Classification of Distal Clavicle Fractures and Indications for Conservative Treatment

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KEYWORDS

• Distal clavicle fracture • Neer classification • Clavicle • Conservative treatment

KEY POINTS

- Distal clavicle fractures are typically caused by direct force to the lateral shoulder.
- Fracture stability is governed by integrity of the acromioclavicular and coracoclavicular ligaments.
- Treatment depends on displacement and stability of the fracture.
- Although management of Neer type II fractures is controversial, types I and III can often be managed nonoperatively.
- Possible complications of nonoperative management include nonunion and acromioclavicular joint arthritis.

INTRODUCTION

Distal or lateral third clavicle fractures are a common injury treated by orthopedic surgeons, yet their nuanced and variable presentation can lead to a lack of consensus in their management. Fractures of the distal clavicle are typically caused by a fall directly onto the lateral shoulder or direct force to the shoulder.[1,2] Clavicular fractures represent 2.6% to 10% of all fractures in the body.[2–6] These fractures have a bimodal distribution, most commonly occurring in younger men and then next most commonly in both men and women aged older than 70 years.[7] Distal third clavicle fractures account for 10% to 30% of all clavicle fractures.[1,4–6,8–11]

Distal clavicle fractures are a unique subset of clavicle fractures (distinct from midshaft of medial-third clavicle fractures) because of their ligamentous attachments and articulation with the coracoid process and acromion. As such, the distal clavicle acts

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as an important strut between the axial skeleton and shoulder girdle and aids with shoulder strength, mobility, and function.

Historically, the vast majority of distal clavicle fractures were managed nonoperatively.[12] It was not until the 1960s, when Dr Charles Neer described the effect of distal clavicle nonunion as a disruption to the coracoclavicular (CC) ligaments[13] that operative fixation was more regularly considered. Although relatively uncommon, clavicle malunions and nonunions have long-term consequences such as persistent pain, loss of strength, and decreased range of motion.[14–17] Since then, significant research on the treatment and classification of distal clavicle fractures have been described, with ongoing work to elucidate which fracture patterns require surgical intervention and which surgical techniques may be most effective for achieving anatomic union.

When indicated, conservative management of distal clavicle fractures involves sling immobilization for 2 weeks, gradual range of motion exercises, and is a reliable method of providing excellent return of function to the extremity, with expected return to sport in 3 to 4 months.

Anatomy

Critical to understanding management of distal clavicle fractures is an understanding of its articulation with the scapula through its soft tissue attachments. Movement of the shoulder and scapulothoracic motion is governed by the articulation of the distal clavicle and scapula.[18] Specifically, glenohumeral motion is influenced by integrity of the ligamentous attachments between the distal clavicle and coracoid.[18] The distal clavicle's integrity is intimately involved with the acromioclavicular (AC) joint. The critical structures that portend stability to the AC joint include the AC capsule, AC ligament, CC ligaments, and coracoacromial (CA) ligaments.[19] The capsuloligamentous AC complex attaches to the distal clavicle approximately 6 mm medial to the AC joint.[20] The AC ligaments attach from the medial acromion to the distal clavicle and act as a primary constraint for posterior displacement of the clavicle.[21] Specifically, the posterior and superior AC ligaments are most important for providing anterior-posterior stability to the AC joint.[21] When the AC joint capsule is disrupted, the CC ligaments then become the primary restraint to anterior-posterior translation.[22] The CC ligaments, composed of the conoid and trapezoid ligaments, are responsible for superior-inferior stability of the distal clavicle with respect to the coracoid process.[21–24] The CC ligaments originate at the base of the coracoid process and insert on the inferior aspect of the distal clavicle. There is some variability in the attachment sites for the conoid and trapezoid ligaments as measured from the distal clavicle between individuals. The trapezoid ligament attaches to the distal clavicle approximately 2 to 3 cm from the AC joint.[20,25] The conoid ligament attaches approximately 4.5 cm from the AC joint.[20,25] On average, the distance between the coracoid process and undersurface of the clavicle, also known as the CC interspace, is approximately 1.1 to 1.3 cm.[26]

Apart from ligamentous anatomy, muscular anatomy surrounding the clavicle dictates many of the deforming forces after a fracture. Muscular attachments to the clavicle include the sternocleidomastoid, trapezius, pectoralis major and minor, and latissimus dorsi.[27] The anterior deltoid inserts on the anterior superior clavicle, whereas the trapezius inserts on the posterior superior clavicle. The subclavius muscle is found on the inferior surface or the subclavian groove of the clavicle. Anteriorly, the clavicular head of the pectoralis major originates on the medial clavicle. Posteriorly, the trapezius inserts posterosuperior while the clavicular head of the sternocleidomastoid inserts on the medial third of the clavicle.[27]

