Acromioclavicular Joint Injuries and Distal Clavicle Fractures

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Abstract

The acromioclavicular joint is commonly affected by traumatic and degenerative conditions. Most injuries are due to direct trauma, such as a fall on the shoulder. Six types of acromioclavicular sprains and three types of distal clavicle fractures have been described in adults. Although there is general agreement on treatment of type I, II, IV, V, and VI acromioclavicular injuries, the treatment of type III injuries remains controversial. Studies have shown no distinct advantage for surgical reconstruction over nonoperative treatment. Because type II distal clavicle fractures are prone to nonunion, operative fixation may be advisable to avoid this complication.

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The acromioclavicular joint is commonly affected by traumatic and degenerative conditions. Because of their subcutaneous position on the top of the shoulder, the acromioclavicular joint and the distal clavicle are susceptible to traumatic injuries to the shoulder girdle. The acromioclavicular joint may also be affected by posttraumatic degeneration. Degenerative involvement of the acromioclavicular joint may also be seen as osteolysis in weight lifters[1,2] and as part of the process of impingement syndrome. In this article, we will review the diagnosis and treatment of traumatic injuries of the acromioclavicular joint and the distal clavicle in adults.

Anatomy

The acromioclavicular joint is a diarthrodial joint between the medial (clavicular) facet of the acromion and the distal clavicle. The joint contains a fibrocartilaginous disk that has been observed to vary considerably in size and shape.[3] The acromioclavicular joint has a thin capsule that is stabilized by anterior and posterior, as well as superior and inferior, ligaments. The most robust of the acromioclavicular ligaments is the superior, which is reinforced by attachments of fibers of the deltoid and trapezius muscles.

Horizontal (anteroposterior) joint stability is provided by the acromioclavicular ligaments.[4] They provide less vertical stability, as evidenced by the fact that complete division of the superior acromioclavicular ligament and joint capsule causes less than 50% subluxation of the acromioclavicular joint.[4]

The coracoclavicular (conoid and trapezoid) ligaments pass from the inferior surface of the clavicle to the base of the coracoid process of the scapula. These strong ligaments provide vertical stability to the acromioclavicular joint. They constitute the primary support by which the scapula is suspended from the clavicle; complete division of these ligaments is necessary for a complete superior dislocation to occur.

Mechanism of Injury

Most acromioclavicular joint injuries, as well as most fractures of the distal third of the clavicle, are the result of direct trauma. The type of injury that is sustained is often dependent on the area of impact on the shoulder. Classically, the acromioclavicular joint is injured by impact to the acromion when the humerus is in an adducted position. Because of the substantial stability of the sternoclavicular joint,[5] the energy of the impact is directed to the acromioclavicular and coracoclavicular ligaments or to the clavicle itself. The magnitude of the applied force will determine the

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severity of the injury and the structures involved. Typically, in an acromioclavicular joint injury, the force is initially absorbed by the acromioclavicular ligaments; if the force is great enough, the injury progresses to affect the coracoacromial ligaments and then the deltotrapezial fascia as well. With fractures of the distal third of the clavicle, there may be an associated coracoclavicular ligament disruption.

Acromioclavicular joint injury by indirect trauma has also been described. By this mechanism, a fall on the elbow or outstretched arm causes force to be directed through the humeral head and upward into the acromion. Injury is primarily to the acromioclavicular ligaments, as the coracoclavicular ligaments are relaxed with upward movement of the scapula with respect to the clavicle.

Classification of Acromioclavicular Joint Injuries

Injuries to the acromioclavicular joint are classified on the basis of the findings from the physical examination and the anteroposterior and axillary radiographs. Standard classifications also consider the degree of damage to the acromioclavicular and coracoclavicular ligaments, as well as the deltoid and trapezius attachments (Table 1). Allman[6] and Tossy et al[7] classified acromioclavicular joint injuries as type I, II, or III. Rockwood added types IV, V, and VI to complete the classification[8] (Fig. 1).

Diagnosis

Injury to the acromioclavicular joint should be suspected in anyone with pain after a traumatic injury to the shoulder. Inspection may reveal prominence of the outer end of the clavicle, abrasion, or swelling in the area. Palpation will reveal local tenderness. Detection of instability is difficult in the acute situation because of patient discomfort. Later, anterior-to-posterior and superior-to-inferior translation of the distal clavicle can be assessed.

