Operative Management for Displaced Distal Clavicle Fractures

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KEYWORDS

• Distal clavicle fracture • Lateral clavicle • Coracoclavicular ligaments
• Surgical fixation • Athlete

KEY POINTS

- Operative treatment is favored for fractures medial to the CC ligaments (Neer type 2A), with CC ligament injury (Neer types 2B and 5) and with concern for skin compromise. In addition, operative treatment is favored for displaced fractures in athletes.
- The most common fixation techniques currently include locked plating, CC fixation with a variety of devices, and combination locked plating with CC fixation. Hook plates may be useful for very lateral fractures, but surgeons should be aware of complications specific to this implant. Tension banding and K-wire constructs should not be considered a first choice.
- Arthroscopically assisted techniques allow the surgeon to address concomitant shoulder pathology.
- While the surgical outcomes of subacute or chronic injuries is inferior to acute injuries, they can be managed successfully through locking plates with CC fixation or salvage AC + CC reconstruction procedures if the lateral fragment is not amenable to fixation.
- The rate of symptomatic hardware requiring removal has been reported to be 50%, and surgeons should aim to use low-profile constructs when feasible.

INTRODUCTION

The previous section on the nonoperative management and classification of distal clavicle fractures has noted that many distal clavicle fractures are amenable to nonsurgical treatment. However, nonunion is estimated to occur in 31% of fractures treated nonoperatively, with the strongest predictors being a high degree of displacement (>100%) and advancing age.[1] These nonunions are estimated to be symptomatic in 50% of patients. A recent systematic review found 8% later undergo surgery.[2]

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While nonsurgical management is appropriate for many distal clavicle fractures, acute operative fixation of displaced fractures provides faster union and more predictable outcomes than nonoperative management. Hence surgery the treatment of choice in athletes for displaced fractures. A recently published prospective, randomized controlled trial of nonoperative versus operative treatment of displaced distal clavicle fractures found the nonoperative group to have a slower return to full activity and less satisfaction with their shoulder cosmesis than the surgery group. In addition, 63% of the nonoperative group developed a nonunion, of which 33% underwent a corrective surgery by 1 year; moreover, two of these patients required multiple procedures.[3] A separate study found that distal clavicle fixation at >4 weeks from injury resulted in lower function scores and a higher complication rate.[4] The literature lacks well-established predictors of which patients will not tolerate a nonunion. In light of inferior subacute outcomes, acute fixation is preferred for displaced fractures, particularly in athletes.

While surgeons may debate whether the frequency of symptomatic nonunion justifies fixation in general for these fractures, acute surgical fixation is the optimal strategy for displaced distal clavicle fractures in athletes because it facilitates return to play. Moreover, for other patient populations, acute surgical management reduces the risk of nonunion, avoids the surgeon having to guess if a patient will be symptomatic from a nonunion, and avoids the inferior results of subacute treatment. In this section, we review the operative management of displaced distal clavicle fractures, including relevant anatomy, indications for surgery, described techniques, and the current clinical outcomes literature.

RELEVANT ANATOMY AND BIOMECHANICS

The static stabilizers of lateral clavicle include the coracoclavicular (CC) and acromioclavicular (AC) ligaments (Fig. 1). The CC ligaments include the conoid ligament medially and the trapezoid ligament laterally, which originate from the coracoid and insert

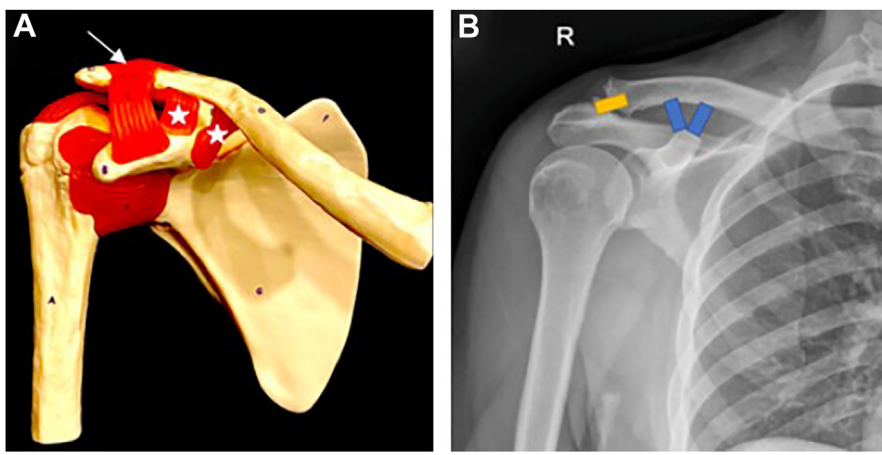

Fig. 1. Anatomy of distal clavicle and stabilizing ligaments. (*A*): Model shoulder including the acromioclavicular (AC) ligaments indicated by the white arrow and coracoclavicular (CC) ligaments indicated by white stars, with the conoid ligament being more medial. (*B*): A shoulder radiograph with a schematic representation of the AC ligaments in yellow and CC ligaments in blue.