The 4 displacing forces on the distal clavicle, described by Neer[8] include the (1) trapezius, (2) weight of the arm, (3) trunk muscles attaching to the humerus and scapula, and (4) rotary displacement from scapula ligaments. The clavicular head of the trapezius attaches on the superior, outer third of the distal clavicle, and draws the clavicular shaft posteriorly.[8] The lateral fragment of the clavicle is pulled downward and anteriorly due to the weight of the arm.[8] The trunk muscles attaching to the humerus and scapula can displace the distal outer clavicular fragment medially toward the apex of the thorax.[8] Finally, the scapular ligaments can rotate the distal fragment as much as 40° with movement of the arm.[8]

The clavicle has an "S" shape in the coronal plane and cephalad-to-caudad bow. A cadaveric biomechanical study demonstrated that different regions of the distal clavicle have differences in bone mineral density and cortical thickness.[28] Length of screws inserted in the superior-inferior dimension can range from 14 to 16 mm in women and 16 to 18 mm in men.[27]

Concerning blood supply, the clavicle has periosteal contributions from the suprascapular artery, thoracoacromial artery, and internal thoracic or mammalian artery.[29]

Mechanism of Injury

The mechanism of injury for fractures of the distal clavicle fractures is typically from a medially directed force from either a fall or a traumatic event in which the lateral shoulder (tip of acromion) is driven into the ground or rigid surface.[30,31] In particular, when the arm is in an adducted position, this force can be transmitted through the AC joint to the distal clavicle and CC ligaments due to the robust stability of the sternoclavicular joint.[25] The bone fails superiorly with tension and inferiorly with compression.[32] These injuries are common in young active individuals who participate in sports or high-speed activities, such as after being tackled or falls from bicycles.[33] This is evidenced by the fact that the mean annual incidence is highest in men aged younger than 20 years.[34] Common sporting activities associated with clavicle injuries include American football, cycling, motocross, and horseback riding.[35]

Presentation and Physical Examination

Presentation is most common after a fall onto the lateral shoulder or from a direct, medially directed blow onto the distal clavicle.[30,31] On physical examination, patients typically present with tenderness to palpation about the distal clavicle and pain with both active and passive range of motion of the shoulder, in particular, cross-body adduction. If there is a significant soft tissue injury patients may present with ecchymosis and swelling, or if fracture displacement is significant enough, there may be tenting of the skin. A thorough examination of surrounding soft tissue should be undertaken. Although motor deficits from nerve injury are rare, paresthesias and numbness can be common, due to swelling, compression, or injury to the supraclavicular nerves.[33] Rarely, suprascapular nerve injuries can lead to weakness in external rotation with the arm adducted.[36]

Imaging

Imaging after the aforementioned presentation should include standard true anteroposterior (Grashey views) and axillary radiographs of the shoulder as well as dedicated clavicle XRs.[33] If a distal clavicle fracture has been identified, then imaging that includes the bilateral AC joints or a contralateral shoulder XR can be useful to compare fracture displacement with the uninjured side. This is particularly helpful for assessing fracture pattern and displacement when normalized to a patient's given anatomy.[33]

Additionally, a Zanca view, which is a shoulder XR with a 10° to 15° cephalic tilt, can be helpful for determining intra-articular involvement.[25]

Although not often included in diagnostic workup, if a fracture has significant comminution or intra-articular extension, or in cases of nonunion/malunion, a CT may also be considered to help better evaluate bony pattern. The authors recommend utilization of MRI if there is concern for concomitant soft tissue injury to the rotator cuff or intra-articular glenohumeral pathology is suspected, although this type of pathologic condition is rare.[37]

Classification

The Neer classification system, which is based on the fracture location in relation to the CC ligament on an anteroposterior radiograph, is widely used.[4,6,8] The original Neer classification[8] described in the 1963 described 3 fracture types in relation to the CC ligaments. In subsequent articles, addendums to include periosteal sleeve avulsion fractures in children and comminuted fractures with an inferior bony fragment were included.[4,8,27] Thus, the most commonly used classification today is a modification to the Neer classification, as follows[4,38] (**Fig. 1**).