Radiographic Evaluation

The anatomy of the acromioclavicular joint is frequently difficult to evaluate on standard anteroposterior radiographs of the shoulder due to overpenetration of the area. An anteroposterior view and a 15-degree cephalic-tilt (Zanca[9]) view are recommended to evaluate for joint displacement and intra-articular fractures. Axillary views are useful for evaluating the position of the distal clavicle with respect to the acromion. They may demonstrate posterior displacement or intra-articular fractures. Stress or weighed radiographs are no longer routinely used to differentiate between type II and type III acromioclavicular joint injuries. Only infrequently is this distinction clinically relevant, given the present treatment standards that will be discussed.

Overview of Treatment of Acromioclavicular Joint Injuries

Although the treatment of third-degree acromioclavicular joint injuries is still controversial, prospec-

Table 1
Classification of Acromioclavicular Joint Injuries

Type	Characteristics
I	Sprain of acromioclavicular ligament only
II	Acromioclavicular ligaments and joint capsule disrupted Coracoclavicular ligaments intact ≤ 50% vertical subluxation of clavicle
III	Acromioclavicular ligaments and capsule disrupted Coracoclavicular ligaments disrupted Acromioclavicular joint dislocation with clavicle displaced superiorly and complete loss of contact between clavicle and acromion
IV	Acromioclavicular ligaments and capsule disrupted Coracoclavicular ligaments disrupted Acromioclavicular joint dislocation with clavicle displaced posteriorly into or through trapezius muscle (posterior displacement confirmed on axillary radiograph)
V	Acromioclavicular ligaments and capsule disrupted Coracoclavicular ligaments disrupted Acromioclavicular joint dislocation with extreme superior elevation of clavicle (100% to 300% of normal) Complete detachment of deltoid and trapezius from distal clavicle
VI	Acromioclavicular ligaments and capsule disrupted Coracoclavicular ligaments disrupted Acromioclavicular joint dislocation with clavicle displaced inferior to acromion and coracoid process