approximately 45 and 25 mm from the lateral end of the clavicle.[5] The CC ligaments provide predominantly vertical stability to the lateral clavicle. The normal distance between the coracoid and clavicle at this level is 11-13 mm. This measurement can vary significantly based on radiographic projection, and a comparison to the contralateral side can be useful with < 5 mm of difference being considered uninjured.[6] The AC ligaments surround the AC joint capsule with thickenings anteroinferiorly and posterosuperiorly; the posterosuperior is the more robust bundle.[7] The AC ligaments provide predominantly horizontal stability.[7] These ligaments are rarely injured in lateral clavicle fractures, and an effort should be made to preserve the ligaments during surgery to avoid iatrogenic instability of the AC joint.

The dynamic stabilizers of the lateral clavicle include the anterior third of the deltoid and the trapezius, which originate on the anterior-inferior and posterior-superior surface of the lateral clavicle, respectively.

The clavicle serves as a lateral strut to the shoulder girdle and its length is essential to the complex mechanics of the scapulothoracic articulation. Shortened clavicle malunions have been shown to result in inferior, anterior, and medialized scapular position, and diminish tolerance for overhead activities.[8–11]

Evaluation and Imaging

The evaluation and imaging relevant to distal clavicle fractures are discussed in Lian and colleagues' article, "Classification of Distal Clavicle Fractures and Indications for Conservative Treatment," in this issue. The most important factor to evaluate on physical exam is the presence of an open fracture or impending skin compromise. Imaging should include radiographs with a 10 to 15° cephalic tilt, which will better assess the superior displacement compared to neutral tilt projections; this view is also known as a Zanca view. CC ligament injury can be inferred by the involvement of the inferior clavicle surface at their insertion. Computed tomography (CT) images can be obtained to assess lateral bone stock, but are generally not required.

Indications for Operative Management

There are not absolute evidence-based indications for the operative management of closed distal clavicle fractures, largely owing to the frequency of asymptomatic nonunions. In general certain fracture patterns are recognized to have a low rate of nonunion and may be treated nonoperatively:

Fractures lateral to intact CC ligaments and not involving the AC joint (Neer type 1).

Physeal fractures involving lateral clavicle tearing through the periosteal sleeve (Neer type 4).

Intra-articular fractures lateral to the intact CC ligaments have generally treated nonoperatively. Recently, some surgeons have advocated for operative repair of these injuries due to a higher than expected rate of nonunion, which they postulated was due to deforming forces of the deltoid and trapezius causing horizontal instability.[1,12] However, this is not yet a universally applied surgical indication.

Indications for operative management include.

- Displaced fractures medial to the CC ligaments (Neer type 2A)
- Displaced fractures involving partial (Neer type 2B) or complete CC ligament injury (Neer type 5)
- Open fractures or those with impending skin compromise.

As with all fractures, the patient's activity level and individual risk factors should be considered. Surgical fixation may be relatively indicated in physiologically younger and more active patients, although surgeons should be aware that advancing age is

a risk factor for nonunion.[1] Smoking, malnutrition, and severe medical comorbidities have also been reported to increase the risk of nonunion,[1,13] but those factors are also relative contraindications to surgical treatment.

With regard to athletes, there are no studies directly comparing return to play for operative and nonoperative treatment to guide management. In general, nondisplaced fractures can be treated non-operatively with return to play guided by signs of radiographic union. Surgical management is favored for displaced fractures. This preference relates to better predictability of fracture union and functional outcomes, and mitigating scapulothoracic dyskinesia related to loss of the clavicle strut. The trend towards surgical management in athletes is reflected in a recent systematic review that found 204 displaced lateral clavicle fractures in athletes were treated surgically compared to only 6 patients treated nonsurgically.[14]

Surgical Techniques

Multiple techniques for operative fixation of distal clavicle fractures have been described. A comprehensive list can be found in **Table 1**. While successful outcomes have been reported with all of these techniques, the most common today are locking plates, CC repair with suture button implants or cerclage, combined plating with CC suture buttons or cerclage, and hook plates.

