



## Analysis of Displaced Middle Third Clavicular Fractures Treated By Plate Osteosynthesis

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### Abstract

**Introduction:** Fracture of the clavicle is common, accounting for 5 to 12% of all fractures. Displaced mid shaft clavicle fractures are common and are generally treated non-operatively. Open reduction and internal fixation with plating provides rigid fixation, early functional recovery and low rates of non union, mal union.

**Materials and Methods:** The study conducted was time bound, hospital based, prospective study. In this study we analyze the functional outcome of 40 cases of displaced middle third clavicular fractures, internally fixed by plate osteosynthesis which was undertaken at the department of orthopaedics and traumatology at Government Mohan Kumaramangalam Medical College and Hospital, Salem from November 2011 to September 2013.

**Results:** Out of 40 cases 18 cases united in 8 weeks and by 12 weeks all cases united except one. In one case there was delayed union followed by implant failure. In our study 24 patients returned to day today activities after 2-3 weeks and 30 patients returned to work within 2<sup>1/2</sup> months.

**Conclusions:** In our study Open reduction and rigid internal fixation of displaced midshaft clavicular fractures have given fracture union and excellent functional outcome.

### Introduction

Fracture of the clavicle is common, accounting for 5 to 12% of all fractures. About 80 to 85% of these fractures are in the middle third of the bone, where the typical compressive forces applied to the shoulder and the narrow cross section of the bone combines and result in bony failure<sup>27</sup>.

Displaced mid shaft clavicle fractures are common and are generally treated non-operatively<sup>1</sup>. Non-operative treatment of these fractures with axial shortening is associated with non union, delayed union, and symptomatic malunion. Other complications are severe pain, neurological complications, loss of shoulder

function and protuberant callus forming swelling and stretching of skin which is cosmetically unacceptable<sup>4</sup>.

The proponents of early fixation of fresh clavicular fractures to prevent complications like malunion and nonunion emphasize the value of accurate reduction and rigid fixation in affording quick pain relief and promoting early functional recovery. Persons with high activity level will hesitate to accept prolonged recovery and impaired shoulder function, therefore may require more aggressive treatment of middle third clavicle fractures. Prompt fixation of these clavicle fractures permits increased patient comfort, and early shoulder mobility. If the patients have high physiological demands shortly after surgery, high pain scores, or strong preference for surgery early plate fixation can offer advantages<sup>1</sup>. In cases of associated scapula fractures, fixation of the clavicle provides restoration of shoulder mechanics leading to improvement of function.

Operative treatment of displaced mid shaft clavicular fractures can be achieved successfully using plates or intramedullary implants like rush pins, kirshner wires or nails<sup>27</sup>. Open reduction and internal fixation with plating provides rigid fixation, early functional recovery and low rates of non union, mal union<sup>10</sup>.

### Materials and Methods

The study conducted was time bound, hospital based, prospective study. In this study we analyze the functional outcome of 40 cases of displaced middle third clavicular fractures, internally fixed by plate osteosynthesis which was undertaken at the department of orthopaedics and traumatology at Government Mohan Kumaramangalam Medical College and Hospital, Salem from November 2011 to September 2013

Patients with age between 18 years to 60 years and clavicle fractures with displacement of more than 2cm, shortening of more than 2cm, fractures with comminuted fragments, segmental fractures, open fractures and impending compound fracture with soft tissue compromise are included in our

study. Patients with age of less than 18 years, undisplaced or minimally displaced fractures and any medical contraindication to surgery (Heart diseases, renal failure or active chemotherapy) are excluded from our study.

On admission resuscitation of the patients in the emergency room was carried out followed by radiographic examination was done which included the three-view trauma series of the shoulder devised by Neer and Rockwood. Radiographs of the chest were done routinely to detect any concomitant fractures of the ribs, pneumothorax or hemothorax.