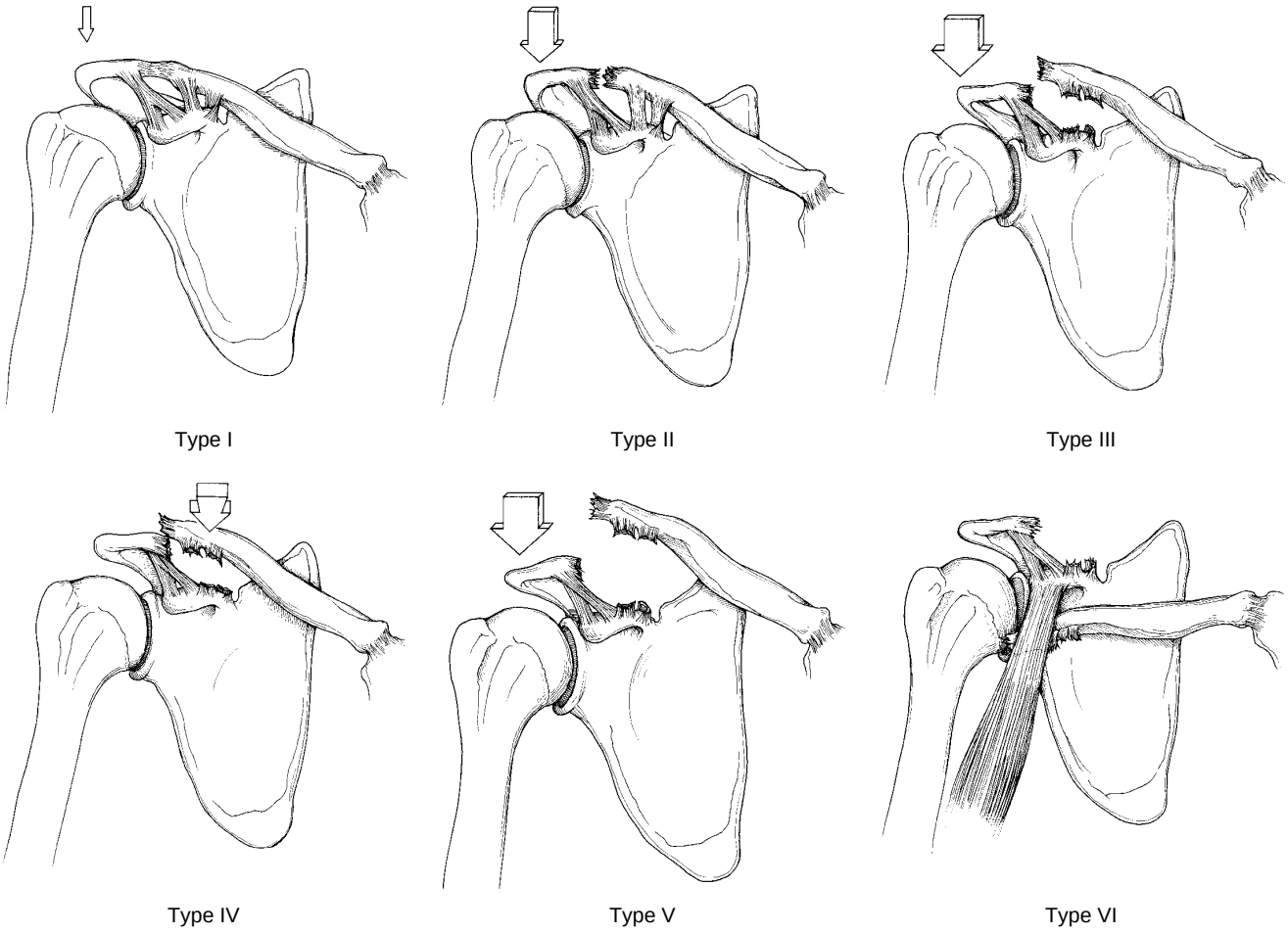

Fig. 1 Classification of acromioclavicular joint injuries. The size and location of arrows indicate the magnitude and direction of the force that typically causes the injury. Type I injury is a mild injury of the acromioclavicular ligaments. In type II injury, the acromioclavicular ligaments are disrupted, but the coracoclavicular ligaments are intact. In type III injury, the acromioclavicular and coracoclavicular ligaments are disrupted. In type IV injury, the clavicle is displaced posteriorly through the trapezius, and the acromioclavicular and coracoclavicular ligaments are disrupted. In type V injury, there is acromioclavicular joint dislocation, with extreme superior elevation of the clavicle. In type VI injury, the clavicle is displaced inferior to the acromion and the coracoid process.

tive studies comparing nonoperative and surgical treatment of these injuries have yielded similar or satisfactory results.[10-12] Nevertheless, not all patients do well with conservative care. Some authors who generally favor a conservative approach may recommend surgical repair for patients involved in overhead-throwing sports or heavy manual labor.[10-15] Other studies indicate very little impact on athletic strength or performance after acromioclavicular dislocation.[16] Questions that still remain are whether complete dislocation of the acromioclavicular joint affects performance of the overhead-throwing athlete or laborer and whether we can restore normal anatomy and function by surgical means.

Type I Injuries

Acute Sprains

Type I sprains lack evidence of instability and should be treated conservatively. A sling and analgesic medication are used to provide comfort to the patient. Icing the area no more than 20 minutes will help reduce swelling. Local wound care may be needed for the abrasions that are frequently seen with these injuries. Most athletes will return to competition within a week or two. Football players can modify their shoulder pads and use cutout protective padding that reduces contact to the joint.

Chronic Sprains

Many of the chronic degenerative changes seen in the acromioclavicular joint in athletes involved in contact sports probably are the result of type I and type II sprains suffered during their careers.[17] An injury may damage the meniscus and articular cartilage and subsequently lead to degenerative changes due to repetitive use or trauma. Excision of the distal clavicle to reduce pain may be necessary in athletes who do not respond to mild analgesics, nonsteroidal anti-inflammatory medications, or intra-articular corticosteroid injections. This can be accomplished with the use of arthroscopic or open techniques.[18-21] The technique used should depend on the surgeon's preference and experience with arthroscopic resection. Advantages of arthroscopic resection are that it is less destabilizing to the joint than open techniques and that it may require the resection of less bone (5 to 7 mm, rather than 1 to 2 cm).[21] The timing of the return to athletic competition after resection is based on the patient's comfort level and the restoration of shoulder motion and strength.

