, the pain and discomfort is often more severe the night after a weightlifting program. The history of these cases never includes a major injury to the AC joint.

Physical Examination

Patients have point tenderness over the affected AC joint and pain with a cross-body adduction maneuver. AC joint stability should be assessed by grasping the distal clavicle between the thumb and forefinger and stressing the clavicle in an anteroposterior and superoinferior direction, while stabilizing the acromion with the other hand.¹⁴ Patients generally have full range of motion (ROM) of the glenohumeral joint. An AC joint injection can be both a diagnostic and a treatment modality in the management of DCO.

Differential Diagnosis

Although DCO may seem like an easy and quick diagnosis, one must rule out other possibilities. Some of the more important etiologies that should be excluded from the differential include hyperparathyroidism, gout, scleroderma, rheumatoid arthritis, multiple myeloma, infection, and massive essential osteolysis (Gorham’s disease).⁶ Cervical spine and neurovascular evaluations are also important to rule out as potential sources of referred pain.

Imaging

Radiographs of both AC joints, using a 35° cephalad technique, will reveal radiographic changes of the AC joint although some will be more subtle than others. Zanca described an AP view with the beam tilted 15° cephalad to better visualize the AC joint without overlapping the spine of the scapula.¹⁵ The early radiographic signs are seen months or years after weight training has begun. In patients who have had severe symptoms, a 10° to 15° cephalic tilt AP plain radiograph view of the shoulder may reveal loss of subchondral bone in the distal clavicle, microcystic changes in the subchondral area, and widening of the AC joint (Fig. 2).³ The acromion in ADCO is spared of lytic changes. The presence of panarticular disease should lead to the consideration of other diagnoses (e.g., AC arthritis). However, previous investigators have noted that radiographic appearance of the distal clavicle may vary

considerably with the age and activity of the individual, as well as with the radiographic technique applied.⁸

Early in the course of symptoms, Tc-99 scintigraphy with marked uptake in the distal clavicle may help to confirm AC joint involvement before changes become apparent on plain radiographs; at times, there is also increased activity in the adjacent acromion.³ Some critics have pointed out that the metaphyseal end of all long bones demonstrates an increase in the uptake on scintiscan, and the clavicle is no exception. A further increase in the uptake of that area can represent a simple increase in bone turnover, due to the stress applied by young individuals, and is a normal phenomenon.¹⁶ It may be related to an increased blood flow and blood pooling. However, active male athletes do not normally have significantly increased activity in the clavicle or metaphyseal ends. In Cahill’s study, 31 patients of the same age group and activity level as a DCO group who had other causes of shoulder symptoms did not demonstrate increased scintigraphic activity.³

Magnetic resonance imaging (MRI), which often focuses on the rotator cuff muscles and glenoid labrum, may overlook clavicular osteolysis if a suggestive history or radiograph is unavailable.⁴ MR imaging demonstrates increased signal intensity associated with T2-weighted images, most notably on the fluid-sensitive STIR and fat-

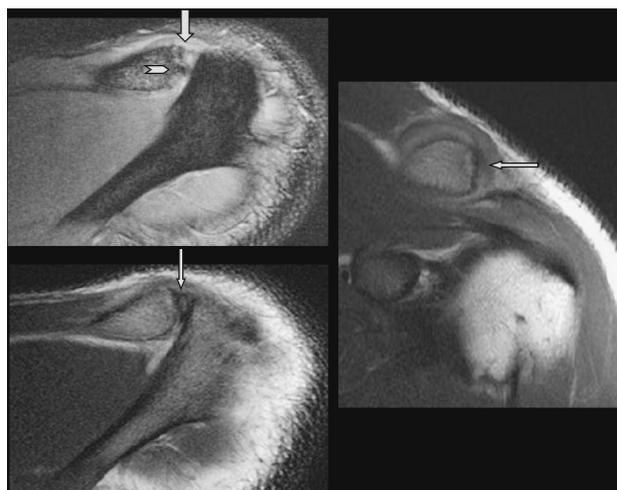


Figure 3 Early MRI changes in DCO. Axial T2 (top left), axial T1 (bottom left), coronal proton density (right) demonstrating subtle erosions (arrows) and mild adjacent subchondral marrow edema (chevron).

