# Arthroscopically Assisted Fixation of Unstable Distal Third Clavicle Fractures

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Fractures of the distal clavicle are less common than their midshaft counterparts. However, these distal third clavicle fractures can be especially problematic due to disruption of the coracoclavicular ligaments, often requiring surgical management for optimal healing and functional outcome. The serpiginous shape of the clavicle, its proximity to vital structures, and its subcutaneous location can make fixation challenging. Numerous surgical techniques and implants have been proposed for the management of these fractures. We present the outcomes of seven patients treated with an arthroscopically assisted technique using a cortical button and suture fixation construct (TightRope® system, Arthrex; Naples, FL). All fractures achieved radiographic union without displacement within three months. All patients were satisfied and no secondary surgeries were required for symptomatic hardware.

## INTRODUCTION

Clavicle fractures are common injuries, representing 35 to 45% of fractures of the shoulder girdle[1]. Fifteen to 25% of those involve the distal portion of the clavicle[2,3]. Previously, non-operative management of midshaft clavicle fractures was based on the premise that even grossly malunited fractures had a minimal impact on functional outcomes[4,5]. However, level I evidence supports the idea that operative management of markedly displaced or shortened midshaft clavicle fractures can improve functional outcomes[6,7]. The operative management of distal third clavicle fractures is similarly supported to improve shoulder function for displaced fractures[8,9,10,11].

Neer classified distal clavicle fractures into three types[8]. Type I fractures are lateral to the coracoclavicular ligaments. Type II fractures are medial to the coracoclavicular ligaments. Type II fractures are further subdivided into type A (coracoclavicular ligaments attached to the distal fragment) and type B (conoid ligament disrupted; trapezoid ligament remains attached to the distal fragment) (Figure 1). Type III fractures extend into the acromioclavicular (AC) joint.

Overall, Type II distal clavicle fractures have a 20 to 30% nonunion rate if treated nonoperatively[9]. Neer Type IIB fractures are especially problematic due to the location of the fracture between the coracoclavicular ligaments[8,10,11]. Displacement of the fracture is enhanced by the weight of the arm, muscle forces, and disruption of the vertical restraint of the medial fragment[11]. Because of these factors, Type IIB fractures are likely to progress to nonunion or malunion.

Initial surgical management of Type IIB fractures has been proposed to encourage properly aligned healing and maximize functional outcomes[12-29]. Currently, there is no surgical standard that provides anatomic fracture fixation, restoration of the superior-inferior and anterior-posterior fracture stability, avoidance of symptomatic hardware, and minimal surgical dissection. Surgical techniques include open reduction and internal fixation with subacromial hook-plates, percutaneous wires, coracoclavicular screws, cerclage wires, unlocked and pre-contoured locked plates, and coracoclavicular ligament reconstruction techniques using various suture materials or tendon grafts with or without excision of the distal fragment[6,7,12,13,15-22,27-34]. Arthroscopically assisted fixation techniques have been recently described, as well[14,23-26,35,36].

In this paper we present the short to midterm results of arthroscopically assisted fixation of Type IIB distal clavicle fractures using the TightRope® system (Arthrex; Naples, FL). This minimally invasive technique accomplishes the essential principles of treating this unique fracture pattern including: anatomic fracture alignment; restoration of superior-inferior and anterior-posterior ligamentous stability; and fracture compression.

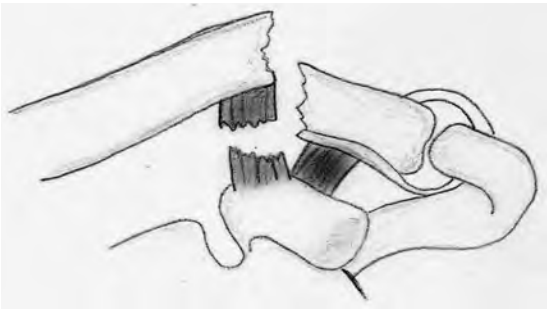

**Figure 1.** Neer Type IIB distal clavicle fracture (conoid ligament disrupted, trapezoid ligament attached to the distal fragment).