Locking plates

A 2021 survey found that the most common operative treatment was locking plates.[15]

Several commercially available anatomically contoured plates have lateral screw clusters to achieve fixation in even small fragments. For most of these cluster designs, obtaining three screws in the lateral fragment requires the fragment to be 10 to 15 mm in size. Some plates are designed with suture holes or to accommodate flush nesting of a suture button if the surgeon wishes to augment the construct with CC suspensory fixation. Drawbacks to locked plating include that lateral comminution can preclude adequate purchase and implant prominence. A retrospective review including 16 distal clavicle fractures treated with plates and screws (not including hook plates) found a 50% hardware removal rate,[16] although other studies have reported lower rates.[17–19] Successful outcomes have also been reported with non-locking "T" plates[20] and mini-fragment plates.[21]

Coracoclavicular suture fixation

CC suture fixation has been described using a suture anchor in the base of the coracoid, cortical button-based suspensory devices passed through the coracoid, and with cerclage sutures around the coracoid. CC screws, also referred to as Bosworth screws, are similar in concept but have fallen out of favor due to reports of migration, screw breakage, and loss of reduction. In addition, they require subsequent surgery for removal.

There are multiple descriptions of arthroscopically assisted techniques. The benefits of an arthroscopic approach include smaller incisions, less stripping of the clavicle's blood supply, and excellent visualization of the coracoid base. Arthroscopy also allows the identification and management of concomitant pathology, which is present in as high as 44% of patients.[22] This approach can be technically challenging (as reflected in longer operative times), and requires conversion to an open approach if scar tissue blocks CC reduction or in the event of coracoid injury. A systematic review on union rates and function following arthroscopically assisted CC fixation found similar results to open techniques.[22] Thus, surgeons may elect this approach based

Table 1
Operative techniques for distal clavicle fixation

Technique	Description	Variations	Pros and Cons
Locking plate	Osteosynthesis with locking fixation in small lateral fragment through a screw cluster	• Anatomic contoured plate • Locking mini-fragment plates • Volar distal radius locking plates	*Pros*: • Robust fixation in lateral fragment *Cons*: • Hardware prominence • Cannot use with lateral fragment < 10–15 mm
Coracoclavicular ligament suture/ suture button repair	Suture ± cortical button or anchor passed through or around clavicle and/or coracoid to stabilize conoid and trapezoid ligament attachments.	• Coracoid: anchor in base, button through coracoid, or sutures passed under coracoid • Clavicle: button on the tsuperior clavicle, bone tunnels, or tied over top • Approach: open or arthroscopy assisted	*Pros*: • Low profile • More directly addresses vertical instability *Cons*: • Coracoid fracture • Clavicle fracture adjacent to tunnels (rare)
Locking plate with CC fixation	Anatomic plate augmented with CC fixation.	Various combinations of plate and CC fixation techniques.	*Pros*: Biomechanical strength *Cons*: Hardware prominence of plate
Hook plate	Cortical plate medially with a hook laterally that is positioned to sit beneath the acromion.	• 90° plate • 115° plate	*Pros*: Provides stable fixation for very small or comminuted lateral fragments. *Cons*: • Requires hardware removal • Acromial erosion or fracture • Subacromial impingement or rotator cuff tear • AC joint arthrosis

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Table 1
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Technique	Description	Variations	Pros and Cons
Mini fragment plating	Osteosynthesis with mini fragment plates.	• Single "T" plate • Dual plating	*Pros*: Low profile *Cons*: Cannot use with lateral comminution
Trans-osseous suturing	2–3 high tensile strength sutures through drill tunnels in fragments.	With and without sutures around the coracoid.	*Pros*: Low profile *Cons*: Cannot use with lateral comminution
Coracoclavicular (Bosworth) screw	6.5 mm or 4.5 mm screw placed through clavicle and coracoid		*Con* • Requires hardware removal • Migration, screw breakage and loss of reduction
Kirschner wires/Knowles pin	Temporary pin fixation across fracture	• Trans-acromial pins • Tension band wiring • Intramedullary fixation	*Pros*: low cost *Cons*: • Skin irritation • Pin migration and higher rates of lost fixation

on their experience and comfort level. The potential to identify and address concurrent intra-articular pathology makes this an attractive option for the treatment of athletes.

