



Original Research Article

Surgical management of displaced clavicle fractures using precontoured locking plate

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ABSTRACT

Background: Most acute displaced clavicular fractures conventionally have been treated non-operatively with the expectation of a high probability of fracture union, good functional outcomes, and a high level of patient satisfaction. However, the outcome of non-operative treatment is not as favorable as once thought and there has been a growing trend to treat these fractures surgically.

Objective: To study the clinical outcome of displaced clavicle fractures managed surgically by pre-contoured locking plate and screws.

Materials and Methods: A prospective study was carried out between April 2015 to March 2019 in School of Medical Sciences & Research, Sharda University where 50 patients with displaced clavicle fractures were treated surgically by pre-contoured locking plate & screws. They were followed up for a minimum period of 9 months and evaluated for clinical outcome using DASH score and CONSTANT MURLEY score.

Results: Out of 50 cases 42 cases had excellent results and 5 patients had good results without complications. 2 cases which were going for delayed union were treated with bone grafting and 1 case, where the plate was exposed on the medial aspect at 8 weeks follow up, plate was removed and wound was closed in layers.

Conclusion: In our study of displaced clavicle fractures, which were effectively treated surgically with pre-contoured locking plate & screws, gave excellent results & to be considered the best surgical modality for displaced clavicle fracture with impending skin puncture management.

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1. Introduction

The very first textbook or treatise on traumatology already mentions the proper handling of dislocated midshaft clavicle fractures. In the Edwin Smith Papyrus (1600 BC) is written:

“If you treat a man for a dislocation in his collarbone, whose shoulders are found drooping while the head of his collarbone is facing toward his face, then you say about him: One who has a dislocation in his collarbone; an ailment I will handle.”

So the ancient Egyptians already knew that clavicle fractures are treatable “by bandage with stiff rolls of cloth and with oil and honey.” Thereafter, thousands of papers

have been published, but are we at all wiser? Thus far, the weaknesses in the published studies are their low quality and poor evidence, since they are mainly retrospective case series reporting various treatment methods. The main issue is still more or less unclear; what type of injuries need surgical intervention?

In adults, clavicle fractures comprise 3% of all fractures.¹ Of shoulder-region injuries, clavicle fractures comprise 37 to 45%, AC joint dislocations 8%, proximal humerus fractures 33%, scapular fractures 5%, and glenohumeral (GH) joint dislocations 17% (Nordqvist et al and Postacchini et al).^{2,3} The incidence of clavicle fractures is 50-64/1,00,000 and AC joint dislocations 8/1,00,000.⁴ Both injuries are more common among men (Nordqvist et al and Nowak et al).^{2,5}

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Traditionally, clavicle fractures and AC joint dislocations have both been treated nonoperatively with a sling. During recent decades, increasing interest in operative treatment has arisen (Hundekar et al).⁶ Fortunately, over the last seven years some randomized controlled trials comparing operative to nonoperative treatment in midshaft clavicle fractures have emerged. On the strength of these studies, it appears that nonoperative treatment results in more nonunion than does operative treatment, but any concrete influence on shoulder function has been unclear.^{7–10} As to the results of AC joint dislocation treatment, the literature provides inadequate data, especially concerning long-term follow-up and chronic injuries. Despite the treatment modality and injury nature, the goal is to restore shoulder function and prevent residual pain and constant disabilities.

2. Objectives

To study the clinical outcome of displaced clavicle fractures managed surgically by pre-contoured locking plate and screws.

3. Materials and Methods

With a level IV evidence, a prospective study was carried out from April 2015 to March 2019 in School of Medical Sciences & Research, Sharda University. A total of 50 patients with displaced clavicle fractures were treated surgically by pre-contoured locking plate & screws and were followed up for a minimum period of 9 months periodically and evaluated for clinic-functional outcome using DASH score and CONSTANT MURLEY score.