- Type I: extra-articular fracture lateral to the CC ligaments, with intact CC ligaments, and sparing the AC joint
- Type II: fracture occurring medial to the CC ligament, with 2 subtypes
  - IIA: fracture occurs medial to the conoid ligament, both conoid and trapezoid ligaments remain intact
  - IIB: fracture occurs between the conoid and trapezoid ligaments with rupture of the conoid ligament
- Type III: fracture lateral to the CC ligaments with extension into the AC joint
- Type IV: fracture with disruption of the periosteal sleeve (in skeletally immature) and superior displacement of the medial fragment
- Type V: fracture medial to the CC ligament, comminuted, and small inferior fragment attached to CC ligament

The modified Neer classification is helpful in determining management. In most cases, types I and III distal clavicle fractures are deemed stable and usually can be

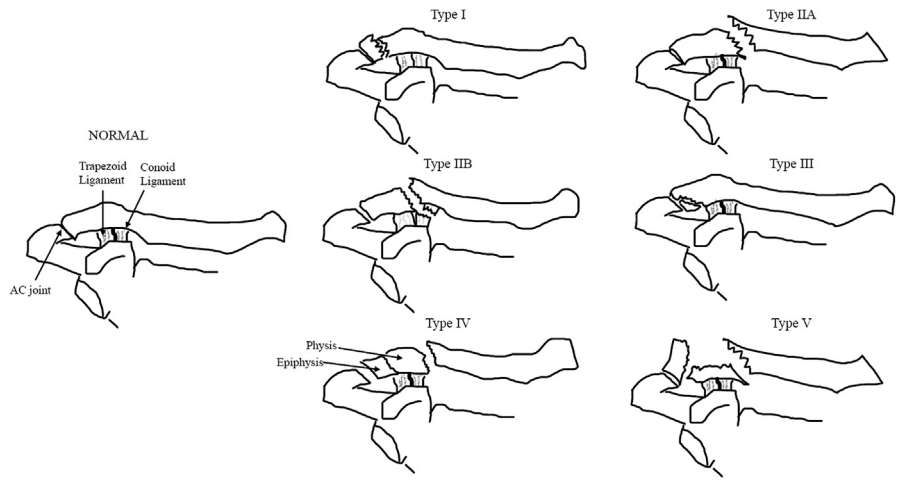

Fig. 1. Modified Neer classification for distal clavicle fractures.

managed conservatively, whereas types II and V are unstable patterns and can be managed either nonoperatively or operatively.

The AO classification[39] for distal clavicle fractures is below.

Type A: nondisplaced fracture with intact CC ligaments
A1: extra-articular; A2: intra-articular
Type B: displaced fracture with intact CC ligaments
B1: extra-articular; B2: comminuted
Type C: displaced with torn CC ligaments
C1: extra-articular; C2: intra-articular

In more recent years, several studies have proposed new classification systems to improve interobserver and intraobserver reliability and utility of fracture classification. In 2018, Cho and colleagues[40] described a classification system utilizing anteroposterior and oblique views of the AC joint and axial shoulder radiographs. This classification system demonstrated moderate interobserver ($k = 0.434$) and substantial intraobserver ($k = 0.644$) reliability. This classification system describes.

Type I–stable: nondisplaced or minimally displaced (<5 mm) irrespective of location
Type II–unstable ($\geq$5 mm)
IIA: medial to CC ligaments; conoid and trapezoid ligaments intact
IIB: medial to CC ligaments; conoid ligament torn, trapezoid ligament intact
IIC: lateral to CC ligaments; conoid and trapezoid ligaments torn
IID: comminuted fracture with CC ligaments attached to inferior fragment

The authors' preferred classification system remains the Neer classification because this provides concise information that is clinically relevant to treatment algorithms (operative vs nonoperative) and allows for consistent communication, given its widely accepted utility.

Nonoperative Management

Determining whether to operate or not on distal clavicle fractures depends on many factors involving the patient, concomitant injuries, fracture characteristics, timing, and skin compromise. Many studies have attempted to elucidate prognostic factors for fracture healing without surgical intervention. Although some distal clavicle fracture patterns are more clearly defined, there are also fracture variations that may spark more controversy.

Absolute indications for surgical intervention include open fractures, skin tenting, neurovascular injury, or floating shoulder.[41] Indications for initial conservative management include stable fracture patterns such as Neer type I and III distal clavicle fractures. This is generally agreed upon as these fracture patterns do not disrupt the CC ligaments and are typically not significantly displaced.[33] Nondisplaced type II distal clavicle fractures can also typically be managed nonoperatively, although this is more controversial. Displaced type II and V fractures are more commonly treated operatively given their higher risk of nonunion, which can be symptomatic.[11,33,42,43] However, debate remains regarding the degree of dysfunction in patients who go on to develop nonunion, specifically older patients.[6,44]

