Distal Clavicle: A Review

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Abstract

Several trauma-related injuries and degenerative conditions affect the distal end of the clavicle. Fractures of the distal clavicle and separations of the acromioclavicular (AC) joint are common, resulting from direct impact onto the shoulder region. Osteolysis and osteoarthritis of degenerative processes of the AC joint are caused by repetitive activity and overuse of the shoulder. To help identify options for treating the distal end of the clavicle, this review highlighted notable anatomical locations and biomechanics; findings of physical examinations; classification systems of injuries; and standard operative and nonoperative methods used for treatment. Although distal clavicle fractures, AC joint separations, osteolysis, and AC joint osteoarthritis can be treated nonoperatively, severe injuries may be successfully treated using operative techniques.

Introduction

Injuries to the distal clavicle and acromioclavicular (AC) joint are common, ranging from fractures to degenerative conditions. Fractures of the distal clavicle account for 10% to 30% of all clavicle fractures seen in patients.[1] Radiographs showing nonunion of the bone have been reported in 10% to 44% of patients with the injury. The severity of the fracture, combined with physical activity of the patient and risk of symptomatic nonunions, has resulted in indications for operative treatment of certain fracture patterns. Furthermore, AC joint separations occur in 40% to 50% of athletic-related shoulder injuries.[2] Indications for treatment are often based on findings of clinical evaluation of the patient and radiographic classification of the injury.

Osteolysis of the distal clavicle most commonly occurs in young male weight lifters and has been typically caused by repetitive stresses to the subchondral bone.[3] This results in microfractures to the subchondral bone, degenerative changes in articular cartilage, chronic inflammation, and fibrosis of the AC joint.[4] Similarly, primary osteoarthritis of the AC joint results from the application of high amounts of force to a small area. Patients often experience pain during activity in overhead positions and cross-body adduction, with tenderness to palpation of the shoulder. Treatment of these overuse-related and degenerative conditions has been generally nonoperative, although distal clavicle resection may be considered for treating chronic symptoms that do not improve with use of conservative methods.[4] The current paper reviewed the anatomy and subsequent biomechanics of the AC joint; important clinical and radiographic findings; classifications of injuries; and treatment options of several conditions that affect the distal clavicle and AC joint.

Anatomy and Biomechanics

The clavicle connects the upper extremy to the appendicular skeleton. The distal end of the clavicle is stabilized by the coracoclavicular (CC) ligaments and AC joint capsule and ligaments. To help reinforce the AC capsule in stabilizing horizontal motion of the joint, the CC ligament attaches to the distal end of the clavicle and medial aspect of the acromion.[5] The trapezoid and conoid ligaments of the CC prevent superior displacement of the clavicle in relation to the acromion. Both ligaments originate at the base of coracoid process of the scapula and insert on the undersurface of the distal clavicle. The trapezoid and conoid attach at 2 and 4 cm from the AC joint, respectively.[6] Typical distance between the coracoid process and undersurface of clavicle is between 1.1 and 1.3 cm.[7]

Physical Examinations and Imaging Procedures

Acute injuries affecting the distal clavicle often result from a direct impact to the shoulder region. Subsequently, patients typically present with symptoms of pain in the anterior and lateral parts of the shoulder.

Physical examination should include visualization of the shoulder region and palpation of the clavicle. During these tests, patients often shows signs of swelling, ecchymosis, and pain during active and passive motions of the shoulder. Additionally, inspection can identify "skin tenting" in displaced fractures or AC joint separations, which suggests soft-tissue attenuation and impending risk of open fracture. Re-creation of pain after a cross-body adduction test suggests changes in pathological features of the distal clavicle. This test is performed by elevating the arm to 90°, holding the elbow, and adducting the arm across the body.[4]

Radiographic evaluation is recommended if findings of physical examinations are suggestive of an injury. Use of a Zanca view of the clavicle, in which the x-ray beam is directed between 10° to 15° of cephalic tilt, can be a helpful diagnostic tool in addition to standard anteroposterior and axillary-lateral radiographs. In this view, any intraarticular involvement of the AC joint can be effectively identified. Radiographs of both shoulders are also helpful in comparing patterns, location, and displacement of acute injuries to the distal clavicle.[1,4]

Fractures

Fratures of the distal clavicle are often categorized using the Neer[8] classification system, which describes anatomical location of the fracture and resultant stability of the clavicle. Depending on the type, the fracture may be treated nonoperatievly. However, because of the high rate of nonunion in distal clavicle fractures, operative treatment is often considered.