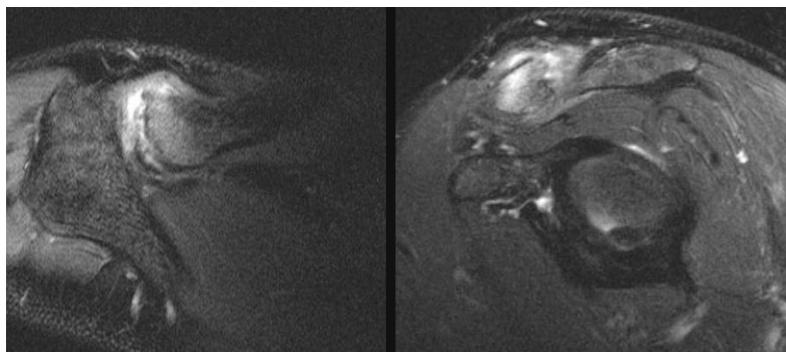


Figure 4 Axial (left) and sagittal (right) fluid-weighted, fat-suppressed images, demonstrating more advanced DCO with a greater degree of marrow edema and more pronounced distal clavicular erosions. Note the prominence of musculature and relative paucity of fat in this avid weightlifter.

suppressed spin echo on the T2-weighted sequences (Fig. 3).⁴ Bone marrow edema may be found in all of the cases, but never solely in the acromion. Bone marrow edema in the distal clavicle is the most common manifestation of this disease.^{4,17} Edema in this area has a high correlation with the presence of symptoms. Overall, posttraumatic and stress-induced osteolysis of the distal clavicle have similar appearances, the most common being the increased T2 signal intensity in the distal clavicle (Fig. 4). Additional findings of osseous fragments, osseous irregularity, and fluid in the AC joint have been deemed to be common, but not universal.⁴ Perhaps the simplest radiographic findings are distal clavicle osteopenia early in the disease and tapering of the distal clavicle late in the disease.⁶

CT Guided Injection

Some physicians have found it helpful to use corticosteroid injections as both a therapeutic and a diagnostic tool. If the patient is suffering from AC joint pain, an injection may temporarily relieve the pain. Intra-articular corticosteroids can be considered for short-term symptom relief; however, they provide little long-term relief. The greatest benefit may be that a positive temporary relief of pain can be seen as a diagnostic tool for confirming that the pain is indeed localized in the AC joint. Worcester and Green noted 100% pain relief for patients who underwent surgery and who experienced temporary relief of symptoms with two or more injections.¹⁸ In his case report, Sopov⁸ presented evidence in support of a CT-guided injection as treatment for DCO. After 3 months of conservative therapy and oral NSAIDs, Sopov's soldier did not improve. Local corticosteroids were deemed to be an appropriate response to patients that do not respond to conservative treatment.^{8,16} Under CT guidance, 5 mL of anesthetic (0.5% Marcaine[®]) and 40 mg of corticosteroid were injected into the AC joint. This procedure resulted in a relief of symptoms for 6 months. It is important to note that, besides possibly relieving symptoms, a CT-guided injection allows location of the best point on the skin, appropriate depth and needle inclination, and correct positioning of the needle tip.⁸

Nonsurgical Therapy

Avoidance of provocative maneuvers, modification of weight training techniques, ice massage, and nonsteroidal

antiinflammatory drugs (NSAID) constitute the basis of initial treatment. Haupt has suggested several modifications to the weightlifting routine, as it is often difficult to remove or alter the young athlete's weight-training program.¹³

Since most athletes find it difficult to eliminate the bench press from their routine, most of the specific modifications of weight training techniques involve narrowing the hand spacing on the barbell (less than 1.5 times the bi-acromial width) and controlling the descent phase of the bench press to end approximately 4 to 6 cm above the anterior chest.¹⁹ Some patients may find that placing towels on their chest as spacers may reinforce this restriction. The narrower handgrip allows the athlete to make adjustments to the component angles of the bench press by maintaining shoulder abduction at less than 45° and shoulder extension at less than 15°. This then decreases the compressive force on the distal clavicle.¹⁹