Clinical outcomes of CC fixation have been reported to be similar to or better than anatomic plating. A retrospective cohort comparison of 15 CC fixations (augmented with K-wire fixation across the fragments) and 26 anatomic plates for type 2B at minimum 2-year follow-up found 100% union in both groups and no difference in function or pain scores (ASES and VAS pain). In addition, the CC fixation group had a better maintenance of coracoclavicular distance, shorter operative time and better cosmesis.[23] Moreover, CC fixation with suture buttons has been found to be cost-effective compared to locking and hook plates, due to lower reoperation rates and high rates of healing.[24]

There are limitations to isolated CC fixation. It is not well suited for fractures exiting medial to intact CC ligaments, or Neer type 2A injuries, because the fixation would have to be oblique towards the coracoid and the surgery may unnecessarily disrupt the intact native ligaments. Moreover, this technique would not be appropriate for fractures lateral to the trapezoid ligament that some authors have felt are horizontally unstable.[12] Other limitations include the risk of coracoid fracture with the use of fixation through the coracoid (suture buttons or anchors) or the risk of coracoid erosion due to the "sawing" effect of sutures passed under the coracoid.[25,26]

Locking plate with coracoclavicular suture reconstruction

Locking plate fixation can be augmented with combined CC fixation. Multiple implant systems are designed for this technique, but it can also be performed with any suture placed through or around a superior plate.

The combination of these techniques has been studied. Two biomechanical studies showed a higher load to failure with the addition of CC fixation compared to locking plates alone.[27,28] There are 2 retrospective clinical studies that have compared locking plates with and without CC fixation. In a series of 34 patients, Xu and colleagues[19] found a statistically significant faster union rate (mean 14 weeks vs 16 weeks) and 5 point advantage in mean Constant score at 1 year (95 vs 90) with the addition of CC fixation. There were no differences in complication and overall union rates. Salazar and colleagues[29] compared 16 patients treated with locking plates to 7 patients with the addition of CC fixation; they found no difference in union rates and function when CC fixation was added. While the number of comparative studies is limited, a recent systematic review found better Constant-Murley scores after locking plates when combined with CC fixation compared to without, but similar rates of union and complications.[2]

The decision to add CC fixation to a locking plate is also informed by studies on either fixation construct in isolation. Furuhata and colleagues[30] found that the use of a locking plate alone for fractures with CC ligament injury resulted in greater residual CC distance compared to fractures treated the same way without CC injury. This finding suggests that locking plates in isolation do not provide sufficient vertical stability in the setting of CC ligament. Therefore CC ligament injury may be an indication to add CC fixation. However, both this study and another similar study found no differences in function scores, union rate, and complications between the 2 groups.[30,31] Additionally, there are reports of favorable results with either technique in isolation for fractures with CC ligament injury.[2,32]

Overall the addition of CC fixation to locking plates improves the biomechanics of distal clavicle fracture repairs. Added CC fixation is warranted in fractures with partial or complete CC ligament injury (Neer 2B and 5), but may not be needed in many injuries with intact ligaments (Neer 2A). In the treatment of athletes, consideration should

be given to their sport-specific demands, which may favor using the biomechanically strongest construct. If CC fixation is added to injuries with intact CC ligaments, we recommend cerclage fixation (around the coracoid) to avoid the disruption of the CC ligament origins on the coracoid, which might occur when drilling to place anchors or suture button suspensory devices.

Hook plate

Hook plates involve cortical screw fixation through the plate on the medial clavicle fragment, and fixation laterally via a hook placed underneath the acromion (**Fig. 2**). This construct provides a method for fixation in distal clavicle fractures with lateral fragments too small for locked plating. It also provides vertical stability and so can be utilized when there is a concurrent coracoid fracture that precludes CC fixation. For type 2B fractures it offers the advantage of achieving lateral fixation without requiring extensive dissection around the trapezoid ligament. A recent meta-analysis found a union rate of 98% and comparable function scores compared to other methods of fixation.[32]

Of concern, the hook can erode the undersurface of the acromion. Acromial erosion was reported in 27% of cases,[32] and some patients may sustain acromial fractures.[33–35] For this reason, implant removal is recommended after fracture union, which adds to the burden of treatment. Factors that increase the likelihood of acromion osteolysis include:

Hook position posterior to the ideal position of being just posterior to the AC joint and pointing anterior[36]

Mismatch of the hook with the slope of the acromion undersurface, that results in point loading rather than load sharing across the entire hook.[37]

Permitting shoulder abduction and flexion of >90° prior to plate removal.