The patients with age more than 18 years, patients with displaced clavicle fractures (ALLMAN group I, II, III), patients with displaced clavicular fractures less than two weeks, patients with bilateral and open clavicular fractures were included in the study. Patients with haemopneumothorax, multiple rib fractures, flail chest, neurovascular injury and patients who were not medically fit for surgery were excluded from the study.

After getting IEC clearance from the institute and informed written consent from the patients enrolled in our study, they were subjected for thorough examination. The baseline investigations and radiographic analysis of the affected clavicle were analysed. According to ALLMAN classification, all cases belong to type 1 and were posted for surgical management with pre-contoured locking plate with 3.5mm locking screws and follow up according to our study protocol. The other associated injuries were addressed off with appropriate management.

Postoperatively, the patients were given a simple sling for approximately 2 weeks, and pendulum exercise and active range of motion exercise were then started. Radiographs were taken after 3 and 6 weeks, and again after 3 and 6 months for the clinical assessment. Assessment included

standardized clinical evaluation and completion of the CONSTANT MURLEY shoulder score and the Disability of the arm, shoulder and hand (DASH) score. The descriptive statistics were reported as mean (SD) for continuous variables, frequencies (percentage) for categorical variables. The data were statistically evaluated with IBM SPSS Statistics for Windows, Version 24.0, IBM Corp, Chicago, IL.

4. Results

Most of patients were in the age group between 21 and 40 years (63%). The youngest was 18 years and oldest was 66 years with an average age of 32.1 years. There were 46 males and 4 females. 45 of the fractures were sustained following Road Traffic Accident (92%) and 5 cases (8%) following fall from height. Right clavicle was fractured in 21 cases and left in 28 cases and bilateral clavicle fracture in 1 patient. 42 cases had comminution at fracture site. All the cases had displacement more than 2 cm. On an average the timing of surgery was 1 day post injury.

A total of 13 cases had associated injuries namely 6 patients with rib fractures, 1 with scapula fracture, 2 cases with tibia fracture, 1 case with patella fracture and 2 cases with facial bone fractures & head injury. Patients with isolated clavicle fracture were in hospital for an average of 3 days. All the cases were operated with precontoured locking plate fixed on superior surface with 3.5 mm locking screws. Interfragmentary screw was used in 27 cases.

The mean operative time was 48 min (range, 30 to 66 min). The bony union was achieved in 48 cases after surgery at an average of 12 weeks (range, 8 to 24 weeks). These patients returned to their daily routine activities from the time of injury on an average of 14 weeks (range, 8 to 20 weeks). 2 cases presented with signs of delayed union at 8 weeks, which were augmented with iliac bone graft and these fractures united by 24 weeks. 1 patient had plate exposed on the medial side (wound dehiscence) with signs of infection when presented at 8 weeks of follow up. The plate was removed on table, the fracture was already uniting, adequate wound debridement was done and the infected granulation tissue was sent for culture and sensitivity. Culture reports showed positive for *Staphylococcus aureus* & specific IV antibiotics was started. Wound was closed in layers.

Postoperative complications were noted in the follow up. The complications were dysaesthesia in the area of the incision in 2 cases and painful shoulder in 3 cases. A total of 9 patients had dissatisfaction regarding the healed surgical scar. The mean DASH score at final follow up was 4.2 (range: 3.1 – 5.3) and mean CONSTANT MURLEY score was 87.5 (range: 85 – 90).