Type II Injuries

Acute Sprains

Acute type II injuries are treated in much the same way as type I injuries. Some practitioners recommend further immobilization in a harness or sling for fear of converting the sprain to a type III injury. Type II injuries may be more likely to develop degenerative changes because of the increased sagittal-plane motion of the acromioclavicular joint and the potential for intra-articular damage. A sling, analgesics, and cryotherapy can be used as necessary for the patient's comfort. Return to athletic activity is predicated on the restoration of painless motion and strength.

Chronic Sprains

Treatment of chronic type II injuries with degenerative changes is similar to that of type I injuries. Analgesics, nonsteroidal medications, and injections of corticosteroids generally provide little long-term relief. A recent evaluation of resection of the distal clavicle after such injuries revealed poor results because the instability led to abutment of the posterior clavicle against the base of the acromion.[21] Symptomatic type II sprains, especially those involving further injury to the coracoclavicular ligaments, may be treated as type III injuries with resection of the distal clavicle and reconstruction of the ligaments.

Type III Injuries

The treatment of type III sprains remains controversial. The recent literature contains discussions of operative options for restoring the acromioclavicular joint,[10-14] although a distinct advantage of surgical treatment over conservative care has never been clearly demonstrated. We conducted an informal survey of physicians who treat professional athletes involved in football, hockey, and baseball and found that the majority favor a nonoperative approach for most athletes. These physicians will still consider operative reduction for the throwing athlete, particularly the baseball pitcher, however. Quarterbacks throw with a less specific motion and generally do not fall into the same category as baseball pitchers. The question remains whether current surgical techniques truly restore normal functional anatomy that allows unimpeded repetitive overhead motion.

Another pertinent issue is the timing of reconstruction. It would appear that many of these procedures can be done on a delayed basis, after it has been determined that the athlete would remain symptomatic. Weinstein et al[13] noted a trend to better results when ligament reconstruction was done within the first 3 weeks after injury. Others have found no difference between early (less than 3 weeks) and late ligamentous reconstruction.[14] Whether the surgeon's preference is operative or nonoperative treatment, there are still patients who will ultimately require surgical intervention after the failure of conservative treatment.

Nonoperative Treatment

The most widely used form of nonoperative treatment is similar to the approach used for type I and type II sprains. Because of the pain and deformity, it is unlikely that the athlete will return to activity as soon as after a type I or type II injury, although it is not uncommon for the professional football or hockey player to return to competition within a few days to weeks.

Correction of the deformity by means of nonoperative methods is still used in some circles but has generally been relegated to being of only historical interest. Adhesive strapping and use of bandages, casts, and slings with pressure dressings to reduce the shoulder to the clavicle have all been attempted. Once the most commonly used device, the Kenny-Howard brace is a sling combined with a strap over the distal clavicle that applies downward pressure while directing a superior force to the humerus. To be effective, the brace must be worn continuously for 6 to 8 weeks with the acromioclavicular joint reduced. Any displacement of the strap during this period will lead to loss of reduction

of the joint and subsequent failure. Because this device is quite cumbersome and painful to wear, the current trend is away from using it. There is also a considerable risk of skin maceration and breakdown under the strap due to the direct pressure. There is a report of a professional athlete who sustained an anterior interosseous nerve compression while using this sling.[22]

Surgical Options

One approach to the acute surgical treatment of the unstable acromioclavicular joint is to consider stabilizing the dominant arm of a throwing athlete or a laborer who places substantial demands on the upper extremity. All other patients with type III sprains should be treated nonoperatively, with repair being performed only if they continue to note symptoms, pain, or motion of the distal clavicle with activity. Most authors report excellent results regardless of whether the reconstruction is performed early or late.

Various surgical options have been described. The most popular will now be presented, along with the pros and cons of each. These options include dynamic muscle transfers, primary acromioclavicular joint fixation, primary coracoclavicular ligament fixation, and excision of the distal clavicle with or without coracoclavicular ligament reconstruction.

Dynamic Muscle Transfers

Various authors in the 1960s reported on a procedure in which the tip of the coracoid process and the attached coracobrachialis tendon and short head of the biceps were transferred to the undersurface of the clavicle.[23] The transferred tendon was considered to act as a dynamic depressor of the clavicle. The risk of nonunion or injury to the musculocutaneous nerve with transfer of the coracoid is substantial. The most recent report on this procedure noted that nearly half of the patients whose shoulders were operated on had continued aching of the joint, particularly those over the age of 40.[23] This procedure fails to provide static stability to the joint and likely continues to allow motion and thus pain at the acromioclavicular joint.