The power clean, although a rather full-body functional exercise, does place significant stress on the AC joint during the "racking" phase. In this part of the exercise, the shoulders are shrugged, the elbows flexed, and then the shoulders are abducted to bring the bar up into a "racked" position. If the athlete is suffering from an AC joint injury, the power clean should be modified to allow only the pulling portion of the lift without racking the bar—an exercise termed a "power clean high pull" or "power pull." The key to this motion is that the athlete still gains a lower extremity benefit but avoids additional AC trauma that can be associated with a mistimed lift.¹⁹ The preferred way to perform the exercise is to adjust the exercise machine or starting position so that the elbows are even with or above the frontal plane when beginning the lift and during repetitions (Honing technique). Haupt notes that his practice routine promotes a program in which the bench press, dips, and push-ups are eliminated. Alternative recommendations are the cable crossover, dumbbell decline press, and incline press with straight bar.¹³ All pressing motions are performed with a narrow grip, no greater than 1.5 times the bi-acromial width. Conservative physicians also stress the use of NSAID and ice massage of the AC joint after all workouts.¹³ Since many of these athletes will tend to work through pain, more conservative physicians may allow them to continue to workout. In a sense, continued physical activity and pathogenesis will result in a "self-surgery";

that is, the clavicle will be resected on its own. With such high association of DCO with power lifting, especially the bench press, one may be quick to avoid some of the aforementioned exercises. However, it is important to note that a questionnaire study of elite power lifters in 1995 and in 2000 showed that no particular movement used in weekly training, including the bench press, led to an increased risk of shoulder injuries.²⁰ A patient whose condition does not respond to conservative management or who is unwilling to alter his or her exercise training and performance regimen require surgery.

Surgery

Much of the literature supports the same general indications for surgery. These include point tenderness of the AC joint, evident abnormal signs with AC joint scintigraphy and AC radiographs, lack of response to conservative treatment, and an unwillingness to give up or modify weight training or manual labor.^{2,3,6} The most common type of surgery for DCO has been a distal clavicle resection. Both open and arthroscopic distal clavicle resection have been successful in alleviating pain and returning patients to previous activity levels.^{3,21} Once the indications are supportive of surgery, the decision must be made as to how much of the clavicle should be resected and whether to perform an open or arthroscopic procedure. While Cahill reported excellent results with an open approach resecting 1 to 2 cm of distal clavicle, a recent study reported that arthroscopic resection of only 4 mm was effective.²² The distal clavicle should be resected enough to prevent AC impingement through a full range of shoulder motion. The arthroscopic technique is technically more demanding, but it is more cosmetically appealing, and patients can perform active range of motion within the first week to prevent loss of shoulder motion. Cahill reports that 37 of 40 patients who had surgical excisions returned to weight training or competitive weight lifting, or both.³

Open Procedure

The rationale of the open procedure is that the pathological articular surfaces can be resected under direct vision in order to create a wide enough margin to prevent further acromion abutment on the clavicle. Two skin incisions can be used, the strap and the horizontal.¹³ The junction of the deltoid and trapezius fascia must be split to provide proper exposure of the AC joint. Classically, the amount of distal clavicle and acromion resected combined has been 1 to 2 cm; this is most commonly referred to as the Mumford procedure. After excision of the clavicle, the inferior AC joint capsule can be incorporated into the repair of the deltoid and trapezius fascia in order to eliminate any potential dead space. Flatow and colleagues support the transferring of the coracoacromial ligament to cover the outer end of the clavicle in order to provide additional stability to the weightlifter.²³ Cahill noted that the AC joint might play a role in impingement syndrome. Further, surgical removal of the lateral end of the clavicle may aid in decompressing the coracoacromial arch.³ Osteolysis may be

differentiated from impingement syndrome by both history and examination.