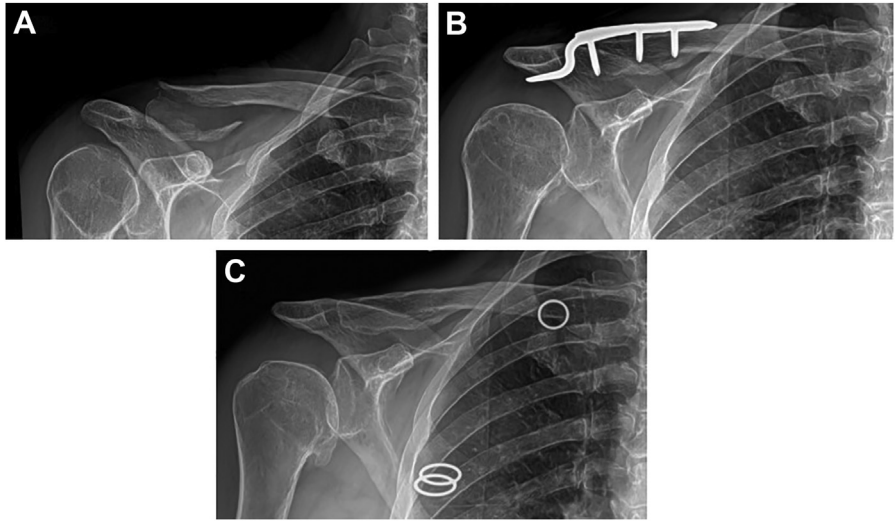

Fig. 2. Hook plate case example (*A*) Radiograph of an acute displaced distal clavicle fracture with lateral comminution. (*B*) Hook plate at 3 months post-operatively with radiographic healing. (*C*) Hook plate removed after radiographic healing. (Images courtesy of Peter S. Vezeridis, MD).

Delayed implant removal after fracture union (ie, noncompliance/loss to follow-up).

In addition, hook plates may be approached with caution when there is existing acromial erosion (such as in cuff tear arthropathy), osteoporosis, or an os acromiale.[38] The mismatch of the acromion slope and hook can be mitigated by manually contouring the plate or possibly by using newer plates with a 15° inferior angulation.[37,39] The anterior position can be ensured intra-operatively by using the posterior aspect of the AC joint capsule as a landmark for ideal hook position.

Other complications associated with hook plates include AC joint arthrosis (22%), clavicle fracture medial to the plate (22%), and painful stiffness or subacromial impingement (47%).[32,34] Rotator cuff tears have been reported, although an MRI study found no complete tears in 39 cases.[40] Lastly, one study found that 66% of athletes treated with a hook plate did not return to sports.[41] While this is a single study, these findings suggest primary distal clavicle fixation with a hook plate should be limited to narrow indications in athletes.

Trans-osseous suturing

Multiple authors have described interfragmentary suturing through anterior to posterior bone tunnels in each fragment with or without incorporating sutures passed under the coracoid.[42–44] Two retrospective reports of 20 and 12 patients showed union at a mean of less than 3 months in all but one patient.[42,43] This technique has the benefit of being low profile and inexpensive. Its limitations include not being possible for comminuted or small lateral fragments.

Other techniques (K-wires, tension band, knowles pinning)

K-wires, tension bands, and intramedullary Knowles pinning are inexpensive, now mostly historical techniques. They have been largely replaced by other methods. Two meta-analyses on the clinical outcomes and complication rates after various distal clavicle fixation techniques support abandoning Kirschner wires, Knowles pinning, and tension bands due to higher complication rates.[2,32]

TECHNIQUES FOR SUBACUTE AND CHRONIC INJURIES

The nonunion rates for displaced distal clavicle fractures suggest that surgeons who treat them initially without surgery will likely encounter symptomatic nonunions. Surgical fixation in these cases can be challenging due to the partial resorption of the lateral fragment. In addition, deformity in the clavicle for as short as 4 to 6 weeks can lead to scapular dyskinesis and affect final function.[8,45]

For cases with adequate bone quality in the lateral fragment, locking plates combined with CC fixation is the mainstay for treatment. A series of 38 nonunions treated with this technique showed a 100% union rate, alongside favorable functional outcomes and a 5% complication rate.[13] Some authors have added iliac crest or proximal humerus cancellous autograft to augment the biologic environment for healing.[46] When stable fixation of the lateral fragment cannot be achieved, we recommend fragment excision with the vertical stabilization of the medial fragment via CC ligament reconstruction using both tendon graft and suture and horizontal stabilization with acromioclavicular stabilization and/or graft reconstruction. Surgeons may elect other technique variations similar to those used for chronic AC joint separations.

The complication rates and functional outcomes of distal clavicle fracture fixation are inferior when surgery is performed at greater than 4 weeks from injury. Klein and colleagues[4] found a mean American Shoulder and Elbow Surgeons score of 78 and 36% complication rate in patients treated after 4 weeks compared to 65 and 7%, respectively, in patients treated before 4 weeks. As mentioned, surgeons should

be aware of these inferior results when considering nonoperative treatment for displaced fractures. When considering the athlete's shoulder, these outcomes support acute surgical intervention for displaced fractures.