Neer Classification

The Neer system categorized distal clavicle fractures into types I through V. Type I fractures occur lateral to the CC ligament, with the AC joint intact. The intact CC ligament and deltotrapezial fascia stabilize the proximal and distal fragments, respectively. Types IIA and IIB fractures are usually displaced and unstable, in which the proximal end of the clavicle detaches from the CC ligament, and the distal fragment remains attached to the scapula by the AC capsule. In type IIA injuries, the CC ligaments connect the distal fragment to the coracoid process; however, in type IIB fractures, the conoid is torn, and the trapezoid is presumably intact and attached to distal fragment. Type III fractures occur distally to the clavicle and extend into the AC joint. The CC ligaments remain intact and subsequently stable, with minimal displacement. Type IV fractures are rare, occur mostly in children, and result from disruption of the periosteal sleeve, which causes damage to the physis and superior displacement of the metaphysis. Finally, in type V fractures, the inferior cortical fragment remains attached to the CC ligaments, creating instability of the clavicle.

Nonoperative Treatment

Types I and III fractures can be treated nonoperatively because most of the associated injuries are stable and nondisplaced. During typical treatment, the patient wears an arm sling for 2 weeks, with limited motion of the shoulder until symptoms of pain are reduced. Obtaining repeated radiographs is suggested at 6-week follow-up.

Type II fractures are often displaced, and 28% to 44% rates of nonunion have been reported.[1,9-13] Robinson et al14 noted similar outcomes at 6-year follow-up in patients with displaced fractures treated operatively and nonoperatively, with nonunion observed in 21% of patients. Delayed surgical treatment was performed for 14% of the patients owing to continued signs of symptoms. The study concluded that nonoperative treatement of displaced lateral clavicle fractures in middle-aged and elderly patients resulted in successful mid-term outcomes, in which asymptomatic nonunions did not affect the postoperative results of treatment.

Operative Treatment

Several techniques have been described for operatively treating distal clavicle fractures, including use of transacromial wires, tension bands, the Weaver-Dunn procedure with modifications, arthroscopic-assisted reconstruction of the CC ligament, placement of screws in the CC ligament, and plate fixation.

A study by Fazal et al[9] reported a 100% rate of union after treating displaced distal clavicle fractures, with minimal postoperative complications, using a temporary coracoclavicular screw. Similarly, Zhang et al[15] reported successful fixation of fractures in patients treated using locking plates or hook plates, without difference in union rates and constant shoulder scores. At 6 months postoperatively, complications of the locking-plate group included 1 loss of reduction and 1 nonunion; hook-plate group, 2 losses of reduction, 3 symptomatic hardware, 1 nonunion, and 1 hardware failure. Similarly, Klein et al[16] compared fixation of hook plates and use of locking plates augmented with fixation of sutures in the CC ligament. Functional outcomes of patients were similar, although more complications were reported with use of hook plates, which required removal of the implant. Finally, Tiren et al[17] reported a 96% rate of union at 5-year follow-up in 28 patients with distal clavicle fractures treated using hook plates. Complications associated with use of the hook plate included shoulder impingement, arthrosis of the AC joint, and subacromial osteolysis that resolved after removal of the plate. At our institution, severe fractures are commonly treated using hook plates (Figures 1A through 1C).

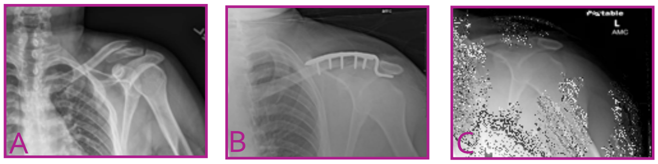

Figure 1. Radiographs of a 21-year-old man with a distal clavicle fracture resulting from a collision on a mountain bike, showing anteroposterior-view progression of operative treatment using hook plates. (A) Preoperatively. (B) Intraoperatively, with the hook plate fixed onto the clavicle. (C) Postoperatively, with successful healing after removal of the hook plate.

Separation of the Acromioclavicular Joint

To help choose effective treatment of AC joint separations, physicians often use the Rockwood[18] classification to identify specific types of injury. These categories, ranging from types I through VI, describe damage to the CC ligaments, AC ligaments, and deltopectoral fascia. Types I, II, and III are typically treated nonoperatively, whereas operative techniques can be effective in successfully treating types IV, V, and VI joint separations of the AC.

Rockwood Classification

The Rockwood classification has been commonly used in describing AC joint separations. In type I injuries, radiographs do not show signs of the injury; the distance of the CC ligament is between 1.1 to 1.3 cm; AC ligaments are sprained; the CC ligaments and deltopectoral fascia are intact; and deformities are not visible, although the patient may be tender to palpation of the shoulder. In type II injuries, the distance of the CC ligament is displaced by a maximum of 25% compared with the uninjured shoulder; AC and CC ligaments are disrupted and sprained, respectively; and the deltopectoral fascia is intact. Type III classifications include displacement of the CC ligament by 25%; disruption of the AC ligament, CC ligament, and deltopectoral fascia; and possible reduction of the AC joint by applying upward force at the elbow. Types IV and V injuries also involve disruption of the AC ligaments, CC ligaments, and deltopectoral fascia. Specifically, in type IV separations, posterior displacement of the clavicle into the trapezius muscle can be noted in radiographs with axillary-lateral views. Type VI injuries typically include decreased distance of an intact CC ligament, with disruption of the AC ligament and deltopectoral fascia.