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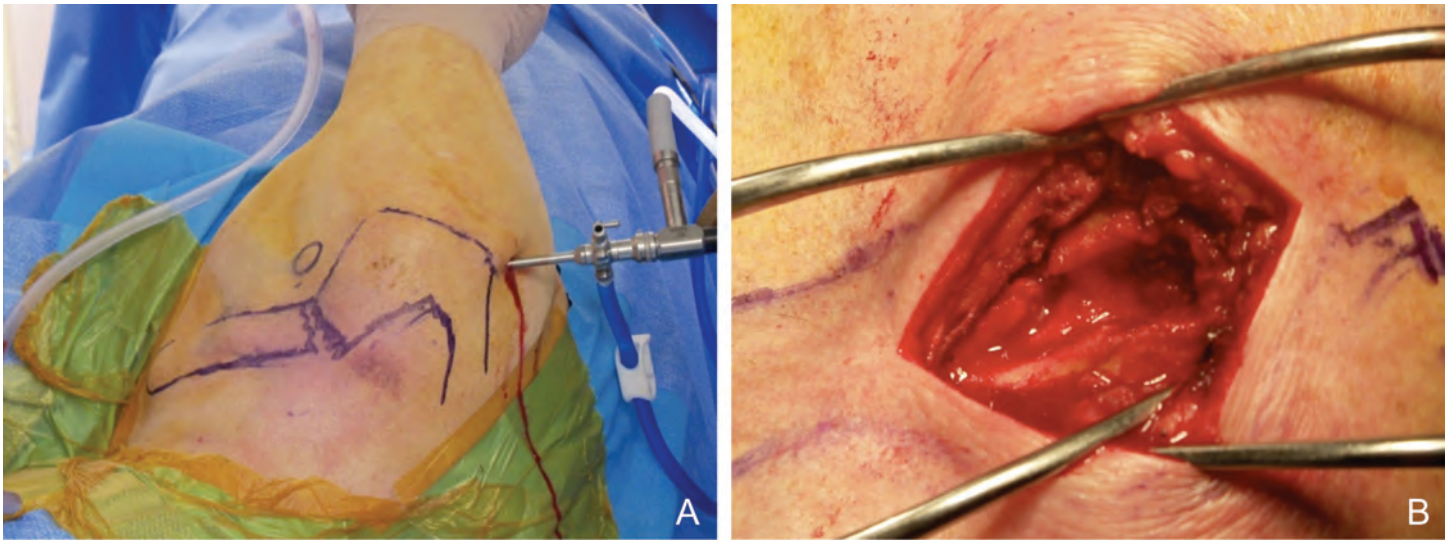


**Figure 2.** (A) The patient is positioned in the lateral decubitus position with the fracture and bony shoulder landmarks demarcated. An arthroscope is placed in the posterior portal. (B) The fracture site is exposed through a small incision along Langer's lines.

## MATERIALS & METHODS

Seven consecutive patients with displaced distal third clavicle fractures from April 2008 to November 2010 were treated with arthroscopically assisted fixation using the TightRope® system (Arthrex; Naples, FL). Criteria for inclusion in the study were radiographic evidence of a displaced Neer Type IIB distal clavicle fracture, no prior surgical clavicle fracture treatment, and radiographic/clinical follow-up until radiographic osseous union. A retrospective review of radiographs, patient satisfaction, and complications was completed.

## TECHNIQUE

After appropriate anesthesia, both shoulders are examined in the supine position for range of motion and stability with the scapulae stabilized. Surgeon's preference determines whether the patient is placed in lateral decubitus or beach chair positions. The osseous structures about the shoulder are identified, including the acromion, AC joint, distal clavicle fracture, and coracoid process. A linear 3-cm incision is made along Langer's lines to expose the distal clavicle fracture and AC joint (Figure 2).

