

## ORIGINAL RESEARCH

# Combined coracoclavicular space fixation with fibrewire and transfragment k-wire in neers type 2 distal clavicle fractures: A novel technique

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### ABSTRACT

**Introduction:** Neer type 2 distal clavicular fractures are inherently unstable injuries owing to disruption of ligamentous tether between clavicle and coracoid. Despite description of various surgical procedures for its fixation, prudent surgical procedure is yet to be ascertained. Recent literature points towards success of combined approach for fixation across fracture site and stabilization of coracoclavicular interval. **Methods and Materials:** 8 patients were operated using a technique to secure fracture fragment apposition using FibreWire® suture (Arthrex, Naples, FL, USA) spanned across coracoclavicular space and secured over bony points through endobuttons. Along with this, temporary acromioclavicular joint sparing K wire spanning fracture fragments is also used. A possible repair of coracoclavicular ligaments is also attempted which ensures robust healing by fibrosis in acute settings. **Results:** All the patients regained painless shoulder with bony union and return to pre-injury activity level after a mean of 4 months. Sequential postoperative radiographs demonstrated good hold of initial bony fixation. Constant Murley scores measured and compared was found to be approaching opposite shoulder level at the end of 6 months after surgery. **Conclusion:** The concept of this technique is novel and provides for a strong fixation across the fracture site in addition to other benefits outlined above.

**Keywords:** Unstable lateral end clavicle fractures, Coracoclavicular ligaments, Endobutton

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### INTRODUCTION

Lateral end clavicle fractures are common injuries of shoulder girdle, making approximately 15% of all clavicular fractures.<sup>[1]</sup> Integrity of distal clavicle and its ligamentous attachments is essential for functioning of shoulder girdle. Fractures of distal clavicle disrupt this vital integrity and are source to various sequelae associated with this fracture.

Clinical implications of fracture pattern of distal clavicle were first pointed out by Neer. He segregated these fractures in three subtypes based on osseoligamentous injury pattern, treatment rationale and outcome of injury. Type I injury is fracture lateral to intact coracoclavicular ligaments with typically minimal displacement. Type II injuries occurred more medial to the coracoclavicular ligaments with significant displacements across fracture site and

ligamentous disruptions. Type III injuries extend intraarticularly in acromioclavicular joint.<sup>[2]</sup>

Neer type 2 injuries assume special concern because of inherent unstable nature. Disruption of ligamentous tether, deforming forces by trapezius on proximal fragment and downward pull by pectoral muscles, latissimus dorsi along with weight of arm on distal fragment essentially impede fracture apposition and is root to problem of nonunion.<sup>[3,4]</sup>

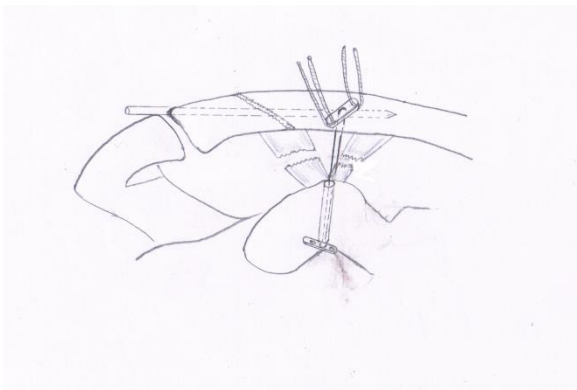
Neer estimated higher risk of nonunion type 2 injuries of distal clavicle compared with other clavicular fracture types with nonunion rates reported as high as 22% to 50% for non-operatively managed fractures. Nonunion of fracture lateral end clavicle has been corroborated with poor functional outcome and symptomatic shoulder in recent literature with evidence favorably siding toward surgical management of this variety of fractures.<sup>[2,5]</sup>

Numerous surgical techniques have been described by various authors with differing clinical results. Despite all these, optimal treatment modality still remains a topic of debate. Transacromial fixation using wire or pin construct offer poor fracture stabilization thus delaying early mobilization, higher rate of infection, arthritis, risk of pin migration. Coracoclavicular screw provides rigid fixation of coracoclavicular space, which causes frequent backing of screw on shoulder mobilization or fracture of screw or coracoid process in noncompliant patients. Hook plate fixation gives in risk of iatrogenic damage to rotator cuff and acromioclavicular joint, devascularization of clavicle, hardware prominence, and problems related to hook of plate. Coracoclavicular slings or sutures has been also associated with redisplacement or suture loosening. Acromioclavicular joint sparing contoured locking plates attempt to decrease inherent problems of hook plate to an extent. [4,6,7,8]