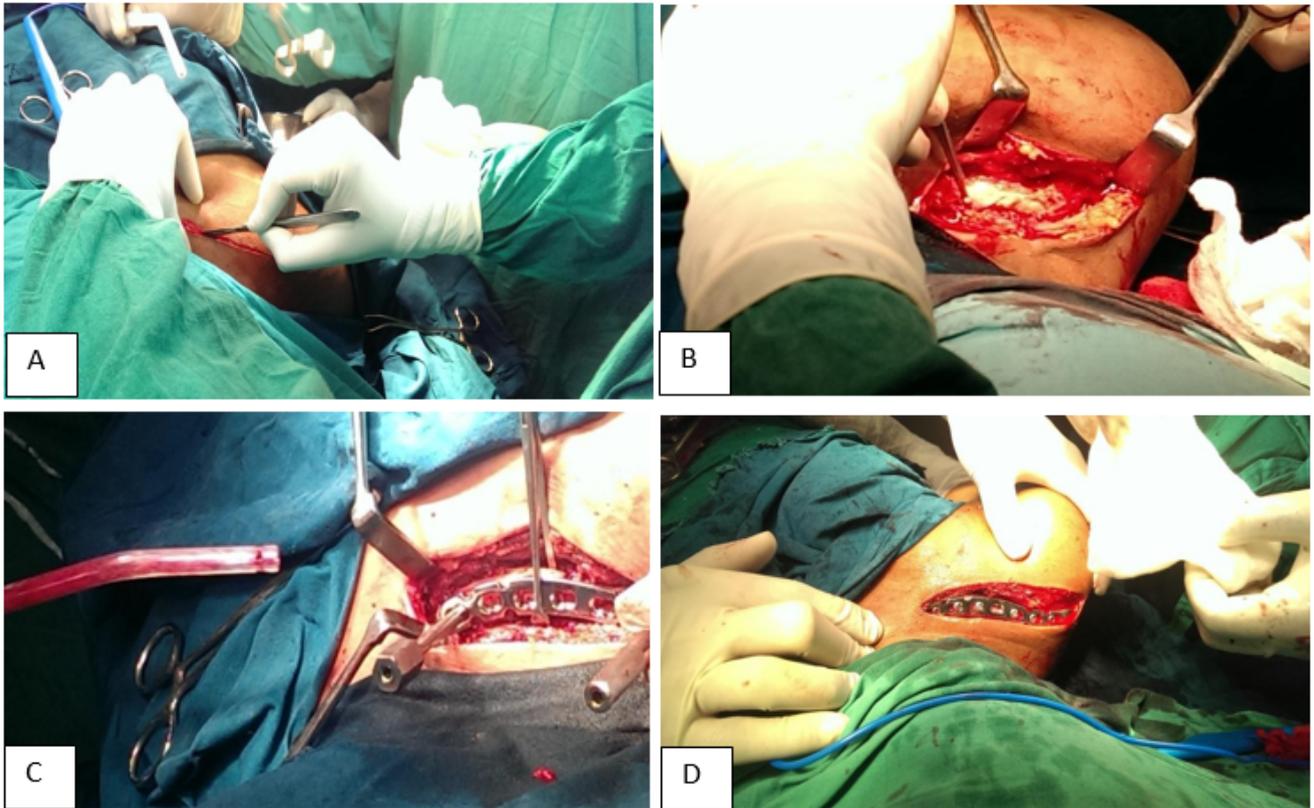
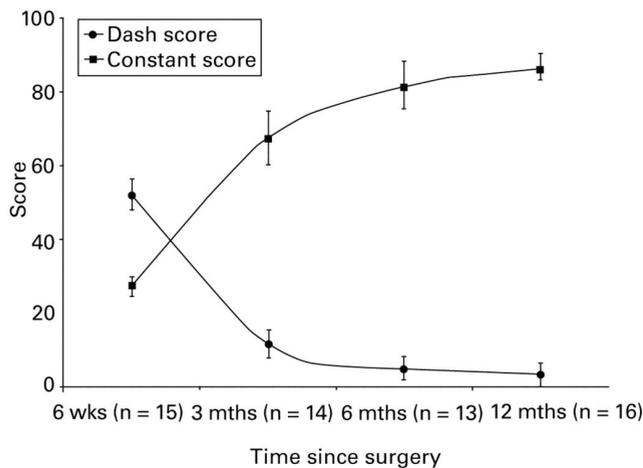


Fig. 1: Intra-operative images of precontoured clavicular LCP plating; (A): Incision over right clavicle; (B): Soft tissue dissection and exposure of fracture; (C): Fracture fragments reduced and plate placed with locking drill sleeve; (D): Fracture fixed with precontoured LCP & screws



Graph 1: DASHscore & Constant Murley score

5. Discussion

The clavicle acts as a strut, which transfers power from the trunk to the arm. The clavicle is S-shaped with a medial convexity and a lateral concavity. The middle third is the thinnest part of the clavicle and is located directly under the

skin with no soft tissue or muscle attachment. Thus, it is vulnerable to direct and indirect trauma. This explains the high frequency of fractures in the middle third.