Various nonoperative measures can be used. Most conservative treatment begins with sling immobilization for 2 weeks primarily for pain control, the authors recommend early initiation of passive range of motion, including pendulum exercises. The authors recommend repeating radiographs within 1 to 2 weeks of injury if any question of fracture stability remains following initial presentation. Although historically, figure-of-eight braces were used, no improvement in outcomes compared with sling

immobilization has been demonstrated.[45] One randomized controlled trial demonstrated similar functional and cosmetic outcomes between sling immobilization and figure-of-eight bracing, while actually reducing short-term pain by wearing a simple shoulder sling.[46] Furthermore, figure-of-eight bandages may even lead to problems such as temporary neurovascular dysfunction and pseudoarthrosis.[45] As pain improves, gentle shoulder motion, including passive range of motion and active-assisted motion is initiated at 2 to 4 weeks.[33,35,41] At 6 weeks, the authors recommend repeat radiographs to be obtained to assess for fracture callus and maintenance of alignment. At that point, if pain has been managed well and there are radiographic signs of union, strengthening exercises are initiated,[33] with expected return to sport at 3 to 4 months[35] (**Fig. 2**A and B).

The bulk of the literature has focused on operative versus nonoperative treatment of type II distal clavicle fractures. Although good functional outcomes have largely been reported for conservatively managed type II fractures, nonunion rates after conservative management have been reported to range from 28% to 44%.[1,11,30,42,47–49] Important to note, however, is that only a fraction of patients who develop nonunion are symptomatic.[44] In one study, although 21% of patients with distal clavicle fractures went onto nonunion, only 14% required surgery for persistent symptoms.[30] Furthermore, many of these patients maintain their functionality despite radiographic nonunion.[30,44] In a large case series of 127 patients, there were no significant differences in Constant or Short Form-36 scores between patients with nonunion or those whose fractures had healed, or those who had nonunion and those who had undergone delayed surgery.[30] Conversely, a prospective, randomized controlled trial published in 2021[50] demonstrated that while functional outcomes were equivalent at 1 year between operatively and nonoperatively managed patients, 15% of patients in the nonoperative cohort needed surgery for symptomatic nonunion. In contrast, 44% of patients in the operative group underwent a second surgery—however all were for implant removal, which in contrast was a relatively benign procedure. The operative group also had a significantly higher percentage of patients return to work by 6 months (78% vs 44%) and all but one patient in the operative group achieved union.[50] More work must be done, in particular, likely randomized controlled trials, to elucidate which type II injuries should be managed operatively to avoid more symptomatic nonunions.[44]

Type I and Type III fractures are unique in that because the fracture is located lateral to the CC ligaments, they are inherently more stable and amenable to primary healing. To the authors' knowledge, there are no dedicated case series that report the rate of distal clavicle resection for these patients who go on to develop AC arthrosis following distal clavicle fracture union.

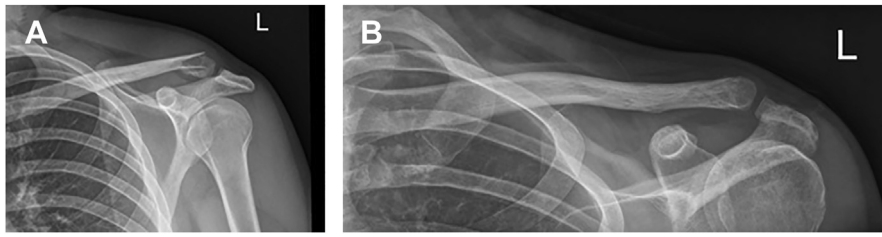

Fig. 2. (*A*) A 32-year-old man with left distal clavicle fracture sustained by fall directly onto lateral shoulder while playing soccer (*B*) Same individual after 4 months of nonoperative management, demonstrating excellent healing/remodeling.

CLINICS CARE POINTS

- Careful evaluation of radiographs to determine fracture pattern and stability at initial evaluation is essential for proper management.
- Shared decision-making[51] with discussion of risks and benefits of nonoperative and operative measures should be had with the patient regarding expectations and goals management of a distal clavicle fractures.
- If a patient with a Type II Neer distal clavicle fracture elects to pursue nonoperative treatment, they should understand that a malunion or nonunion can occur up to half of the time; however, full clarity of the clinical impact of this outcome is uncertain.

Summary

Most patients can expect good functional outcomes even with conservative management of distal clavicle fractures; however, in displaced type II and V fractures there is likely a benefit to operative management with regards to achieving reliable rates of union and returning to normal function at an earlier time point. Patients should understand that there may be residual cosmetic deformity if their fracture is displaced and they elect for nonoperative treatment. A sling is sufficient for nonoperative management for 2 weeks for pain control, at which point gentle range of motion exercises can be started. At 6 weeks, if signs of radiographic union are maintained, strengthening exercises can be incorporated in physical therapy.

DISCLOSURE

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