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Outcomes following fixation of distal clavicle fractures utilizing arthroscopically assisted coracoclavicular ligament stabilization with a suspensory endobutton and cerclage tape

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Background: Distal one-third clavicle fractures are frequently unstable and often require surgical fixation due to high rates of nonunion. Many common methods of fixation have high rates of union but are associated with hardware discomfort and need for secondary surgery. The purpose of this study was to evaluate the outcomes of a fixation technique involving arthroscopically assisted open reduction internal fixation of unstable distal clavicle fractures via a coracoclavicular (CC) suspensory endobutton and cerclage tape.

Methods: This was a retrospective case series evaluating patients who underwent fixation of unstable distal clavicle fractures via arthroscopically assisted CC stabilization by a single fellowship-trained shoulder and elbow surgeon between 2020 and 2022. Demographic and injury-related data were collected via chart review. Preoperative and postoperative radiographs were reviewed to evaluate for signs of radiographic union. Primary outcome measures included fracture union, complications, and need for additional procedures. Patients were also contacted via telephone to obtain American Shoulder and Elbow Surgeons scores.

Results: Six patients were eligible for inclusion in this study with a mean age of 52.8 ± 14.0 and a mean follow-up of 2.0 years (range 1.6-2.7 years). Mean American Shoulder and Elbow Surgeons scores were 86.2 ± 21.8 (range 52-100). There were no postoperative complications, signs of symptomatic hardware, or need for secondary surgery at the final follow-up among this cohort of patients. All patients had achieved and maintained full radiographic union at a mean radiographic follow-up of 5.5 months (range 2.0-12.9 months).

Conclusion: Arthroscopically assisted CC stabilization of distal clavicle fractures demonstrated high union rates while limiting complications or need for secondary hardware removal. Further analysis on a larger scale is recommended to determine long-term outcomes and direct comparison to other surgical techniques.

Clavicle fractures are commonly encountered in orthopedic practice, comprising approximately 44% of fractures within the shoulder girdle.[21] While a majority can be treated nonoperatively, fractures of the distal third of the clavicle are more amenable to operative treatment due to their inherent instability and higher rates of nonunion. As originally classified by Neer,[19] type II fractures have a significantly higher rate of displacement due to the loss of the coracoclavicular (CC) ligaments from the proximal fragment and the high degree of deforming forces along the lateral shoulder.[31] Due to symptomatic nonunion rates of 20-45%, there has been a trend toward operative fixation of these injuries to improve chances of healing and patient outcomes.[11,19,20,23,28,17]

Operative treatment of distal clavicle fractures can be mechanically challenging as there is often a small lateral fragment that offers minimal fixation possibilities to counteract the deforming forces at the shoulder.[12,31] Many different methods have been utilized, and there is no current consensus for optimal management. Neer et al first developed the use of transacromial wire fixation.[19] However, this has since fallen out of favor due to high rates of nonunion and potential for hardware migration.[4,22] Other techniques including tension band constructs, CC screw fixation, and

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Table I
Demographics and outcomes of included patients.

Patient	Age (y)	Gender	Hand dominance	Laterality of injured extremity	Smoking history	Time to surgery (d)	ASES score
1	65	M	RT	LT	No	8	65
2	73	F	RT	LT	No	6	100
3	30	M	RT	RT	No	11	100
4	54	M	RT	LT	Yes	14	52
5	43	M	RT	LT	No	3	100
6	52	M	RT	RT	No	9	100
Mean	52.8					8.5	86.2
SD	14.0					3.5	21.8

y, years; *d*, days; *ASES*, American Shoulder and Elbow Surgeons; *M*, male; *F*, female; *RT*, right; *LT*, left; *SD*, standard deviation.

constructs including hook plates and locking plates have been described with high rates of union.[5,7-10] However, these strategies are often associated with hardware discomfort and need for secondary removal of hardware, especially when using hook plates.[1,14,28]

More recently, strategies using indirect osteosynthesis and CC interval stabilization with suture or cable devices have been explored. This can be conducted via open[20,29,33] or arthroscopic-assisted[2,15,18,26,27,30] techniques, which have shown comparable outcomes to locking plates in recent studies and have many inherent advantages.[3] Indirect stabilization can provide rigid fixation in cases where there is a small distal fragment that cannot adequately accommodate a plate or screws. One biomechanical study suggests a higher load to failure with coracoid fixation alone.[32] With hardware removal rates following locking plate fixation as high as 40%,[16] use of a low-profile endobutton device serves to decrease rates of hardware removal and may be more cost-effective than plate fixation.[6] Additionally, arthroscopic-assisted protocols, while technically demanding, allow for simultaneous management of concomitant injuries to the shoulder and may limit the size of clavicular exposure required.[2]

In this series, we present the surgical technique and outcomes for 6 patients who underwent fixation of unstable distal clavicle fractures via arthroscopically assisted CC stabilization utilizing a suspensory endobutton device and cerclage tape. We hypothesized that this technique would demonstrate excellent outcomes and low rates of nonunion or reoperation.