A diagnostic arthroscopy through a standard posterior portal is then performed to evaluate for any intra-articular pathology (e.g. labral, biceps, or rotator cuff pathology). A standard rotator interval working portal is established under direct visualization. The middle glenohumeral ligament is released and the subscapularis bursa is resected until the base of the coracoid process is visualized. Alternatively, the coracoid process can be approached arthroscopically from the subacromial space. An anterior cruciate ligament reconstruction guide is set to 90° and inserted through the anterior portal. The foot of the guide is centered on the undersurface of the base of the coracoid process. The drill guide is centered on the clavicle 15-mm medial to the fracture. A guide pin is then passed from the clavicle through the base of the coracoid process under direct visualization. A cannulated drill is passed over the guide pin. A nitinol wire is passed through the drill and retrieved through the anterior portal. The TightRope® device is shuttled using the nitinol wire. The fracture is reduced under direct visualization and the TightRope® device is tensioned in place, thereby ensuring vertical stability of the fracture. The #5 FiberWire (Arthrex; Naples, FL) sutures from the device are then tied over the clavicle and subsequently passed through the AC joint capsule in a figure-of-eight fashion using a free needle (Figure 3). This last step restores anterior-posterior stability while providing compression across the fracture.

Intra-operative fluoroscopy and/or radiographs may be performed to confirm adequacy of reduction. However, it is not mandatory as the fracture is reduced under direct visualization and the cortical buttons are observed directly on the clavicular side and arthroscopically at the base of the coracoid process.

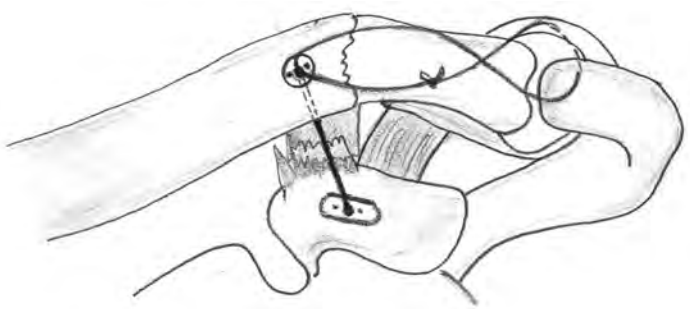

**Figure 3.** Technique of arthroscopically assisted Type IIB clavicle fixation as described by the senior author. This allows vertical and horizontal fracture stability as well as fracture compression.

The arm is placed into a standard sling. Passive range of motion and pendulum exercises are started on post-operative day #1. Weight bearing activities are delayed until radiographic confirmation of osseous union.

## RESULTS

There were four men and three women with a mean age of 51 years (range: 21 – 89). The mean postoperative follow-up was 11.9 months. Additional injuries included three labral tears, one scapula fracture, one brachial plexopathy, and one non-displaced glenoid fracture. There were no cases of infection, malunion, nonunion, or symptomatic hardware. No patients required reoperation related to their clavicle fracture fixation. All fractures achieved radiographic evidence of fracture union within three months. No patients demonstrated loss of motion compared to the contralateral shoulder with the exception of the complete plexopathy patient who underwent a subsequent plexus exploration and nerve grafting.

## DISCUSSION

Displaced fractures of the distal third of the clavicle often benefit from surgical stabilization due to the poor outcomes associated with non-operative management[8,11-29]. This is especially true of Neer Type IIB distal clavicle fractures due to disruption of the coracoclavicular ligaments and the resultant instability and superior displacement of the medial fragment[8]. Multiple surgical techniques have been developed to treat these injuries[6,7,12,13,15-22,27-34]. Arthroscopically assisted fixation techniques have been recently described, as well[14,23-26,35,36].

The TightRope® system was originally indicated for stabilization of syndesmotic injuries of the ankle. The device consists of two metal buttons, one oblong and one round, that are joined by #5 FiberWire[37]. Similar suture button systems have been described for use in AC joint reconstruction with success[38]. Fewer reports have been published on the use of a suture button system for the treatment of distal third clavicle fractures[23-26,35,36].

