

# Clinical study of surgery with locking compression plate in clavicular fractures in adults

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## Abstract

**Background:** Treatment options for clavicle midshaft fractures include intramedullary K-wires, Steinmann pins, and plate fixation. In severe displaced or comminuted fractures, plate fixation can help achieve good anatomical reduction. Present study was undertaken to assess the functional outcome following the repair of displaced clavicular fractures with locking compression plates.

**Material and Methods:** Present study was single-center, prospective, observational study, conducted in patients within the age group of 16-60 years, with middle third clavicle fracture, displaced shaft of clavicular fractures (Displacement >2cm), with shortening >2cm, bone loss > 2mm, underwent open reduction and internal fixation with locking compression plating.

**Results:** The present study consists of 20 patients of type-2 middle third fracture type-2 B1 (displaced with simple or single butterfly fragment) occurred in 17 patients (85%) and type-2 B2 (displaced with comminuted or segmental) fracture occurred in 3 patients (15%). In this study, In 11 patients (60%) 7 hole locking compression plates were used. In 4 patients (20%) 8-hole compression plates were used and in another 4 patients (20%) 9 hole locking compression plates were used. In middle third clavicle fracture 18 patients (90%) united at the end of 12 weeks. In 2 patients (10%) delayed union occurred. In this study 3 patients (15%) had hypertrophic skin scar and in 2 patients (15%) had plate prominence and in another 2 patients (10%) delayed union occurred. In 1 patient (5%) plate loosening occurred which went for malunion. At post-operative 6 months, 16 patients (80%) had excellent functional outcome and good functional outcome in 4 patients (20%).

**Conclusion:** Operative procedures using LCP, which can be shaped to match the contour of the clavicle, can be effective in the treatment of clavicle midshaft fractures.

**Keywords:** Bony union, LCP clavicle, clavicle midshaft fractures

## Introduction

Clavicular fracture in adults account for 2.6-4% of all fractures, and shoulder girdle injuries account for 35% of all injuries <sup>[1, 2]</sup>. Midclavicular fractures are among the most common bone injuries, accounting for 3% to 5% of all fractures and 45 percent of all shoulder injuries. Midclavicular fractures affect 64 persons per 100,000 each year <sup>[3, 4]</sup>. Shaft fractures account for 70% to 80% of all clavicular fractures; lateral fractures account for 15% to 30% of all clavicular fractures, and medial fractures account for just 3% of all clavicular fractures. The peak incidence occurs in the third decade of life <sup>[2, 5]</sup>.

A favorable outcome with a low complication rate is attainable in many difficult clavicle fractures when a locked compression plate is used <sup>[6]</sup>. Primary internal fixation of comminuted displaced mid-shaft clavicular n fractures leads in predictable and prompt function <sup>[7]</sup>. Treatment options for clavicle midshaft fractures include intramedullary K-wires, Steinmann pins and plate fixation. In severe displaced or comminuted fractures, plate fixation, in particular, can help achieve good anatomical reduction.

Among the various plates offered are Sherman plates, dynamic compression plates and semitubular plates. The most popular are a reconstruction plate and a reconstruction locking compression plate (LCP), both of which may be bent to the S-shaped curvature of the clavicle [6]. Present study was undertaken to assess the functional outcome following the repair of displaced clavicular fractures with locking compression plates.

### Material and Methods

Present study was single-center, prospective, observational study, conducted in department of orthopedic surgery, at XXX medical college & hospital, XXX, India. Study duration was of 2 years (September 2019 to September 2021). Study was approved by institutional ethical committee.

### Inclusion criteria

- Patients within the age group of 16-60 years, with middle third clavicle fracture, displaced shaft of clavicular fractures (Displacement >2cm), with shortening >2cm, bone loss > 2mm, underwent open reduction and internal fixation with locking compression plating, willing for participation in study.

### Exclusion criteria

- Any medical contraindication to surgery (heart disease, renal failure or active chemotherapy).
- Patients with Poly-trauma.
- Non-ambulatory patient before injury.

After obtaining the informed consent from the patient/relative the patient were included for the study. Detailed history was taken from the patient in view of etiology, preexisting comorbidities and examination of both normal and affected clavicle were carried out. Radiographic evaluation on basis of x rays and functional parameters was carried out. Clavicular strapping, clavicular brace and arm pouch. Pre-op investigations and physician fitness was taken.

All the patients were properly counseled and explained regarding the surgical procedure and need of the surgical procedure. Open reduction and internal fixation with plates and screws. Follow up on 10 days, 1 month, 2 months, 6 months. On each visit clinical and radiological evaluation was done to assess functional outcome.

- Clinical assessment for pain and stiffness.
- Assessment of radiological and clinical union and functional ability of the shoulder.
- Assessment of function using DASH score & constant-murley score.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

### Results

The present study consists of 20 patients of middle third clavicle fracture which were treated surgically with locking plate & screws for middle third clavicle fracture. Majority of the patients were from age group of 19-29 years (40%). 90% were male cases and 10% were female cases. There were 17 patients (85%) of Left sided fracture and 3 patients (15%) of Right sided fracture. There was case of scapular fracture (5%).

