

Primary plate fixation for displaced clavicular fractures

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ABSTRACT

Objective: Recent studies have shown that displaced mid-shaft clavicular fractures do not have assured favorable outcomes with non-operative management and nonunion rates could be as high as 20%. In addition many mal unit are with significant shortening. Non-union or mal-union cause functional deficit and majority of them may benefit from primary internal fixation. Following these recommendations, we have managed patients of displaced clavicular fractures with primary plate fixation and achieved satisfactory outcomes.

The purpose of selecting this study for presentation is to highlight the recent trends in managing such fractures.

Materials and Methods: This study comprised of 8 patients of acute, displaced midshaft clavicle fractures treated with either non-contoured or pre-contoured superior clavicle plate fixation. Post-operative assessment included ROM, radiographs, function and return to pre fracture status.

Results: There were 7 males and 1 female, the average age being 34 years (Range 23-46 years). Dominant side was fractured in 62.5% of the patients. The follow- up varied between one to twenty four months. Seven fractures healed in anatomical position, except for the one which has been operated recently and currently under follow-up.

Conclusion: Plate fixation of completely displaced mid-clavicular fractures offers the benefits of anatomical alignment, stable fixation, early rehabilitation, better functional outcome and patient satisfaction.

Keywords: Clavicle, Primary, Plating

INTRODUCTION

Clavicle fractures accounts for approximately 4% of all fractures and most commonly these are seen in the middle third of the bone, 76-85%¹. Traditional treatment of displaced fractures of the middle third of the clavicle was conservative. Historically, we were taught “all clavicle fractures would do well with non-operative treatment”².

Many methods have been described for closed reduction of displaced clavicle shaft fractures but unfortunately, none of them has been consistently reliant in achieving and maintaining the reduction³. Thus displaced midshaft fractures of the clavicle typically heal approximately in the same position, as seen on the initial radiographs with the characteristic inferior, medially translated and anteriorly rotated deformity of the lateral fragment⁴.

A number of articles have characterized the symptoms with clavicle mal-union⁵⁻¹³ which is associated with skeletal deformity especially unsightly prominence, drooping of the shoulder especially when the shortening is around 2 cm or more. Subjective weakness was a consistent symptom in these series. When it involves a young active individual, any compromise due to non-union or mal-union would restrict his employability or sporting activities.

MATERIALS AND METHODS

This study included 8 patients of acute displaced fractures of the shaft of the clavicle from 2009 to 2014; who met the following criteria: acute midshaft clavicle fracture with 2 cm or more displacement, closed fracture, no neurovascular deficit.

There were 7 males and 1 female, between the ages of 23 to 46 years, average age 34 years. 6 patients had sustained injuries due to fall from standing height and the remaining 2 were because of vehicular accidents. 1 patient also had an ACL tear of the left knee. Majority of them were seen in the accident & emergency department and after initial treatment were advised to attend the orthopedic outpatient. Standard AP views were taken for the diagnosis of these fractures. A typical displaced midshaft fracture is seen in Figure 1.



Figure 1. A typical displaced midshaft fracture

Informed consent was obtained by the operating surgeon, and it was explained to the patient that they might require a second surgery to remove implanted hardware, if symptomatic, once the fracture had healed. The average delay of the surgery was 4 days post injury. All patients were operated under a general anesthetic in the beach chair position and received a pre-operative antibiotic. A curvilinear incision was made along the superior subcutaneous border of the clavicle. The skin and soft tissue along with the muscles were elevated as a flap; prominent branches of the supraclavicular nerves were identified and protected. The fracture site was identified and all intervening soft tissue removed (Figures 2 & 3). The fracture was anatomically reduced and held in position with a clamp. Lag screw fixation with a 3.5 mm or 2.5 mm cortical screw was performed when compatible with the fracture pattern. If significant comminution was encountered then careful initial approximation of the smaller fragments was performed with one or two 3.5 mm or 2.5 mm inter-fragmentary screws, if possible, if not, then as in 1 patient who had comminution, the larger fragments were reduced and the gap was augmented with tri-calcium phosphate blocks (Figure 4). After reducing and stabilizing the fracture with inter-fragmentary screws, the fracture was fixed with a plate, placed superiorly; at least three 3.5 mm cortical screws or locking screws when we used a locking plate were carefully placed through the plate and through both cortices of the clavicle on either side of the fracture site. While drilling, care was taken to avoid “plunging” through the inferior cortex and potentially damaging the underlying neurovascular structures and pleura.