The majority of follow-up studies have reported positive results when considering pain as a major indicator of success. In 1994, Slawski and Cahill published a paper analyzing the efficacy of an open distal clavicle resection on patients suffering from distal clavicle osteolysis.⁷ At the time, it was the first known series evaluating the results of this procedure for DCO and using a standard shoulder rating scale, the UCLA Shoulder Rating Scale. The study group consisted of 12 active weight lifters and two manual laborers. All patients returned to full sports activity and employment by an average of 9 weeks postoperatively (range, 5 to 12 weeks). In addition, all patients reported returning to a level of competition or productivity as good as or better than when they had been symptomatic. Although some minimal residual pain was reported, all were satisfied with the results and no postoperative complications were reported. The UCLA Shoulder Rating Scale was then used to evaluate follow-up pain and function. The average score was 33.5 (range, 29 to 35). There were eight excellent and nine good results, with no fair or poor scores. There were no discernible measured losses of motion or strength in the operated shoulders. None of the patients were weaker on the operated side, compared to the nonoperated side.⁷ Worcester and Green noted pain relief within 4 to 8 weeks in most patients. Good to excellent results were noted in 53% to 100% of patients in follow-ups of 13 months to 9 years.¹⁸

It is important to note that Cook and Tibone attempted to quantify weakness objectively in 23 athletes who reported painless full range of motion at an average of 3.7 years postoperatively. Their goal was to measure true weakness as opposed to pain-induced weakness. The findings included radiographic evidence of increased horizontal translation, decreased flexion and extension power when tested on a weight machine at 60° per second, and diminished strength in the bench press.²⁴

Although, the open procedure has been shown to produce good to excellent results clinically, the extensive tissue damage required to gain access to the AC joint may involve a hospital stay, requires more rehabilitation, and has been linked to resulting muscle weakness.²⁴⁻²⁷ Some open procedures have been considered failures due to limited range of motion. The abutment of the distal clavicle stump on the acromion with arm motion can be due to a result of disruption of the AC ligaments from an open resection.²³

Arthroscopic Technique

The Arthroscopic technique, on the other hand, involves less tissue dissection, less rehabilitation time (patients can begin active and passive range of motion on day 1 postoperatively), can be performed on an outpatient basis, and avoids postoperative muscle weakness.²⁸ Pain relief was achieved an average of 3.4 months earlier in arthroscopic patients who received a superior approach.²³ Additionally, less bone can be removed than in the open procedure.^{23,26} Evidence has shown that 0.5 to 1.0 cm arthroscopic resections are comparable to the 1.5 to 2.0 cm resections performed during an open procedure.^{26,29}

Subacromial (Indirect) Approach

The subacromial approach, first described by Ellman and Esch, preserves the superior AC joint ligaments and provides less chance for postoperative instability (Fig. 5). The technique uses anterior instrumental, posterior scope, and lateral inflow portals. A shaver is used to debride initially any obscuring bursa. Electrocautery is used to clearly demarcate the distal clavicle and minimize bleeding. Great care should be used not to disrupt the supporting ligaments and capsule. Once good visualization is obtained, a burr (usually 5 to 6 mm) is used through the anterior portal to clear any remaining osteophytes and to resect the distal clavicle from anterior to posterior. Modifications of this technique include burring from both the posterior and the lateral portals, as well as visualization through the three standard portals. Bone depth can be gauged using the known diameter of a burr; however, Tolin and Snyder³⁰ recommend the routine use of two needles to demarcate the orientation of the joint, as well as to gauge the amount of bone resected, by measuring the distance between the two needles on the skin. Although some investigators recommend resecting a small portion of the medial acromion, most find it unnecessary. To aid in resection of the superior portion of the distal clavicle, manual pressure can be applied to bring the clavicle into the subacromial space. It has been suggested that failure of this technique is not due to the amount of bone removed, but rather the result of uneven resection or disruption of the AC ligaments. This would lead to translation of the clavicle, resulting in an abutment on the acromion and cause recurring symptoms.^{21,31-34} This problem often happens after aggressive arthroscopic resection when care is not taken to preserve the stabilizing ligamentous envelope. Morrison and colleagues recommend beveling the posterior edge of the distal clavicle if this instability is recognized intraoperatively to avoid the resultant painful impingement.³⁵