Primary Acromioclavicular Joint Fixation

Transfixion of the acromioclavicular joint with Kirschner wires, pins, or screws has been a popular form of treatment in the past. This usually is undertaken in conjunction with repair or reconstruction of the acromioclavicular or coracoclavicular ligaments. Pinning of this joint is difficult to perform blindly, and the risks of loss of fixation, pin breakage, and pin migration and the necessity of hardware removal make this an unpopular procedure. Further injury to the meniscus and the articular cartilage of the acromioclavicular joint may occur with hardware fixation, which leads to degenerative changes.

There have been recent reports of the use of bioabsorbable materials to fix the joint and allow repair or reconstruction of the ligamentous structures. These materials have the advantage that they allow secure fixation of the joint without requiring a second operation for removal.

Primary Coracoclavicular Ligament Fixation

Bosworth[24] was the first to describe a technique in which a screw is placed through the clavicle and then inserted into the base of the coracoid process, thus reducing the acromioclavicular joint (Fig. 2). Initially, the coracoclavicular ligaments were left alone. Others have subsequently recommended repair of the coracoclavicular ligaments along with exploration of the acromioclavicular joint.[8] Repair of the overlying deltotrapezial fascia may also be accomplished during this procedure. As with pin fixation of the acromioclavicular joint, use of hardware requires subsequent removal.

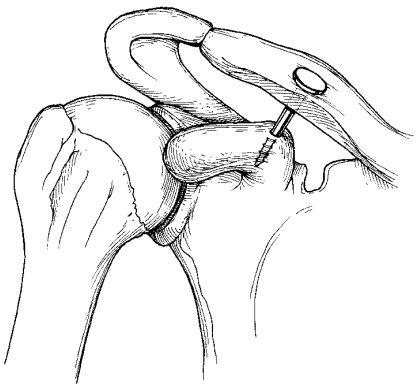

Fig. 2 Reduction of the acromioclavicular joint by inserting a screw through the clavicle and into the base of the coracoid.

To eliminate the need for screw removal, some authors have recommended use of synthetic loops between the coracoid and the clavicle. Morrison and Lemos[26] demonstrated the need for accurate positioning of the synthetic augmentation loop to achieve proper reduction of the acromioclavicular joint. The loop should be placed as near the base of the coracoid as possible and then inserted through a hole at the junction of the anterior and middle thirds of the clavicle. If the loop is too posterior or if it goes around the clavicle, it will tend to displace the clavicle anterior to the acromion. It is our recommendation that the loop be made of an absorbable material, such as a braid of polydioxanonsulfate sutures forming a 5- or 10-mm band. Nonabsorbable materials are used by many surgeons,

although potential problems include erosion through the clavicle or coracoid and the risk of late infection.

Excision of the Distal Clavicle

Weaver and Dunn[25] described a procedure they use to treat both acute and chronic dislocations of the acromioclavicular joint. Recently, most authors have reported using some variation of this procedure when surgical reconstruction of the joint is elected.[13,14] Our preference is to perform a variation of the Weaver-Dunn operation, with resection of the distal clavicle and recreation of the coracoclavicular ligaments by using the coracoacromial ligament as a substitute (Fig. 3).[26] With this procedure, the distal end of the clavicle is resected, and the coracoacromial ligament is detached from the acromion and transferred to the hollowed canal of the clavicle, where it is sutured to bone. A thin sliver of bone from the acromial attachment may be taken to allow bone-to-bone healing of the reconstruction. In this manner, the coracoacromial ligament becomes the newly reconstructed coracoclavicular ligament. Placement of an augmentation band made of an absorbable braid or ribbon between the coracoid and the clavicle will protect the reconstruction in the early stages of healing. A 5-mm band of polydioxanonsulfate has a high initial strength of 350 N and a half-life of 6 weeks, which provides protection until the coracoclavicular ligament reconstruction has healed.