Nonoperative Treatment

Nonoperative treatment of Rockwood types I and II injuries typically involves use of a sling for 1 to 2 weeks, with gradual increase of shoulder motion and avoidance of sports-related activities and heavy lifting for 3 months. However, no gold standard exists for treatment of type III separations.

A systematic review by Korsten et al[19] reported no difference in objective shoulder function between conservative and operative treatment of patients with type III injuries. A higher complication rate was noted with the operatively treated group, yet the resulting cosmesis between the two groups was similar, with presence of a prominence or operative scar, respectively. No conclusive evidence was noted for treatment recommendations. Furthermore, Press et al[20] discussed treating type III separations and reported similar treatment outcomes between operative and nonoperative methods at 32-month follow-up. Additionally, a case report by Watson and Wyland[21] found a full return to sports-related activity in a high school-aged baseball pitcher, with proposed play in college after successful nonoperative treatment of a type II AC joint separation and an extensive rehabilitation period.

Operative Treatment

Joukainen et al[22] found no functional difference between operative (using two transarticular K-wires and suturing of the AC ligament) and nonoperative treatments of types III and V separations; however, the operatively treated group showed fewer presences of prominence at the AC joint. Development of arthritis and calcification of the AC joint and CC ligament, respectively, was equal between the two groups at 20-year follow-up. On the other hand, Struhl and Wolfson[23] described promising results after performing a clavicle-to-coracoid procedure using an endobutton and imbrication of the AC capsule, with repair of the deltopectoral fascia and CC ligament. At 5-year follow-up, a mean distance of the CC ligament was noted at 1.1 cm.

One study[24] reported a postoperative complication rate of 27% after anatomical fixation of the CC ligament using cortical buttons and tendon allografts. Complications included fracture of the coracoid, ruptures of allografts, hardware failures, loss of reduction, signs of pain resulting from the hardware, and fracture of the clavicle. The ability to successfully maintain reduction of the AC joint in all patients was reported at 86% at 12 months postoperatively.

Yoon et al[25] compared fixation techniques using hook plates or ligament reconstruction for treating temporary, unstable AC joint separations. Postoperative results were not significantly different, yet findings of long-term follow-up indicated that the the hook plate improved possible reduction of the AC joint (ie, distance of the CC ligament reduced by 106% and 134% in hook-plate and ligament-reconstruction groups, respectively). Overall results of using a hook plate were more promising, despite performing implant-removal procedures for preventing subacromial erosion that occurred in 37.5% of patients. This outcome may be caused by implant removal at nearly 8 months postoperatively and can be avoided by successful initial placement of the hook plate (Figures 2A and 2B).

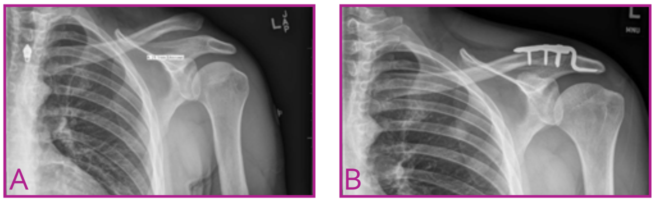

Figure 2. Radiographs of a 16-year-old soccer player, who fell onto his left shoulder, which show anteroposterior views. (A) Preoperatively, showing signs of a type V separation of the acromioclavicular joint, with the distance of the coracoclavicular ligament displaced at greater than 100%. (B) Postoperatively, showing successful fixation with use of hook plate.

Osteolysis

In identifying osteolysis of the distal clavicle, a study by Cahill[3] reported that 46 of 47 patients with osteolysis were weight lifters, whereas Scavenius and Iversen[26] reported that 28% of weight lifters had osteolysis and associated signs of pain, swelling, and tenderness at the shoulder. Findings of radiographs included osteopenia, subchondral lysis, cysts of the distal clavicle, and an intact acromion. Furthermore, results of magnetic resonance imaging often show an increased signal on T2 and STIR (short T1 inversion recovery) sequences with osseous fragments, irregularity, and presence of fluid in the AC joint (Figures 3A and 3B). The condition is typically treated nonoperatively, with careful progression to operative techniques if initially unsuccessful.