The main advantages of our arthroscopically assisted fixation technique are its minimally invasive nature, restoration of anterior-posterior and superior-inferior stability, fracture compression, ability to identify and treat intra-articular pathology and low profile hardware. Implant use in the treatment of distal third clavicle fractures can be especially problematic due to hardware migration, symptomatic hardware requiring removal, and hardware failure. Additionally, arthroscopically assisted fixation allows for anatomic reduction of the fracture without violation of the AC joint, which is typically otherwise uninjured.

Pujol et al described a similar technique of arthroscopically assisted fixation of distal clavicle fractures[36]. They noted osseous union and asymptomatic shoulders in the four patients treated with their technique. However, their technique lacked the additional anterior-posterior stabilization of the fracture that our technique provides. The senior author previously described the addition of a figure-of-eight compression suture placed through the AC joint capsule to provide fracture compression and anterior-posterior stability[35].

In our study, all patients treated with arthroscopically assisted fixation of a distal third clavicle fracture maintained an anatomic reduction that went on to radiographic union by three months (Figure 4 is representative). There was no symptomatic hardware that required removal.

One particularly illustrative case for the use of arthroscopically assisted distal clavicle fracture fixation is that of a 63-year-old right hand dominant male who fell onto his


**Figure 4.** (A) Displaced Neer Type IIB distal clavicle fracture. (B) Six months following arthroscopically assisted fixation. The fracture has healed in satisfactory alignment.