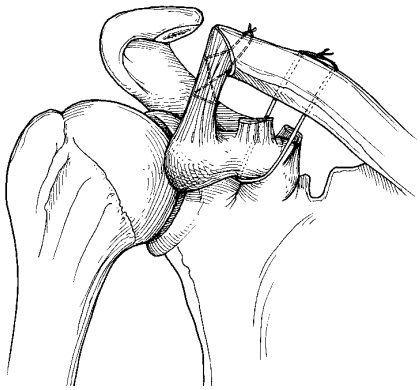

Fig. 3 Variation of the Weaver-Dunn procedure with transfer of the coracoacromial ligament.

Type IV Injuries

All authors agree that posterior displacement of the clavicle through the trapezius will lead to discomfort with motion. They therefore recommend surgical treatment of this deformity. Options include closed reduction, converting the injury to type III, and then treating conservatively or with open reduction and fixation by means of one of the options outlined under the treatment for type III injuries. We prefer operative reduction of these injuries because posterior displacement of the clavicle involves considerable stripping of the deltotrapezial fascia. As with type III injuries, we prefer to resect the end of the clavicle and reconstruct the coracoclavicular ligament with the coracoacromial ligament. Meticulous closure of the deltotrapezial fascia over the clavicle augments stability.

Type V Injuries

Type V injuries require surgical fixation because of the substantial fascial stripping and the potential for compromise of the overlying skin. Meticulous repair of the deltotrapezial fascia will also aid in securing the repair. We prefer to excise the end of the clavicle because of the concern that degenerative arthritis will eventually develop after reduction of the acromioclavicular joint, causing discomfort and setting the stage for rotator cuff impingement if inferior clavicular spurs develop. No compromise in muscle strength has been reported with excision of the distal clavicle in athletes.[16]

Type VI Injuries

These are exceedingly rare injuries. The potential for closed reduction of such an extensive injury is exceedingly remote. We recommend operative reduction and reconstruction. Excision of the distal clavicle would aid in reduction of the acromioclavicular joint.

Fractures of the Distal Clavicle

Classification

Fractures involving the distal portion of the clavicle have a characteristic pathologic anatomy that relates to the position of the fracture with respect to the coracoclavicular ligaments (Fig. 4). A type I fracture is distal to the coracoclavicular ligaments. Because the ligaments remain intact, there is little displacement of the fracture fragments.

Type II fractures occur medial to (type IIA) or between (type IIB) the coracoclavicular ligaments. As the medial clavicle fragment lacks vertical stability from the coracoclavicular ligaments, it can be displaced superiorly. Displacement of the fragments is further accentuated by muscle forces and the weight of the arm. Because of these factors, nonunion of the clavicle is frequent.

Type III fractures are intra-articular, frequently without ligament disruption. Because there is often little or no displacement, these fractures are frequently missed or mis-