COMPARATIVE STUDIES ON FIXATION TECHNIQUES

Recent studies have directly compared the outcomes of fixation techniques, as summarized in **Table 2**.[3,18–20,23,47–50] In general, the majority of studies comparing locked plating or CC fixation to hook plates have found similar rates of union and final functional outcome, but inferior early function and more complications with hook plates (even when excluding planned hardware removals).[32] Studies comparing locked plating with and without CC fixation have found either similar results or favor the use of adding CC fixation.[19,29]

A recent systematic review and meta-analysis of 59 studies and 2284 patients compared the results of distal clavicle fixation techniques, including locked plating, CC fixation, hook plates, K-wires, and combinations of fixation constructs.[2] With regard to function, they found that hook plates showed lower Constant scores compared to CC fixation but were similar to locking plates and K-wire constructs. There was no significant difference in union rates across all fixation methods. K-wire constructs (including tension banding) had the highest rate of complications overall, as well as specifically for hardware failure, infection, and wound complications. Hook plates had the second highest rate of complications overall, with 1 of 5 patients experiencing a complication (excluding planned hardware removals); a separate systematic review found a higher rate of complications with hook plates compared to locked plating and CC fixation.[32] The authors concluded that the first choice of surgical fixation should be CC fixation alone, followed closely by a locking plate with CC fixation.

Overall, the recent literature has helped guide the selection of fixation techniques:

Low-profile techniques, such as isolated CC fixation and trans-osseous suturing, should be favored when possible due to the frequency of symptomatic hardware and similar union rates compared to plating techniques.

There is not currently strong evidence to support arthroscopic assisted CC fixation over an open technique.

There is no strong clinical evidence to support the addition of CC fixation to locked plating. Biomechanical studies support the combination construct, and thus it may be favorable in high-demand patients such as athletes.

K-wires and tension bands should not be considered a first choice because are associated with inferior results compared to multiple other techniques.

Hook plates should be reserved for fracture patterns in which adequate fixation of the lateral fragment cannot otherwise be achieved. The need for subsequent hardware removal, higher complication rate compared to other techniques (locking plates, CC fixation, trans-osseous suturing) and risk of particularly morbid complications (ie, acromial fractures) unique to hook plates preclude more routine use of these implants. Based on these data, we propose an algorithm for fixation techniques that are best suited for particular fracture patterns (**Fig. 3**). The main points to consider are whether the lateral fragment is large enough for fixation and if the CC ligaments are intact.

Return to Sport

Unlike mid-shift clavicle fractures, there is limited literature on return to sport after distal clavicle fractures. A systematic review[14] of 204 lateral clavicle fractures treated surgically attempted to analyze return to sport rates and times for various fixation

Table 2
Comparative studies of specific fixation techniques for distal clavicle fractures

Comparison (n)	Design	Union	Final Function	Complications
CCR (23) vs HP (49)[48]	Retrospective cohort	87% vs 92% [b]	CS: 95 vs 87.[a]	0% vs 25% [a]
HP (19) vs aCCR (21)[47]	Retrospective cohort	95% vs 95% [b]	CS: 89 vs 93 [b]	16% vs 10% [b]
LP (16) vs **LP + CCR**(18)[19]	Retrospective cohort	100% both groups	CS: 95 vs 90 [a]	17% vs 31% [b]
CCR (15) vs LP (26)[23]	Retrospective cohort	100% both groups	ASES: 92 vs 87 [b]	Higher rates of AC arthritis and cosmetic dissatisfaction with LP [a]
HP (13) vs **LP + CCR** (17)[18]	Prospective RCT	100% both groups	CS: 88 vs 88 [b]	Rate not specifically reported. All HP underwent HWR, compared to 1/17 LPs.
Non-op (30) vs LP/HP (27)[3]	Prospective RCT	64% vs 95% [a]	CS: 90 vs 90 [b]	13% vs 7% [b]
LP (20) vs **CCR** (20)[49]	Retrospective cohort, multicenter	100% both groups	UCLA: 35 vs 35 [b]	25% vs 10% [b]
aCCR (16) vs HP (32)[50]	Prospective cohort	100% both groups	ASES: 89 vs 84 [a]	0 vs 3% [b]
HP (30) vs non **locking T-plate** (30)[20]	Prospective cohort	100% both groups	CS: 92 vs 92 [b]	6% vs 3% [b]