Methods

A database query was performed based on the International Classification of Diseases, Tenth Revision, codes for displaced fractures of the lateral clavicle (S42.301A and S42.032) as well as the Current Procedural Terminology code for open treatment of clavicular fractures (23515). The primary indication for surgery included unstable distal clavicle fractures with disruption of the CC ligaments (Neer classification type II). All patients were treated by a single fellowship-trained shoulder and elbow surgeon. Demographic data based on age, sex, smoking status, hand dominance, laterality of injury, and time from injury until surgery were recorded (Table I). Patients were included if they had a Neer type II distal clavicle fracture that was addressed via arthroscopically assisted CC stabilization. Patients were excluded if they had a follow-up of less than one year or insufficient medical records precluding full analysis. The primary outcome measures included rate of fracture union, complications (infection, hardware failure, etc.), and need for reoperation or subsequent procedures such as removal of symptomatic hardware. Patients were also contacted via telephone to obtain American Shoulder and Elbow Surgeons scores and to determine if there were any reoperations following the index surgery. Preoperative, first follow-up, and final follow-up radiographs were obtained to evaluate for radiographic union (Figs. 1-3). The method of fixation by the treating surgeon is described below.

Surgical technique

The patient is placed in the beach chair position with the use of the McConnell arm attachment. The affected extremity is prepped and draped in typical, sterile fashion. Standard posterior and anterior arthroscopic portals are created. First, a standard diagnostic arthroscopy is completed, which allows any concomitant shoulder pathology to also be addressed. The standard 30-degree arthroscope is then switched to a 70-degree arthroscope to help visualize the undersurface of the coracoid. An ablator wand is then utilized to prepare the undersurface of the coracoid. The arthroscope is removed, and a formal small incision is made along Langer's lines, approximately 2-4 cm from the distal clavicle. Subcutaneous flaps are elevated, and the deltotrapezial fascia is incised in line with the clavicle. Using both direct visualization and intraoperative fluoroscopy, the Arthrex acromioclavicular joint drill guide (Arthrex, Naples, FL, USA) is positioned at the appropriate position on the clavicle and undersurface of the coracoid, via the anterior working portal. A 3-mm cannulated drill is passed through the clavicle, and the arthroscope is used to visualize as it exits the base of the coracoid. The center sleeve is removed and a FiberStick (Arthrex, Naples, FL, USA) is passed. The #2 FiberWire is brought out of the anterior working portal, and the FiberStick sleeve/cannulated drill bit are removed. The #2 FiberWire is then used to shuttle the primed Arthrex FiberTape Cerclage (Arthrex, Naples, FL, USA) through the drill holes from proximal to distal. Care is taken to ensure the FiberTape Cerclage is passed with the slipknot superior to the clavicle and that the passing FiberWire suture has a long tail. The inferior aspect of the Dog Bone (Arthrex, Naples, FL, USA) button is then placed on the inferior loop of the cerclage that was shuttled through. The button is then positioned on the undersurface of the coracoid by pulling on the FiberTape Cerclage. The superior Dog Bone is then placed on the superior loop of the cerclage, below the slipknot and above the clavicle. The Cerclage is then slowly pulled until the slipknot pushes the superior button onto the clavicle. The clavicle is reduced using the cerclage tensioner, under fluoroscopy, to ensure anatomic reduction. The cerclage tape is then tied with 2 reverse half hitches. The wound is thoroughly irrigated. The deltotrapezial fascia is then imbricated with interrupted 0-Vicryl suture. Subcutaneous tissue is closed with interrupted 3-0 Monocryl followed by a running 3-0 Prolene subcuticular stitch. Portal holes are closed with interrupted 3-0 nylon sutures. The incisions are covered with dry, sterile dressings, and the patient is placed into an abduction sling.