Type-2 middle third fracture type-2 B1 (displaced with simple or single butterfly fragment) occurred in 17 patients (85%) and type-2 B2 (displaced with comminuted or segmental) fracture occurred in 3 patients (15%). Direct injury occurred in 17 patients (85%) among them 8 patients (40%) were due to fall on shoulder from two wheeler, 5 patients (25%) were due to road traffic accident, 4 patients (20%) were due to fall on the shoulder after slipping. Indirect injury occurred in 3 patients (15%) due to fall on outstretched hand.

**Table 1:** General characteristics

Characteristic	No. of cases	Percentage (%)
Age (in years)		
19-29	8	40
30-39	4	20
40-49	3	15
50-59	5	25
Gender		
Male	18	90
Female	2	10
Side		
Right	3	15
Left	17	85
Robinson Classification		
B1	17	85%
B2	3	15%
Mode of Injury		
Fall on shoulder from two	8	40
Road traffic accident	5	25
Simple fall on	4	20
Fall on outstretched hand	3	15

In this study, 18 patients (90%) were operated in the first week and 2 patients (10%) were operated in the second week.

**Table 2:** Time of surgery

Time of surgery	No. of cases	Percentage (%)
< 7 days	18	90
7-14 days	2	10

In 11 patients (60%) 7 hole locking compression plates were used. In 4 patients (20%) 8-hole compression plates were used and in another 4 patients (20%) 9 hole locking compression plates were used.

**Table 3:** Length of Plate

Length of Plate	No. of cases	Percentage (%)
7 hole	12	60
8 hole	4	20
9 hole	4	20

In middle third clavicle fracture 18 patients (90%) united at the end of 12 weeks. In 2 patients (10%) delayed union occurred. In both patients it was due to large butterfly fragment at fracture site which united at 16 weeks each.

**Table 4:** Duration of union

Time of union	No. of cases	Percentage (%)
8-12 week	18	90
>12 weeks	2	10

In this study 3 patients (15%) had hypertrophic skin scar and in 2 patients (15%) had plate prominence and in another 2 patients (10%) delayed union occurred. In 1 patient (5%) plate loosening occurred which went for malunion.

**Table 5:** Complications

	Types	No. of cases	Percentage (%)
Minor	Hypertrophic skin scar	3	15
	Plate prominence	2	10
	Delayed union	2	10
	Plate loosening	1	5
Major	Pate breakage	0	0

The functional outcome was assessed by Constant and Murley score. At post-operative 10 days, 17 patients (85%) had Fair functional outcome and 15% cases had poor functional outcome. At post-operative 1 month, 16 patients (80%) had Fair functional outcome, 15% cases had Good functional outcome and 5% cases were seen with poor functional outcome at 1 month. At post-operative 2 months, 16 patients (80%) had Good functional outcome, 15% cases had Fair functional outcome and 5% cases were seen with excellent functional outcome at 2 month. At post-operative 6 months, 16 patients (80%) had excellent functional outcome and good functional outcome in 4 patients (20%).

**Table 6:** Functional outcome

Functional outcome	At 10 days	%	At 1 month	Percentage (%)	At 2 months	Percentage (%)	At 6 months	Percentage (%)
Excellent	0	0	0	0	1	5	16	80
Good	0	0	3	15	16	80	4	20
Fair	17	85	16	80	3	15	0	0
Poor	3	15	1	5	0		0	0
Total	20	100	20	100	20	100	20	100

## Discussion

The midclavicular region of the clavicle has a weak point, which accounts for the majority of clavicle fractures. The clavicle is subjected to a variety of muscular and ligamentous stresses, and understanding these forces is crucial to comprehend the nature of clavicle fracture displacement and why particular fracture patterns tend to produce issues if not minimized and surgically stabilized.

Nonunion in displaced comminuted midshaft clavicular fractures in adults occurs between 10% and 15% of the time, according to more recent statistics based on full fracture classification<sup>[3]</sup>. Surgery is becoming more widely accepted as the primary treatment for displaced midshaft clavicular fractures, because non-surgical treatment is seen as clinically, functionally inferior to operational treatment with a high rate of union and low complication rates<sup>[5]</sup>.

The present study of patients with middle third clavicle fractures is compared with Bostman *et al.*,<sup>[8]</sup> study which treated only middle third clavicle fractures, in this totally 103 patients were treated by early open reduction and internal fixation with plate and screws. It was also compared with Cho *et al.*,<sup>[9]</sup> study where 41 patients with a clavicle midshaft fracture were treated by internal fixation with a reconstruction plate (19 patients) or reconstruction LCP (22 patients).

Middle third clavicle fracture commonly occurred between the age group of 19 to 29 years in 8 patients (40%). The youngest patient age was 19 years and oldest patient age was 55 years. The average patients' age was 32 years. In Bostman *et al.*,<sup>[8]</sup> study patients average age was 33.4 years and the youngest patient age was 19 years and oldest patient age was 62 years. In Cho *et al.*,<sup>[9]</sup> study, in reconstruction plate group the mean age was 45 (range 22-70) and that of the locking compression plate was 46 (range 19-69).