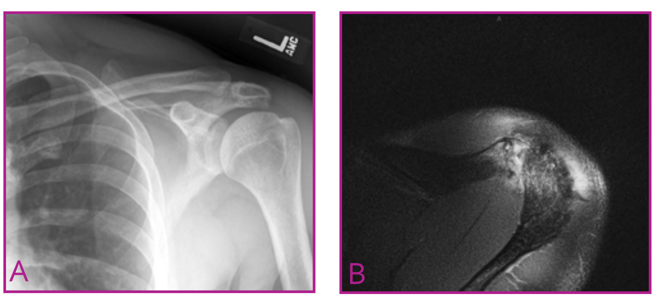

Figure 3. Imaging tests of a 22-year-old weight lifter, who presented to our clinic with worsening shoulder pain and limited shoulder activity at 1 year after initial injury. (A) Postoperative radiograph, showing anteroposterior view, with presence of osteopenia, subchondral lysis, and cysts at the acromioclavicular (AC) joint. (B) Postoperative magnetic resonance imaging, showing axial view, with osseous fragments, irregularity, and fluid noted in the AC joint.

Nonoperative and Operative Treatment Methods

Initial treatment of osteolysis of the distal clavicle can be conservative, with recommendation to modify current levels of activity. Use of corticosteroid injections may be considered to provide temporary relief of pain and can result in promising surgical outcomes after performing distal clavicle excision (DCE).[4]

Operative treatment can be performed if conservative treatment proves unsuccessful or patients cannot change their weight-lifting routines. Surgical procedures include open and arthroscopic DCE. Slawski and Cahill[27] noted successful return to activity in sports and work of 14 weight lifters who underwent open DCE. Furthermore, Zawadsky et al[28] reported similar results of treatment between arthroscopic and open DCE techniques (excluding trauma-related injuries).

Treating Osteoarthritis of the Acromioclavicular Joint

Nonoperative procedures for treating symptomatic arthritis of the AC joint include physical therapy and modification of activity levels. Additionally, use of corticosteroid injections can be therapeutic and provide a helpful diagnostic tool if signs of pain continue despite change in activity levels. When symptoms of pain persist, treatment with open or arthroscopic resections of the distal clavicle can be considered. Pensak et al[29] compared studies on open and arthroscopic DCE and noted a shorter time in returning to activities after arthroscopic treatment; however, long-term outcomes were similar between the two techniques. Unsuccessful treatment was reported with posttraumatic arthritic and workers' compensation injuries.

Concomitant Injuries

Diagnosis of AC joint arthritis occasionally occurs during evaluation of concomitant shoulder injuries, including rotator cuff tears and impingement of subacromial structures.

Operative treatment of asymptomatic AC joint arthritis, diagnosed radiographically, has not been recommended. Oh et al[30] reported no difference in functional outcomes or healing after resection of asymptomatic AC joint arthritis, using arthroscopic methods to repair rotator cuff tears. Postoperative complications of DCE included AC joint subluxation (viewed on radiographs), gross protrusion of the bone, and expressed tenderness at the AC joint. Furthermore, Park et al[31] compared results of repairing rotator cuffs with and without DCE for treating symptomatic AC joint arthritis. The study reported that 33% of patients who underwent DCE continued to experience pain in the AC joint. Additionally, treatment of isolated rotator cuff tears resulted in fewer observable symptoms of the injury, compared to treatment with concomitant injuries (despite progression of arthritis of the AC joint as seen in radiographs) in 80% of patients.

Conclusion

Operative and nonoperative methods exist for treating the various injuries and conditions affecting the distal end of the clavicle (ie, fractures, AC joint separations, osteolysis, and arthritis of the AC joint with or without concomitant injuries). Neer and Rockwood classifications of distal clavicle fractures and AC joint separations can be helpful in determining appropriate methods used for treatment.

Operative treatment is often considered in high-grade AC joint separations and distal clavicle fractures owing to high rates of symptomatic nonunion. When operative treatment of distal clavicle fractures and AC joint separations is indicated, use of hook plate fixation is the technique of choice at this institution. Despite reported complications, use of hook plates can achieve adequate reduction of distal fractures that cannot be stabilized with fixation of plates. To avoid associated hardware complications, surgeons at our institution routinely schedule removal of implants at 3 months postoperatively. Symptomatic arthritis of the AC joint can be treated similarly to osteolysis of the clavicle, including use of open and arthroscopic DCE. However, treatment of arthritis of the AC joint with concomitant shoulder injuries (eg, during repair of the rotator cuff) may not result in successful outcomes, and the decision to perform an operative procedure shoulder be given careful consideration.

Although indications for treatment are not always clear, severe injuries of the distal clavicle may be effectively treated using operative techniques. Physicians should initially explore nonoperative methods, with careful progression to operative treatment if the symptoms continue.

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Conflict of Interest

The author reports no conflict of interest.

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