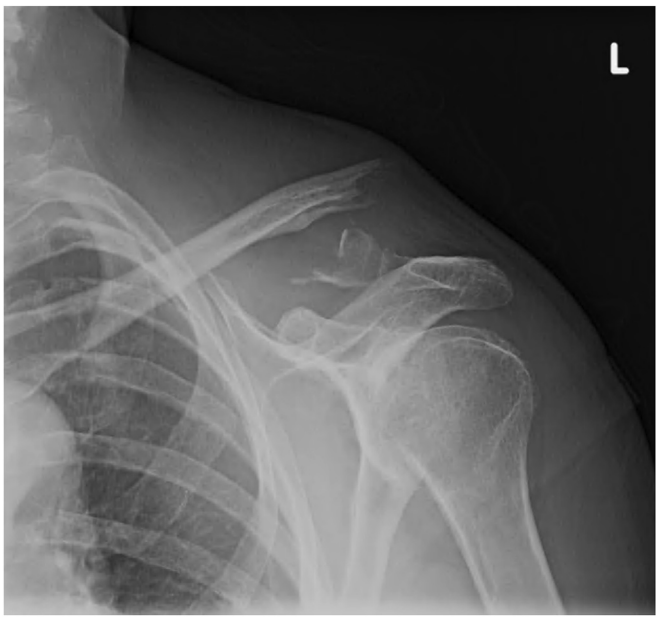

Figure 1 Preoperative anteroposterior radiograph of a comminuted, displaced Neer type 2 distal clavicle fracture.

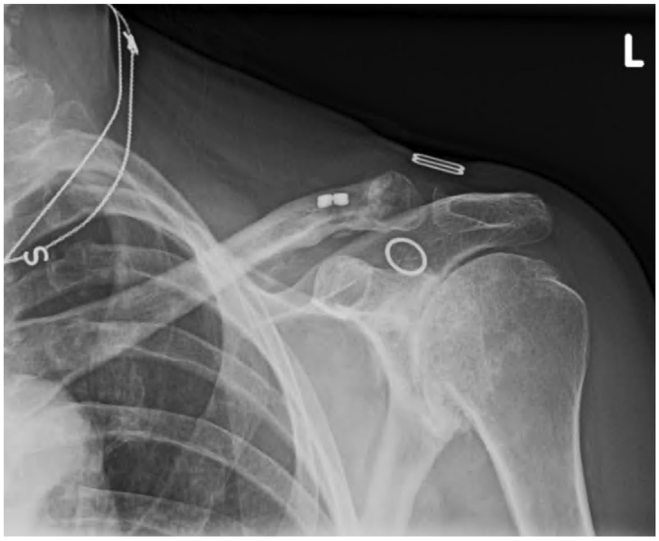

Figure 2 Postoperative anteroposterior and Zanca view radiographs following distal clavicle fixation with coracoclavicular ligament stabilization.

Results

Six patients were eligible for analysis who underwent open reduction internal fixation of the distal clavicle utilizing arthroscopically assisted CC ligament stabilization with suspensory endobutton and cerclage tape. Five patients were male, and one was female with a mean age of 52.8 ± 14.0 years (range 30-73 years). The mean follow-up of this cohort was 2.0 years (range 1.6-2.7 years). Four patients sustained injuries to their nondominant extremity. Only one patient in the cohort was an active smoker. The mean time to surgery from the day of injury was 8.5 ± 3.5 days. At the final follow-up, mean American Shoulder and Elbow Surgeons scores were 86.2 ± 21.8. All patients demonstrated maintained signs of full radiographic union at a mean of 5.5 months (range 2.0-12.9 months). One patient continued to be symptomatic from advanced glenohumeral joint arthritis that was present prior to the initial injury (patient 1), however there otherwise no reoperations, revisions, fracture nonunions, symptomatic hardware removals, or infections at a mean follow-up of 2 years.

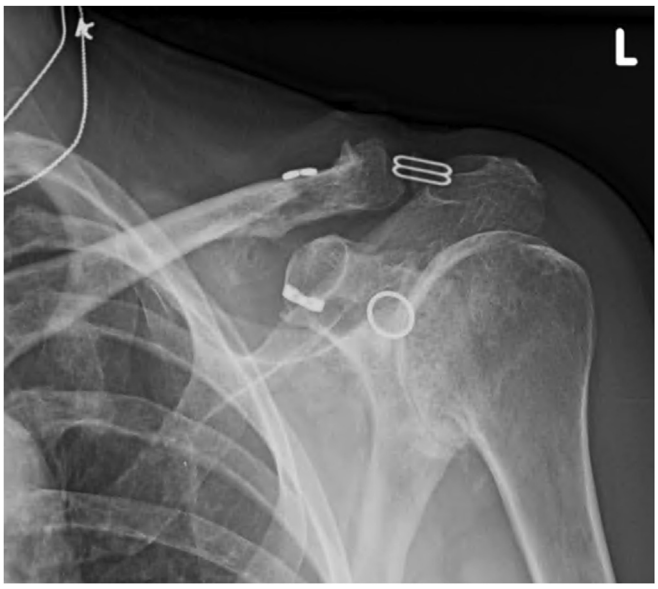

Figure 3 Radiographs at final follow-up demonstrating maintained reduction and complete fracture healing.