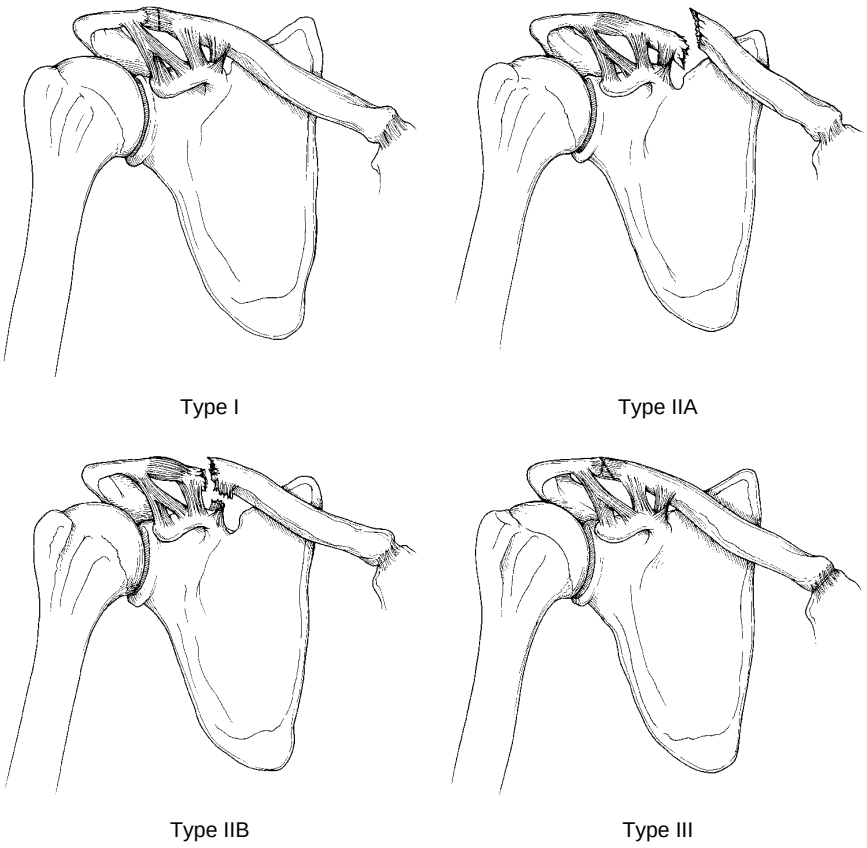

Fig. 4 Types of distal clavicle fractures. A type I fracture is distal to the coracoclavicular ligaments, with little displacement of the fracture fragments. A type IIA fracture is medial to the coracoclavicular ligaments. A type IIB fracture occurs between the coracoclavicular ligaments. Type III is an intra-articular fracture, frequently without ligament disruption.

diagnosed as acromioclavicular joint injuries. Intra-articular extension of the fracture line may also be seen, with pathologic changes similar to those of a type II injury. These fractures are also unstable, and treatment considerations are similar to those for type II fractures.

Treatment

Type I and III fractures can be treated with immobilization with a sling. These fractures typically heal with minimal deformity. Fractures into the joint present some risk of long-term degenerative change but can be treated with resection of the distal clavicle if the condition becomes chronically symptomatic.

Type II fractures of the distal clavicle have a high incidence of nonunion (20% to 30%) if treated nonoperatively.[27] If the ligament disruption and fracture-dislocation are left unattended, there may be residual shoulder dysfunction and pain.[28] These fractures are generally reduced and fixed internally.[29] The optimal type of fixation has not been determined. Options include placement of pins across the fracture, cerclage wiring of the fracture fragments, plate fixation if the distal fragment is large enough, and fixation of the displaced proximal clavicle with a coracoclavicular screw.

A recent study indicated that these nonunions may remain asymptomatic and not require fixation.[27] Another option would be to treat the type II fracture conservatively, excising the distal clavicle and performing a Weaver-Dunn ligamentoplasty only if the patient remains symptomatic.

Complications

Complications related to acromioclavicular injuries may occur as a result of the injury or its treatment. Complications related to an injury to the acromioclavicular joint include associated fractures of the distal clavicle or the coracoid. Fractures of the coracoid are rare and easily missed when they are associated with an acromioclavicular separation. More commonly seen after these injuries are calcification and ossification of the ligamentous structures. This occurs in injured coracoclavicular ligaments as often as 40% of the time. Individuals with type I and type II injuries may be more prone to degenerative arthritis and osteolysis of the distal clavicle.[17]

Complications related to the surgical treatment of acromioclavicular sprains are numerous and can be quite severe. The most worrisome complication is injury to the great vessels and the possibility of death related to pin migration. The use of hardware may be unnecessary in the treatment of these injuries and should be avoided if possible.

Inadequate resection of the clavicle, particularly if the joint remains unstable, will result in continued pain. Overzealous resection may further compromise stability of the joint. We have recently seen three infections related to use of nonabsorbable augmentation tapes. One of these occurred as late as 5 years after the index procedure.

Summary

There is general agreement on the appropriate treatment of type I, II, IV, V, and VI acromioclavicular joint injuries. Type I and II sprains should be treated conservatively, with restriction of activity and analgesia until the patient is comfortable enough to return to activity. Type IV, V, and VI injuries require open reduction and repair or reconstruction of the ligamentous structures. We recommend a variation of the Weaver-Dunn procedure for reconstruction, with excision of the distal clavicle, reconstruction using the coracoacromial ligament, and augmentation with an absorbable tape between the coracoid and the clavicle. Disagreement still exists regarding the most appropriate treatment of type III injuries, particularly in the dominant extremity of the throwing athlete or heavy laborer. Studies show no convincing difference between operative and nonoperative treatment in the level of function ultimately attained. We tend to treat all individuals with a type III separation conservatively and rely on reconstruction if the athlete remains symptomatic. To date, the literature has not shown a clear-cut advantage to early repair or reconstruction of the type III ligamentous injury. The long-term results of all forms of treatment, both open and closed, have been satisfactory.

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