Kay and coworkers studied a lateral decubitus position in conjunction with subacromial decompression and distal clavicle resection via a bursal approach.³⁶ The lateral position allows the patient's arm to be suspended by a boom loaded with weights. If the lateral position is used, an inflatable "bean

bag" can be positioned to support the patient. An axillary roll will protect the uninjured arm, and pillows placed between the patient's knees and under the bottom leg will protect the peroneal nerve. All 10 patients studied obtained a satisfactory outcome. The five recreational athletes, including the weightlifters, returned to their sports at or above their preinjury level. All patients returned to their preinjury occupation, with half missing work only on the day of surgery. One patient was at a hockey camp participating in drills 5 days after the surgery. Postoperatively, the patients' functionality was a 9.6 on the UCLA shoulder scale (range, 8 to 10), and their pain averaged a 9.4 (range, 8 to 10). Seven of the 10 patients were pain-free by 12 weeks postoperatively.³⁶

It has often been believed that the bursal approach may not allow easy access of the clavicle in a tight joint with medial inclination, especially in osteoarthritic joints, even with direct superior pressure on the clavicle.³⁷ An open incision has been proposed for these cases by surgeons favoring the bursal approach. Tolin and Snyder believed they overcame this problem by using a lateral position with 10 to 15 pounds traction on a 70° abducted arm.³⁰

First described by Lanny Johnson and later championed by Flatow and associates,²³ the superior approach offers a direct approach to the AC joint, avoiding violation of the subacromial space, in which there may be no pathology.

Superior (Direct) Approach

While some investigators recommend routing arthroscopic examination of the subacromial space for potential pathology, others believe that there is no reason to violate the bursa in isolated AC problems.²³ Therefore, their preferred method for surgically treating DCO is a superior direct approach. A superior approach also allows resection of the outer end of the clavicle under direct visualization, without the edema and bleeding of a bursal approach. Prior to the start of a superior approach, regional interscalene anesthesia may be used. The patient can be placed either in a beach chair position³⁸ or the arm can be suspended by a boom, with less than 50° of abduction and less than 15° of forward flexion with 10 pounds of

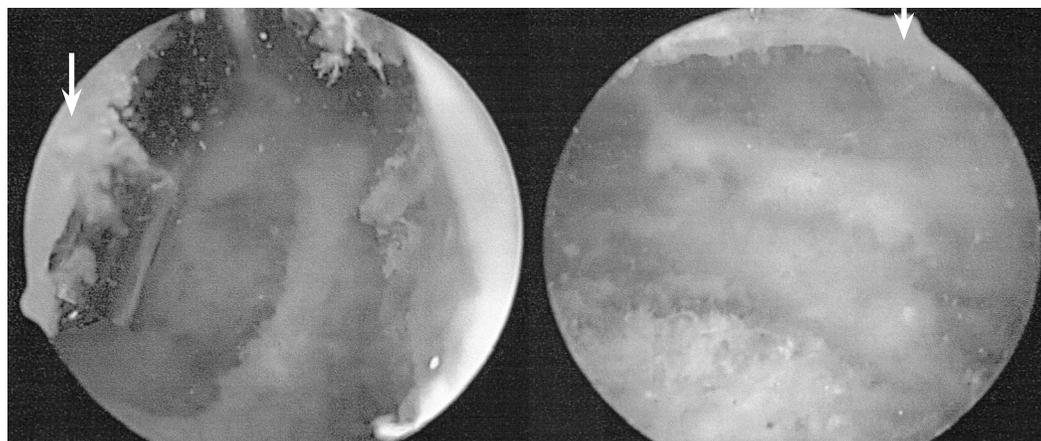


Figure 5 Intraoperative photos of the indirect subacromial approach; posterior-anterior (left) and lateral (right) views of the right AC joint, centered on the clavicle, with arrows indicating the acromion.

weight.¹⁴ Two small-bore needles (22 gauge, 1.5 inch) are used to determine the location and orientation of the joint so as to allow precise introduction of the instruments. This is critical, because otherwise variations in joint inclination may be hard to appreciate. A 4.0 mm 30° arthroscope and necessary instruments are placed into the AC joint via direct anterosuperior and posterosuperior portals. A 2.7 mm arthroscope may be placed initially if the joint space is narrow.^{23,38} The capsule and ligaments of the AC joint are subperiosteally elevated to expose the distal clavicle, allowing direct visualization of the clavicle. The meniscus and intra-articular soft tissues are resected with a 5.0 mm motorized full-radius resector.³⁸ An electrocautery unit may be used to shell out the outer end of the clavicle in order to preserve the soft tissue containing the AC ligaments and capsule.²³ After this, if the joint space is large enough, a 6.0 mm burr is introduced. If the space is too small, more room can be created using smaller burrs first until the 6.0 mm burr can be accommodated. Approximately 4 to 7 mm of the distal clavicle is removed.³⁸ After resection, the joint should be carefully examined arthroscopically from both the anterior and posterior portals to ensure adequate bone removal and to check for loose fragments. It is essential to probe the edges to be sure that no overhanging ridges remain.²³ Flatow and associates reported a 91% success rate with the superior approach,²³ while Zawadzky and colleagues determined that all results of superior arthroscopic distal clavicle resection of ADCO were either good or excellent.³⁸