Fractures of the clavicular shaft were considered to be a domain of non-operative treatment for a long time. This dogma was based on the studies conducted by Neer CS and Rowe CR.^{11,12} However, recent studies have shown that the rate of malunion and non-union after non-operative treatment might well be much higher than previously shown. Subjective contentment with the results of non-operative treatment is not uniformly high.^{13,14} In 2007, the Canadian Orthopaedic Trauma Society reported that internal fixation with plates resulted in more rapid union, excellent clinical outcomes, and lower complication rates in 132 patients with displaced clavicle fractures than non-operative treatment.⁷ Hence, there has been increasing interest in surgical treatments with open reduction and internal fixation.

The operative methods for the treatment of clavicle midshaft fractures involve intramedullary K-wire fixation or Steinmann pin fixation or elastic stable intramedullary nailing and plate fixation. The procedures using the former two materials result in low resistance to torque, carry risks

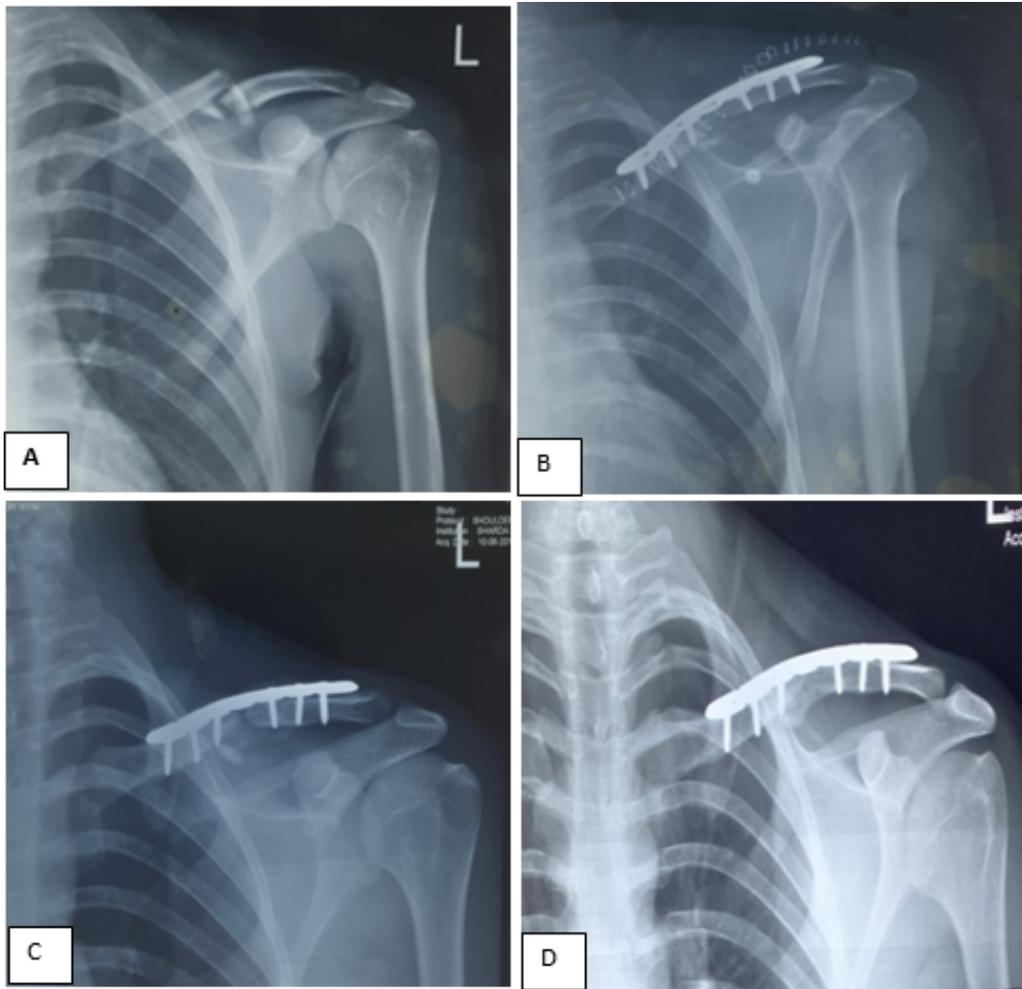


Fig. 2: Radiographic images of precontoured clavicular LCP plating; (A): Pre-op radiograph; (B): Immediate post op; (C): 3 months follow up; (D): 6 months follow up



Fig. 3: Range of movements of right clavicle fixed with precontoured clavicular LCP plating

of pin loosening and infection, and require a long-term fixation period.¹⁵ In addition, Elastic stable intramedullary nailing leads to good cosmetic and functional results. Patients profit from marked postoperative pain reduction and a rapid recovery of range of motion in the shoulder joint.^{16,17} However, multifragmentary fractures or oblique fractures can lead to a telescoping of the fracture site. This leads to a postoperative length reduction. To prevent this complication, Elastic stable intramedullary nailing is only recommended for simple or displaced wedge fractures.^{8,9,16,17}

Open reduction and internal fixation with plates (plate osteosynthesis) is still the standard method for the surgical treatment of clavicular shaft fractures.¹⁸ The goal of surgical treatment is the anatomic reduction with reconstruction of clavicular length and alignment of the shoulder girdle. To prevent early stress fracture of the implant, a fairly strong implant in comparison to the bone strength should be chosen. Pre-contoured LCP have been preferred for plate osteosynthesis of the clavicle. The advantages of Pre-contoured LCP include strong fixation due to locking between the screw and plate, and blood supply preservation due to minimal contact between plate and cortical bone.