Abbreviations: aCCR, arthroscopy-assisted coracoclavicular ligament suture reconstruction; CCR, coracoclavicular ligament suture reconstruction; HP, hook plate; HWR, hardware removal; LP, Locking plate; RCT, randomized controlled trial; CS, Constant Score.
Bold type denotes techniques this review finds preferable.
[a] Statistically significant difference.
[b] Not statistically significant difference.

techniques. The overall return to sport rate including all fixation techniques was 85% at a mean 19 weeks. The lowest return to sport rates were for hook plates (79%) and tension band wiring (40%). The mean time to return was reported only for transosseous sutures, Bosworth screws, and arthroscopic CC fixation, and were found to be 13, 36 and 17 weeks, respectively. Overall, this study was limited by the few studies reporting return to sport after these injuries, and further research in this area is needed to better prognosticate and optimize treatment for athletes.

CASE EXAMPLES

Case 1

29-year-old female recreational athlete presented the day of a fall onto her shoulder while running. She had no skin compromise and was neurovascularly intact. Radiographs (**Fig. 4**) showed a displaced lateral clavicle fracture that appeared to involve the conoid ligament insertion on the clavicle and a comminuted lateral fragment. This is classified as a Neer type 2B injury.

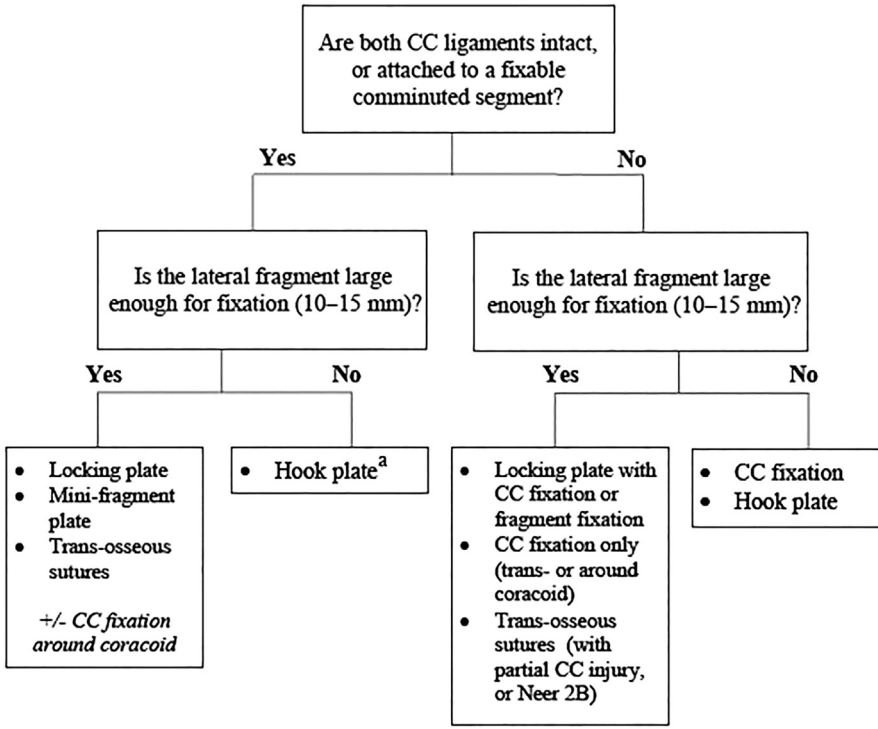

Fig. 3. Algorithm for recommended fixation techniques for acute displaced lateral clavicle fractures C [a] = this fracture pattern (lateral fragment too small for fixation with intact CC ligaments, Neer 1) is rare, and when it does occur, is typically nondisplaced. For all injury patterns, including ones with intact CC ligaments, CC fixation can be considered to augment the construct strength, but there is not strong clinical evidence to support its routine use. For injuries with intact CC ligaments, CC fixation around the coracoid is favored to avoid iatrogenic native CC ligament injury by fixation into the coracoid base.

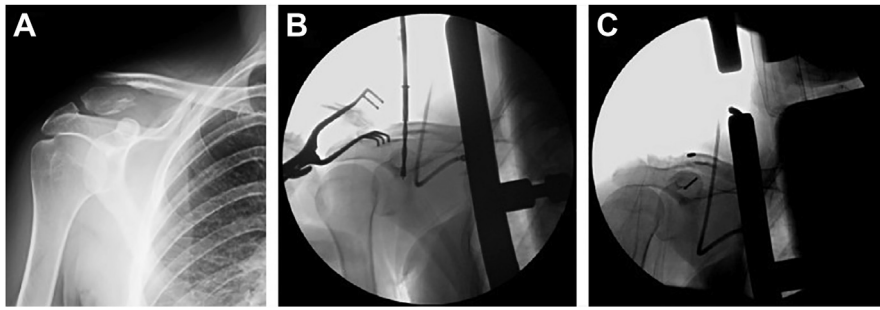

Fig. 4. Case example of a distal clavicle fracture treated with CC fixation only (*A*) Radiograph of an acute displaced distal clavicle fracture with CC ligament injury. Lateral fragment comminution is seen. (*B*) Intra-operative image shows coracoclavicular drilling. (*C*) Intraoperative image showing final reduction after suture button deployment and tensioning.