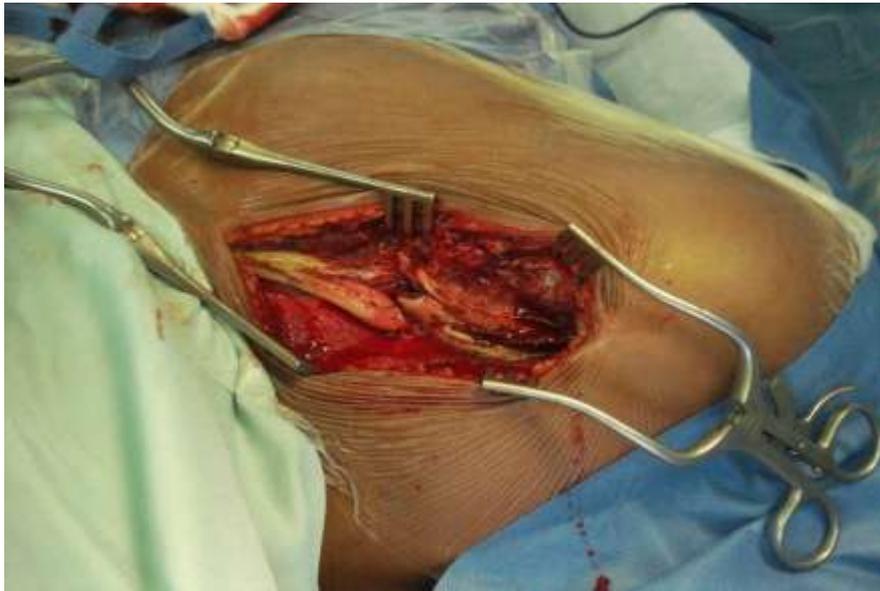


Figure 2. Intraoperative photograph showing comminution and displacement

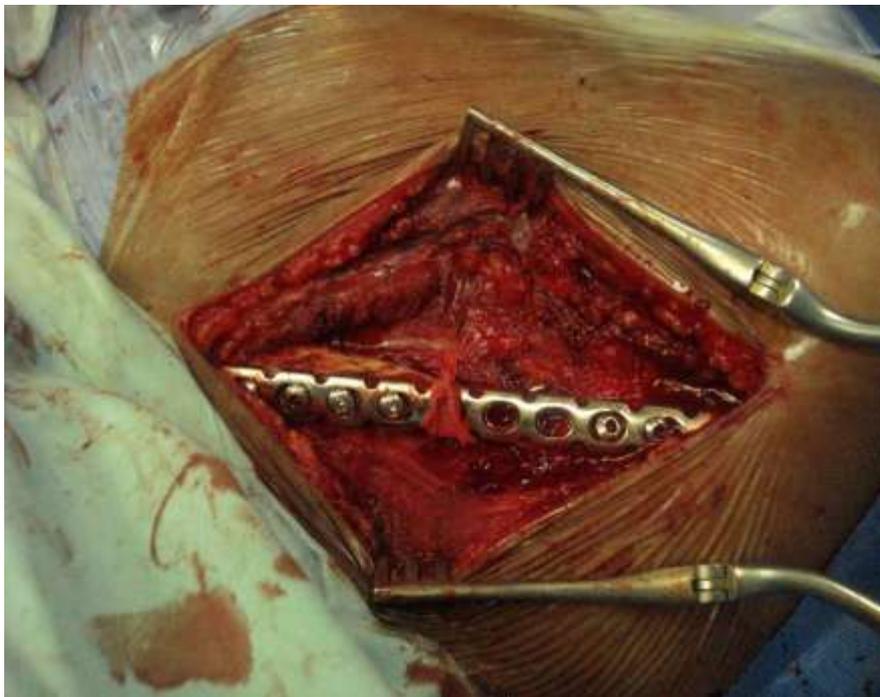


Figure 3. Intraoperative photograph showing fixation of the fracture with a 3.5 mm reconstruction plate



Figure 4. Radiographs of comminuted fracture of the clavicle augmented with tri-calcium phosphate blocks

In the initial six patients, we had used a contoured 3.5 mm reconstruction or a 3.5 mm narrow DCP (Figure 3). Recently, in the two cases done this year we used an anatomically pre-contoured superior locking clavicle plate (Figure 5). The average duration of surgery was around 90 minutes.



Figure 5. 10 weeks postoperative radiograph (superior locking clavicular plate) showing union of the fracture

Following closure, a dressing and sling was applied. After discharge the patients were seen approximately, 12 to 14 days postoperatively at which time skin sutures were removed. The patients were started on passive range-of-motion exercises as soon as the post-operative pain subsided and he or she was comfortable and these were continued along with the sling for 6 weeks.

At 6-8 weeks postoperatively the patient returned for a clinical exam and radiographs. Healed fracture is seen in Figure 5.

If the fracture showed evidence of healing, the sling was removed and the patient sent to physical therapy for active range-of-motion exercises. Strengthening exercises were allowed at approximately 10-12 weeks postoperatively. Contact sports were permitted at 4 months postoperatively or after complete healing of the fracture.