^{19,20} When LCP are used to treat clavicle midshaft fractures, the risks of injury to the subclavicular artery or brachial plexus could potentially be reduced because fixation can be achieved without the tip of the screw reaching the opposite bone cortex and periosteal stripping can be minimized to promote rapid union.²¹ It is believed that the surgery time can be reduced using LCP because accurate plate contouring is not necessary and periosteal stripping could be minimized using self-tapping screws. Surgical treatment of displaced midclavicular fractures with pre-contoured locking compression plate and screws, which can be shaped to match the shape of the clavicle, can be effective in the treatment of clavicle midshaft fractures. However, there remains some problem such as increased soft tissue stripping, infections, extensive scars, supraclavicular nerve injury.

In our study of 50 cases of displaced clavicle fractures, we conclude that 42 patients had excellent outcome and 5 had good outcome as deduced by DASH SCORE & CONSTANT MURLEY SCORE. 2 patients had complication of delayed union and 1 patient had plate exposure medially with signs of infection.

The surgical procedure is easy, less time consuming, less amount of intraoperative bleeding, with no requirement of fluoroscopic usage and surgeon friendly. The pre-contoured LCP helps to achieve anatomical reduction with an excellent end result of bony union by retaining the normal 'S' shape of the clavicle. The patients have no limitation of motion of the shoulder joint and can return to their full daily routine activities as soon as 8 weeks. Majority of the patients have no subjective complaints.

6. Conclusion

Though there are various surgical methods for fracture clavicle fixation, our study and other published series has shown that open reduction internal fixation with minimal periosteal stripping using pre-contoured locking plate & screws is far superior compared to other surgical modalities. So, clavicle fracture fixation with precontoured LCP and screws can be considered the best modality for displaced clavicle fractures with impending skin puncture.

7. Sources of Funding

Nil

8. Conflicts of interest

Nil.

9. Acknowledgements

Nil.

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