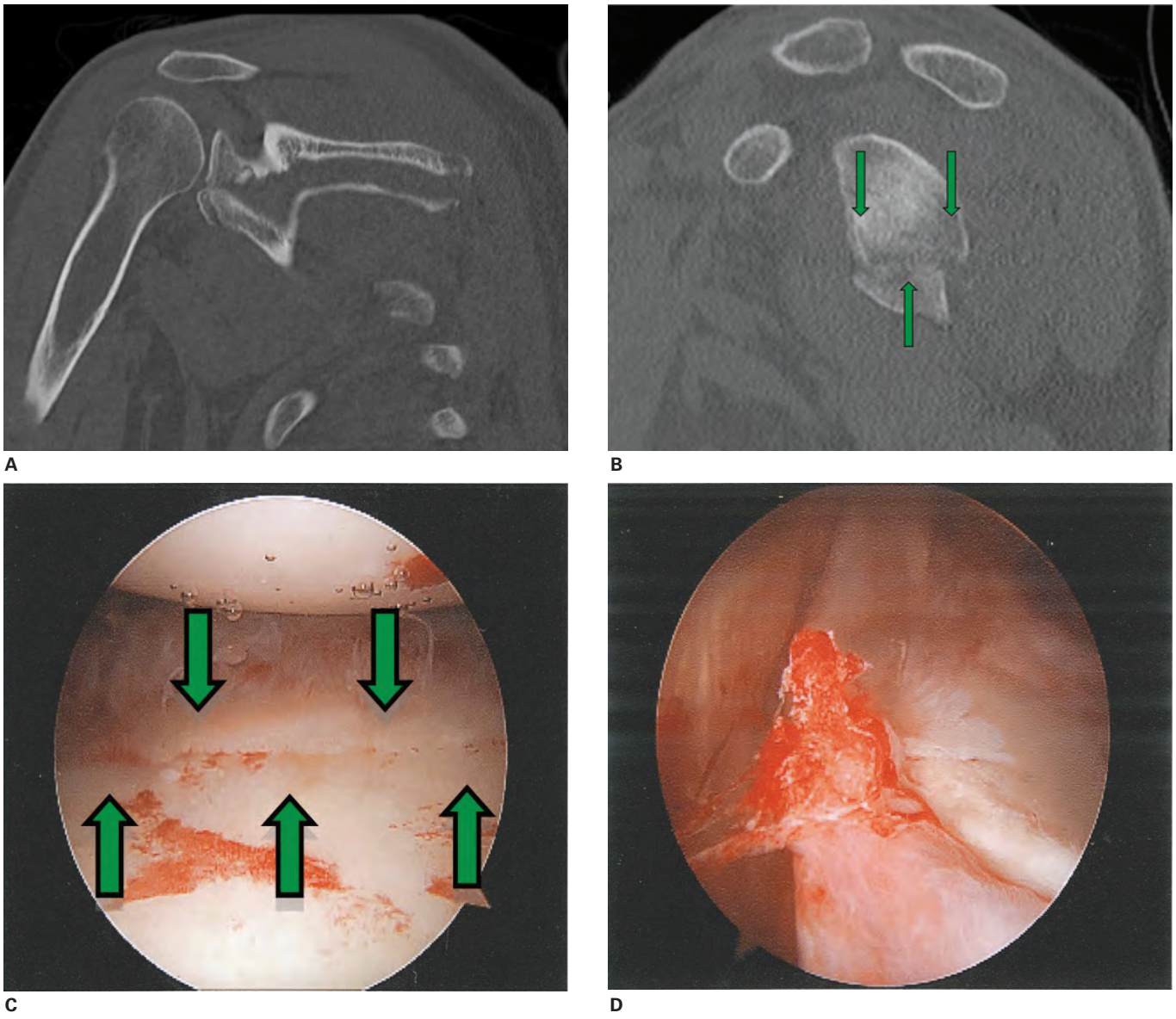


**Figure 5.** (A). Coronal CT scan image of a 63yo man who fell off of his bicycle and sustained a closed head injury revealing a displaced glenoid fracture. Plain radiographs of the same patient revealed a displaced Neer Type IIB distal clavicle fracture. (B) Sagittal CT scan image of a 63yo man who fell off of his bicycle and sustained a closed head injury revealing a displaced glenoid fracture (delineated by green arrows). The coracoid is to the left of the image. (C). Arthroscopic view from the posterior portal of a non-displaced glenoid fracture (delineated by green arrows). The patient is in the lateral position. As the fracture is non-displaced at the articular surface upon arthroscopic inspection, only fixation of the distal clavicle fracture was performed. (D). Arthroscopic view from the posterior portal of a tear of the posterior-superior labrum. The patient is in the lateral position with the glenoid at the right of the image.

right shoulder while riding his bicycle. He sustained a closed head injury and a combined injury to the superior shoulder suspensory complex. Plain radiographic examination revealed a Type IIB distal clavicle fracture and computed tomography documented the glenoid fracture (Figures 5A-B). Computed tomography further revealed a displaced intra-articular glenoid fracture. This fracture was found to be non-displaced upon arthroscopic inspection (Figure 5C). The patient underwent arthroscopically assisted fixation of his clavicle fracture with a TightRope®. Diagnostic arthroscopy further revealed a glenoid labrum tear that was debrided to a stable rim (Figure 5D). As the glenoid fracture was found to be non-displaced at the articular surface, isolated treatment of the clavicle fracture was performed for this double injury to the superior shoulder suspensory complex. His clavicle fracture healed by 10 weeks after surgery. At six months postoperatively, he had 0 out of 10 pain on the Visual Analog Scale and a Penn Shoulder Score over 90.

A high number of intra-articular injuries were encountered during diagnostic arthroscopy (three out of seven patients). Further investigation is required to evaluate the possible correlation between distal clavicle fractures and intra-articular pathology.

A strength of this study is that all patients were followed until radiographic union of their respective fractures. Additionally, a wide variety of injury mechanisms were encountered, including falls from a standing height and motor vehicle accidents. A relative weakness, though, is the limited number

of patients. This is partly due to the relative infrequency of Type IIB distal clavicle fractures.

In conclusion, the TightRope® system can be used to treat displaced distal third clavicle fractures, particularly Neer Type IIB fractures. It can be performed in a minimally invasive fashion using arthroscopic assistance to achieve fracture reduction and compression, restoration of vertical and horizontal stability, and is useful in addressing additional intra-articular shoulder pathology.

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