RESULTS

All the fractures healed by 8 to 10 weeks. There were no malunions, infections, neurovascular complications or evidence of hardware failure. 2 patients complained of paraesthesias over the infra-clavicular region in the post-operative follow up, which subsided over time. All patients had returned to their previous activity level at approximately 4 to 6 months follow-up with full range-of-motion and strength in the affected extremity (Figure 6), (except for the one patient recently operated). 3 of the 8 patients requested hardware removal, 12-18 months after the procedure due to intermittent discomfort over-lying the implant with certain activities. After plate removal a sling was worn for a week. The 3 patients undergoing plate removal were instructed to avoid contact sports and heavy lifting for 6 weeks after hardware removal. No complications were seen in those patients. All patients returned to their pre-injury activity level at 6 months postoperatively.



Figure 6. Post-operative follow up at 4 months, showing good ROM of the shoulder

DISCUSSION

Fractures of the clavicle account for 5-10% of all fractures, representing 35-45% of shoulder girdle injuries¹⁴. Middle-third fractures are the most common clavicle fractures, accounting for approximately 80% of all fractures.

As clavicle does have several important functions, each of which can be expected to alter in nonunion or malunions. The clavicle facilitates the placement of the shoulder in a more lateral position, so the hand can be more effectively positioned to deal with the three dimensional environment¹⁵.

Majority, 97% of the fractures in the middle third of the clavicle are mild to moderately displaced and may be treated non-operatively. However, 3% of middle-third clavicle fractures are completely displaced and shortened. This small group of fractures accounts for 90% of nonunion in middle-third fractures and therefore may warrant early open reduction and internal fixation¹⁶.

The incidence of nonunion of the clavicle following midshaft fracture has traditionally been described as 1% or less, based on two landmark studies from the 1960s^{17, 18}, this figure has been used to avoid primary internal fixation. However, a number of recent studies on completely displaced, midshaft fractures of the clavicle reveal nonunion rates between 15-20%^{1,2,5} due to better follow-up, inclusion of more severe fractures, elimination of children from the series (with their intrinsically good prognosis), patient reluctance to remain immobilized^{5,19}.

It is also of concern that clavicular malunions are now a distinct clinical entity with characteristic orthopedic (weakness, easy fatigability, winging of scapula), neurologic (thoracic outlet syndrome) and cosmetic (droopy, asymmetric shoulder, difficulty with backpacks, shoulder straps, etc.) symptoms²⁰.

Displaced fractures of clavicle with shortening of 20 mm or more should not be treated the same way as un-displaced or minimally displaced fractures. It is very rare to achieve success with conservative treatment of such fractures^{21,22}. A meta-analysis of recent studies reduced the risk of nonunion by 86% in the operative group compared to non-operative group². The deforming force of sternocleidomastoid is very strong²³ and cannot be overcome by external supports provided by the figure of eight bandage.

Studies show that plate fixation is an extremely effective technique for treatment of clavicular shaft fractures with a low complication and nonunion rate^{23, 24}. They quoted a nonunion rate of 2.2% in operative management of these fractures as compared to more than 15% rate in those managed with conservative methods.

When the plate is placed superiorly on the bone, it functions as a tension band and theoretically is effective because it is sufficiently rigid to withstand both the bending and the torsional forces at the middle third of the clavicle. It can also be bent to the contour of the clavicle (Figure 2). Additional fixation with inter-fragmentary screws can be achieved with a plate for oblique fractures.

A study conducted by a Canadian orthopedic trauma society on 111 patients showed not only overall improvement in shoulder functions at one year, but also much rapid return of function and decrease pain in the operative group^{25,26}.

Stable operative fixation performed in carefully selected clavicle fractures can be a safe and effective treatment method to restore shoulder function with minimal complications²⁷.

In this study we have analyzed results of plating of fresh midshaft clavicular fractures with an initial shortening of 20 mm or more. In our cases the union rate was 100% and all (except one recently operated) patients have regained good to excellent functions of the shoulder at 4 to 6 months post-surgery. 3 patients (37%) required hardware removal after 12 to 18 months due to prominence of the plate. 2 (25%) patients complained of paraesthesias over the infra-clavicular region in the post-operative follow up which subsided over time. We accept that this is a relatively small series and a larger number of patients would be necessary to draw inferences.

Having personally found dealing with delayed unions/non-unions relatively difficult to deal with in the past, coupled with patient dissatisfaction, it seems prudent to primarily fix displaced midshaft clavicle fractures with more than 20 mm

shortening, the results support the change in managing these group of fractures /patients.

CONCLUSION

The most predictable method to maintain anatomic reduction of displaced mid-shaft clavicular fractures, including length and rotation is in our opinion a plate and screw fixation. Although there is a learning curve with this form of treatment, once a surgeon becomes proficient in fixing two parts of clavicle fractures, displaced comminuted clavicle fractures become far less intimidating.

Ultimately, choice to proceed with operative intervention for a displaced mid-shaft clavicular fracture will be a decision made between the surgeon and the patient.

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