Discussion

This retrospective case series demonstrated excellent outcomes and no reoperations following arthroscopically assisted CC stabilization for unstable distal clavicle fractures utilizing an endobutton device and cerclage tape at a mean follow-up of 2 years. All patients in the cohort achieved full radiographic union and there were no cases of implant-related discomfort or symptomatic hardware removal. We believe this technique successfully provides durable fixation of distal clavicle fractures that may minimize the need for subsequent hardware removal or revision surgery.

Management of distal clavicle fractures is a difficult endeavor due to high levels of deforming forces along the lateral shoulder and high rates of nonunion. Robinson et al, in a large prospective series, found that the overall nonunion rate of lateral clavicle fractures was approximately 2.5 times greater than middle 1/3 fractures when treated nonoperatively. While minimally displaced fractures in this cohort had union rates approaching 100%, more unstable fractures, such as type II injuries, had significantly higher rates of nonunion.[24] This trend has led to more frequent operative management in these unstable subtypes and has prompted the development of several different fixation strategies, all with inherent advantages and disadvantages. Locking plate fixation has demonstrated high rates of union. However, it is not always possible to get adequate screw purchase in the distal fragment, and due to subcutaneous positioning of the plate, many patients require symptomatic hardware removal.[16] Additionally, some argue that locking plate fixation alone may not fully address the CC ligament instability that results from Neer type II fractures and may precipitate hardware failure.[12] Techniques such as K-wire, CC screw, and hook plate fixation can capture the distal fragment with high rates of union. However, all are associated with increased rates of

complications and mandated interval hardware removal, which makes them somewhat less appealing.[1,4,5,7-10,14,22]

Contemporary techniques involve stabilization of the CC interval with flexible devices such as suture or cerclage tape, which have shown promising results. Zheng et al found no complications or additional surgeries in their group of 15 patients who underwent fixation with a suspensory endobutton device at a mean follow-up of 9 months.[33] Struhl et al had no complications and 100% union rate in their group using a similar technique followed for over 3 years.[29] Arthroscopic-assisted fixation strategies similar to ours have also shown high healing rates and minimal complications, with a potential added benefit of identifying and addressing concomitant glenohumeral pathology.[2,15,18,26,27,30]

One potential advantage to indirect osteosynthesis of these injuries is minimizing the surgical footprint and the incidence of subsequent hardware removal. Erden et al found equivalent outcomes when comparing CC button vs. locking plate fixation of distal clavicle fractures. However, the locking plate group required hardware removal in 25%.[3] While complications of CC suspensory fixation including symptomatic hardware, nonunion, implant failure, and coracoid fracture have been reported, the incidence of these findings is relatively low and their occurrence does not always necessitate further intervention.[13,15,27]

Given the smaller footprint of these devices, some argue that supplementing fixation with a locking plate may decrease the rate of hardware failure. Robinson et al, in a series evaluating distal clavicle nonunion, suggest that combined constructs using a locking plate and CC stabilization device provides more rigid fixation that may be required due to high deforming forces that can tension the suspensory suture.[25] While combined fixation in this group led to high rates of healing, recent biomechanical studies suggest that CC fixation alone may have higher load to failure vs. combined CC and locking plate constructs.[32] We also believe that the success of arthroscopic-assisted CC stabilization in our group may demonstrate that these constructs can provide adequate fixation in isolation. As a result, this minimally invasive technique may be useful in addressing unstable clavicle fractures while minimizing complications and need for hardware removal. Also, the additional benefit of the cerclage system decreases the need for multiple assistants that is usually required for the procedure. The surgeon is able to reduce fracture simply by tightening the cerclage, and there is no need for an assistant to manually apply force to aid in reduction.

The present study is limited by a small sample size and retrospective design which may precipitate selection bias. Additionally, the lack of a control group does not allow for comparison to other current methods of fixation. Further prospective, comparative studies and longer-term follow-up data in the future may improve our understanding and implementation of this surgical technique.

Conclusion

In this retrospective case series, arthroscopic-assisted CC stabilization with a suspensory endobutton and cerclage tape demonstrated excellent outcomes without perioperative complications, reoperations, or cases of nonunion. Further evaluation with a larger sample size is warranted in the future.

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