In present study 19 (90%) were male cases and 1(10%) cases was female. In Bostman *et al.*,<sup>[8]</sup> series also commonly males are affected 76 Patients (73.79%) compared to females 27 Patients (26.21%). In Cho *et al.*,<sup>[9]</sup> study, the reconstruction plate group that 12 male and 7

female Patients and in the locking compression plate group it was 17 male and 5 Patients. In this study all Patients with midshaft clavicle fractures were of closed type. This is comparable to Bostman *et al.*,<sup>[8]</sup> and Cho *et al.*,<sup>[8]</sup> study which also showed all their patients were closed fractures.

In this present study, Robinson Type-2 B1 (Displaced with simple or butterfly fragment) were more common and there were 17 Patients (85%). Type-2 B2 (displaced with comminution) occurred in only 3 Patients (15%).

In Bostman *et al.*,<sup>[8]</sup> study also Robinson type-2B1 was common in 81 patients (78.64%). Robinson type-2 B2 occurred only in 22 patients (21.36%). In Cho *et al.*,<sup>[9]</sup> study, in reconstruction plate group there were 7 Patients with B1 type and 12 Patients with B2 type and that of the locking compression group had 9 B1 type and 13 B2 type.

Most of the patient in our study were operated in the first week i.e. 18 patients (90%). 2 patients (10%) were operated in the second week. In Bostman *et al.*,<sup>[8]</sup> study all the patients were operated within 3 days of injury. In Cho *et al.*,<sup>[9]</sup> study, the reconstruction plate group was operated by 4 days and that of locking compression plate was 9 days.

In this study 7 hole plates were used in 12 Patients (60%), 4 Patients (20%) each with 8 and 9 hole plates, depending upon type of fracture. In Bostman *et al.*,<sup>[8]</sup> study plate length was above 6 holes to place atleast three screws in each fragment. Plate length also depends upon the amount of comminution.

In this study majority of the middle third clavicle fracture cases united between 8 to 12 weeks i.e. 18 Patients (90%). In 2 Patients (10%) delayed union occurred as there was a displaced butterfly fragment which united with the main fragment at the end of 16 weeks. There were no non-union. Lazarus MD<sup>[10]</sup> stated radiological union occurred approximately between 6 to 12 weeks. In Cho *et al.*,<sup>[9]</sup> study, bony union for reconstruction plate was 14.6 weeks and that of locking compression plate was 13.2 weeks.

Plate loosening occurred in 1 Patient (5%) at the end of 6 weeks postoperatively. The cause in this patient was also due to noncompliance with the post-operative protocol. The patient went for farming in the field before the fracture union. With further advice of not to lift heavy weights in the affected limb clavicle fracture went to unite in mal position at end of 12 weeks and no reoperation was performed for this.

In Bostman *et al.*,<sup>[8]</sup> study 7 patients (6.80%) had implant loosening. In all the patients loosening occurred at 6 postoperative weeks. Malunion of varying degree followed in all of these patients and no reoperations were performed. In Cho *et al.*,<sup>[9]</sup> study, only the reconstruction group that plate loosening in 3 Patients (15.8%).

Delayed union occurred in 2 Patients (10%) due to a large butterfly fragment in the inferior aspect of clavicle which went on to unite with the main fragments at the end of 16 weeks. In Bostman *et al.*,<sup>[9]</sup> study delayed union occurred in 3 Patients (2.91%).

There were hypertrophic skin scar in 3 Patients (15%). Plate prominence through the skin was reported in 2 Patients (10%). The total complication in this study were 15% excluding skin related minor complications. The total complication rate of Bostman *et al.*,<sup>[8]</sup> study was 23%.

The functional outcome according to Constant and Murley<sup>[11]</sup> in this study at 6 months of follow up out of total 20 Patients of fresh middle third clavicle fracture fixed with locking compression plate and screws showed excellent results in 15 Patients (80%) and good functional outcome in patients 4 Patients (20%). The advantage of rigid internal fixation and early mobilization of fresh displaced clavicle fracture is that it (displaced comminuted middle third) gives immediate pain relief and prevents the development of shoulder stiffness and non-union.

The advantages of reconstruction LCPs include strong fixation due to locking between the screw and plate, and blood supply preservation due to minimal contact between plate and cortical bone. With conventional screws and plates, fracture site stability is provided by friction between the plate and bone cortex. Accordingly, screws need to be fixed onto both cortices.

## Conclusion

Bony union could be achieved with LCP clavicle and the clinical outcomes were satisfactory. Overall, operative procedures using LCP, which can be shaped to match the contour of the clavicle, can be effective in the treatment of clavicle midshaft fractures. All the fractures united and there was no non-union. No implant removal was done till the end of this study. We were able to achieve excellent results in 80% patients.

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