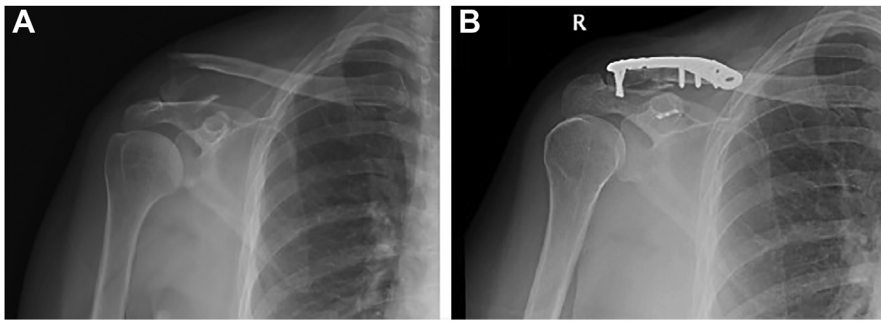

Fig. 5. Case example of displaced distal clavicle fracture treated with a locking plate and CC Fixation. (*A*) Radiograph of an acute distal clavicle fracture with > 100% displacement and a separate inferior clavicle fragment containing the CC ligament insertions. The lateral fragment measured 15 mm. (*B*) 3 month post-operative radiograph demonstrating fracture union.

Based displacement, desire to return to athletic activity, and cosmetic concerns, acute surgery consisting of CC fixation with a suture button was performed. Intraoperative fluoroscopy showing the button deployment and final reduction are shown (see Fig. 4B, C). At 2 months post-op she had near full active motion, the fracture was uniting, and she was progressing appropriately in physical therapy.

Case 2

59-year-old female housekeeper presented the day after a fall from standing onto the lateral aspect of her shoulder. She had no skin compromise and was neurovascularly intact. Radiographs (Fig. 5A) showed a displaced distal clavicle fracture with a comminuted segment involving the CC ligament insertions and a lateral fragment measuring 15 mm in length. This is classified as a Neer type 5 injury.

After a detailed discussion about treatment options, she elected acute surgical fixation. Locked plating in combination with suture button CC fixation was performed. Radiographic union was achieved at 3 months, as shown in Fig. 5B.

SUMMARY

Operative treatment of displaced lateral clavicle fractures is supported by a faster rate of recovery compared to nonoperative management, the risk with the nonsurgical treatment of symptomatic nonunion, and the inferior results of subacute operations. The fracture patterns at highest risk of nonunion that warrant fixation include fractures medial to the CC ligaments or involving CC ligament injury. Several techniques have been described with successful results, however an understanding of the injury pattern and clinical evidence can guide the surgeon to particular options. Surgeons should be aware of the high rates of symptomatic hardware with multiple techniques and the complication profile of hook plates when considering treatment options.

CLINICS CARE POINTS

- Operative treatment is favored for displaced distal clavicle fractures in athletes.
- More broadly, fracture patterns that favor operative treatment include those medial to the CC ligaments (Neer type 2A) or involving CC ligament injury (Neer types 2B and 5), and with concern for skin compromise.

- The most common fixation techniques currently include locked plating, CC fixation with a variety of devices, and combination locked plating with CC fixation.
- Arthroscopically assisted techniques allow the surgeon to address concomitant shoulder pathology.
- Hook plates may be useful for very lateral fractures, but careful attention to technique is critical to avoid complications specific to this implant, including subacromial erosion and fracture.
- Tension banding and other K-wire constructs are shown to provide inferior fixation and have higher complication rates, and should not be considered a first choice.
- While the surgical outcomes of subacute or chronic injuries is inferior to acute injuries, they can be managed successfully through locking plates with CC fixation or salvage AC + CC reconstruction procedures if the lateral fragment is not amenable to fixation.
- The rate of symptomatic hardware requiring removal has been reported to be 50%, and surgeons should aim to use low-profile constructs when feasible.

DISCLOSURE

The authors have nothing to disclose relevant to this topic.

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