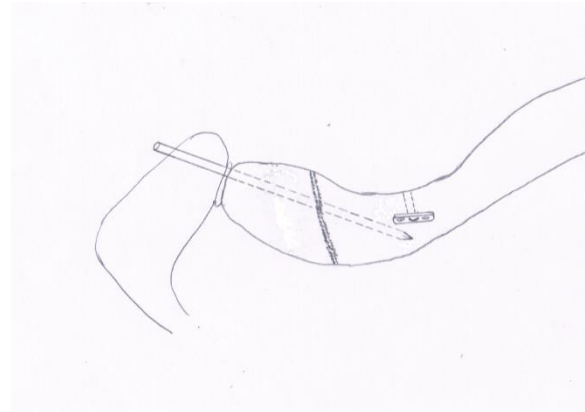
All these techniques strive to reestablish integrity of suspensory mechanism of shoulder either by direct fixation or indirect reduction so that sequent bony consolidation reassumes its function. Based on these principles, we employed a new technique of reduction of type 2 distal clavicle fractures and its maintenance by spanning coracoclavicular space with FibreWire® suture (Arthrex, Naples, FL, USA) secured over 2 endobuttons along with possible repair of damaged ligaments. Construct is augmented with temporary K-wire spanning fracture fragments but sparing acromioclavicular joint for a short period. Technique is simple, causes minimal damage to soft tissues, allows for indirect reduction. Other purported benefits are physiological non-rigid fixation, least hardware prominence and least effect on vascularity of clavicle.

**SURGICAL TECHNIQUE**

Patient is operated under general anesthesia and in supine position with a small bolster placed under ipsilateral shoulder. An incision is made from palpable coracoid to medial clavicle fragment near fracture site. Medial and lateral skin flaps are created. Supraclavicular nerve twig, if met in incision need protection and retraction on medial side. Deltopectoral fascia is opened transversally along the directions of its fibers and muscle



**Figure 1- Diagrammatic scheme of fixation (AP view)**



**Figure 2- Diagrammatic scheme of fixation (Axial view)**

beneath it. Anterior fibers of deltoid may need to be lifted subperiosteally from antero-superior clavicle to facilitate visualization of coracoid with due protection of coraco-acromial ligament. Subperiosteal lifting preserves retrograde nerve supply of deltoid. This small muscle flap is secured with suture for later reattachment. Integrity of coracoclavicular ligament is inspected, and care taken not to inflict any iatrogenic damage to it. Medial and lateral borders of coracoid are identified.

Location of acromioclavicular joint is confirmed as a landmark for further work. An drill hole using 4.0 mm drill bit is made in center of coracoid at junctional surface area as described by Bhatia et al [9] where it turn laterally with care not to tether surrounding tissues or overshoot drill. Fracture reduction is achieved indirectly manipulating upper limb and a Kirschner wire is passed spanning two fracture fragments. Now another drill hole is made using 2.5 mm drill bit on superior surface of clavicle in area above coracoid junctional area in middle portion. This drill hole falls on medial clavicle fragment and makes fixation amenable using this technique.

FibreWire® suture No#5 is spanned across first and fourth hole of endobutton and using an endobutton plunger, it is passed through coracoid hole and flipped on its undersurface. Now two suture end are passed underneath clavicle to superior surface using a straight needle and secured with knot over endobutton again after final confirmation of fracture reduction. Snow shoe effect by endobutton on cortical bone holds suture well and secures fractures strong enough to allow future bone healing. Wound is closed in layers. K wire holding reduction is cut beneath the skin. (figure 1-4)

Postoperatively, limb is comforted in universal shoulder immobilizer for 3 weeks with intermittent pendulum exercises and abduction exercises. After 3 week, when fractures is expected in stage of preliminary sticky callous, K wire is extracted under local anesthesia. Gradual range of motion exercises are started with limb being comforted in arm pouch sling. Heavy work and contact sports is prohibited till solid bony union is confirmed on radiographs.