Limited (less than 1 to 2 cm) arthroscopic distal clavicular resection (DCR), specifically in weightlifters, has shown promising results.²² The surgical approach consists of a superior arthroscopic approach to the AC joint with two portals.^{22,23,28} Standard arthroscopic instrumentation (30° camera and 4.0 mm arthroscope), an arthroscopic shaver, and a 4 mm motorized burr should be used. The AC joint is debrided of material such as meniscal remnants and cartilaginous debris. The distal 4 mm of the clavicle is resected with the burr, using the diameter of the burr as a guide. The outer cortical shell of the distal clavicle is addressed with the burr after elevating the capsule from the clavicle with electrocautery, sparing the superior AC ligament. A rhinoplasty rasp can be used through the portals to complete the distal clavicle contouring.²²

Experienced weightlifters are accustomed to self-directed training and biofeedback. Follow-ups of limited DCR on weightlifters have shown that they can resume their training within the first week postoperatively (average, 3.2 days; range, 1 to 6 days). Preoperative training levels can be reached by the second week postoperatively (average, 9.1 days; range 7 to 12 days). Very few patients will lose strength in the military press or the incline press.²²

Although distal clavicle resection has been shown to be a successful procedure, some failures have been reported. One of the least recognized reasons of failure may be heterotopic bone formation. Thus, most investigators recommend removal of all bone and fragments within the joint in order to avoid a nidus for new bone formation. Berg and Ciullo suggested that it might be a more common cause of failure of both acromio-

plasty and distal clavicle resection.³⁹ They suggested the use of prophylactic measures with patients considered at risk. They found their at-risk group to include patients with hypertrophic AC joint osteoarthritis that either were long-standing smokers or had other chronic pulmonary diseases. However, since periosteal bone formation can be a component of pulmonary osteoarthropathy, the results could have been attributed to a low partial pressure of oxygen and tissue hypoxia in their patients. This is reinforced by the fact that 60% of their patients had an incidence of chronic pulmonary disease, which was significantly higher than the United States average.³⁹

Resection of the distal clavicle and disruption of the AC articulation creates the potential for another complication—abnormal postoperative motion. Blazar and colleagues studied 17 isolated distal clavicle patients (open and arthroscopic) and discovered that the average anterior plus posterior translation was 8.7 mm (range, 3 to 21 mm), which was significantly greater than the contralateral shoulders (mean, 3.2 mm; range, 1 to 6 mm). The amount of pain determined by a questionnaire, correlated with the amount of translation and showed that excessive anteroposterior instability of the distal clavicle can cause postoperative pain and lead to poor surgical outcomes.⁴⁰ In a cadaveric study, Miller and coworkers determined that there was no statistically significant difference in the anteroposterior translation between direct or indirect arthroscopic distal clavicle resections.⁴¹ Other complications include underlying muscle injury, excessive bleeding, lateral clavicle fracture, and infection.

Conclusions

In summary, distal clavicle osteolysis is a unique disease most likely due to an overuse phenomenon. When activity modification and conservative treatment fails to provide relief in an active patient, distal clavicle resection has provided good results. In isolated DCO, there is scarcely any indication for an open procedure, while the superior and subacromial approaches have their pros and cons. The subacromial approach offers certain advantages, including: 1. assessing for other pathology or working through established portals if other pathology is already being addressed, 2. less injury to the capsule, and 3. no need for smaller instruments. Disadvantages include: 1. violating an area with potentially no pathology, 2. more portals, and 3. more bleeding and fluid extravasation. The merits of a direct approach should not be discounted.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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