## RESULTS

The authors has utilized this fixation technique on 8 patients. Operative indication in all patients was Neer type 2 distal clavicle fracture. Seven patients were male while one was female in age group of 25 to 58 years



**Figure 3: 6 weeks follow up xray (AP view)**

(mean 41 years). The dominant limb was involved in 5 out of 8 cases. None of the patient had concomitant injury to ipsilateral upper limb. All the patients were operated within 2 weeks of sustaining trauma to clavicle. Early results were encouraging in these patients with minimum follow up of 4 months and maximum of 12 months.

All the patients regained painless shoulder with bony union and return to pre-injury activity level after a mean of 4 months. Sequential postoperative radiographs demonstrated good hold of initial bony fixation. Constant Murley scores measured and compared was found to be approaching opposite shoulder level at the end of 6 months after surgery.

## DISCUSSION

Basic principle of surgery is to reestablish the integrity of shoulder suspensory mechanism by reaffirming bony continuity and a healed coracoclavicular ligament. Numerous techniques have been employed to fulfill these principles with differing clinical results, and mix of merits and demerits over each other.

Flinkilla<sup>[10]</sup> and Klein<sup>[11]</sup> found fracture union rate after clavicular hook plate approaching 95%, but with significant complication rate in around 22%. Frequent peri-implant fracture medial to



**Figure 4: Shoulder levels during followup**

plate(5%), persistent pain by acromial abrasions obligating second surgical procedure for implant extraction in almost all cases make it a less preferential modality. Rigid construct of clavicular hook plate translates into increased deforming forces at plate ends and thereby causing subacromial abrasions and stress fractures at ends. Use of superior locking plates used alone is also waning due to frequent implant failure and poor biomechanical construct.

Various pin and wire constructs have been used but have fallen out of favor as preferential modality. Bisbinas<sup>[4]</sup> Lyons and Rockwood<sup>[12]</sup> found troubles like poor stabilization, lack of early mobilization, high infection and nonunion rates(23%), acromioclavicular arthritis(10%), bizzare pin migrations even in thorax, aorta, subclavian artery and spinal canal.

Sambandam<sup>[13]</sup> reviewed literature about lateral end clavicular fractures and found that although coracoclavicular screw is simple and cost effective, it need prolonged immobilization of shoulder risking joint mobility, mandatory avoidance of arm abduction and forward flexion beyond 90degree. Obligatory need of implant extraction and risk of coracoid fracture, which make it wane in clinical practice.

As evidenced in recent literature, coracoclavicular space spanning slings, sutures, tapes are gaining momentum as preferred modality for fixation of Neer type II clavicular fractures owing to nonrigid near biological fixation, obviated need for implant extraction, least mechanical problems, minimal tissue invasion, and feasible use of endoscope using modes of fixation. Few constant problems have been cited with these methods are loosening of sutures, slip of sling over clavicle surface, biomechanically weaker construct.<sup>[4,7,13]</sup>

Cognizing all these aspects of techniques, we employed a novel method of fixation for type 2 clavicular fractures. Whole idea was to keep tissue dissection minimal, use of material with ample strength, secure fixation of suture over clavicle surface, temporary assistance for fracture apposition till soft callus by K wire and providing milieu for natural coracoclavicular ligament healing.

Fibrewire secured with endobuttons provide enough stability across fracture to facilitate bony union. Tensile strength of fibrewire is highly comparable to native coracoclavicular ligaments, with 2 strands spanned across space providing theoretically more strength.<sup>[14]</sup> Endobutton also have pullout strength in excess of 1150N. Endobuttons provide snow shoe effect for firm hold on bone.<sup>[15]</sup> Smaller hole in clavicle lessens chances of fracture line propagation and comminution. Being a low profile implant, need for future extraction of implant is also obviated. Extraction of K wire is easy, almost noninvasive and out patient procedure.

Any injury to coracoclavicular ligament is also dealt by accompanying stable fixation. In acute settings,

healing response to ligament injury is robust and other than respecting soft tissues in vicinity and providing stable fixation, additional grafting is not necessary.<sup>[16]</sup>

Prudent contraindications for the use of this technique include coracoid fractures, comminution at fracture site, lack of soft tissue coverage, a narrow coracoid and ongoing infections.

The concept of this technique is novel and provides for a strong fixation across the fracture site in addition to other benefits outlined above. Further studies with longer follow up and on more number of patients need to be done to elucidate out correct surgical utility of technique over others.

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