### Operative Procedure

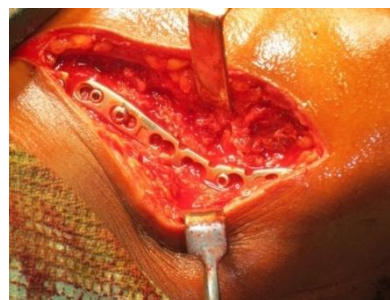
Under anesthesia the patient was placed in supine position with sand bag between the scapulae. Keeping the sand bag allows the shoulder girdle to fall backward. It restores the length and increases the exposure to clavicle. We made an incision along the axis of the clavicle, centering the fracture site. Subcutaneous tissue along with platysma incised together and were mobilized. This will prevent wound healing related issues and implant prominence after wound closure. Myofascial layer was incised and elevated from the fracture ends for exposure. After that fracture ends cleared of hematoma, fracture reduced using bone clamps. If there was a comminuted wedge fragment, it was fixed with a lag screw either through the plate or separately. Reconstruction plate or anatomical clavicular plate was used. In case of reconstruction plate the plate was contoured accordingly. The Plate is placed over the superior surface of the clavicle will often restore the correct rotation. Once the fracture alignment, length and rotation were satisfactory the screws were inserted. Minimum of six cortical purchases was attained on either side of the fracture. The myofascial layer followed by skin and subcutaneous tissue sutured and immobilized in a shoulder immobilizer.

Rehabilitation of the affected arm was started at the end of 3<sup>rd</sup> post operative day onwards. Gentle pendulum exercises to the shoulder in the arm

pouch were allowed. At 2 to 3 weeks gentle active range of motion of the shoulder was allowed but abduction is limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed.

### Results

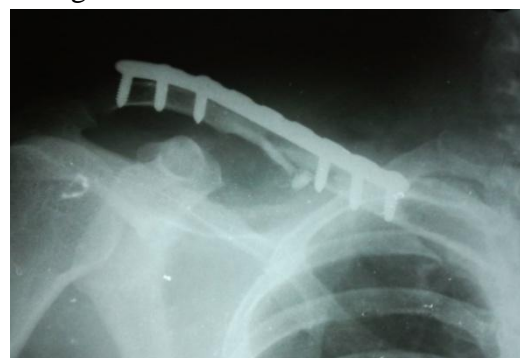
In our study 40 cases of displaced middle third clavicular fractures were treated with plate osteosynthesis using locking compression plate and reconstruction plate. In our study of 40 cases 35 patients are male and 5 patients are female. Age of the patient varies from 20 years to 50 years. The mean follow up period was 1 year ranges from 22 months to 4 months. Of the 40 patients 28 patients sustained injury to the right side and remaining 12 patients on left side. In the majority of the cases road traffic accidents (30 cases) was the cause for injury followed by accidental fall. Regarding the mechanism of injury the fall on outstretched hand was the common cause of injury (25 cases) followed by direct impact. The direct impact injury was associated with fragmentation at the fracture site. The time of presenting to the hospital ranges from 1 hour to 7 days with average time of 20 hours. The average duration of surgery was 50 minutes. The average blood loss during the surgery was less than 100ml. In our study out of the 40 cases 18 cases were united in 8 weeks and by 12 weeks all the cases united except one case. In one case there was delayed union followed by implant failure. In our study 24 patients returned to day today activities after 2-3 weeks and 30 patients returned to work within 2<sup>1/2</sup> months. We had complications of hardware irritation in four cases, infection in one case and delayed union with hardware failure in one case. No nonunion or refracture in our cases. We removed the plate and screws in 3 cases after fracture union during the study period for hardware irritation patients.



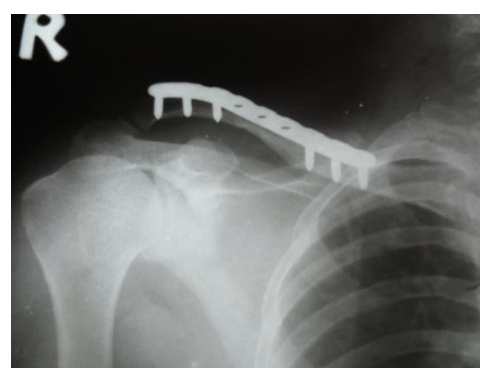
**Fig 1.** Intra operative picture showing fixation with locking compression plate.



**Fig 2.** Pre operative x ray showing fracture clavicle right side



**Fig 3.** Post operative x ray showing fracture clavicle right side fixed with locking plate.



**Fig 4.** Follow up x ray showing fracture union clavicle right side



**Fig. 5.** Pre operative post operative x ray showing fracture clavicle left side fixed with reconstruction plate



**Fig. 6.** Pre operative post operative x ray showing fracture clavicle left side fixed with reconstruction plate and interfragmentary screw .



**Fig. 7** Post operative picture showing the prominent and hardware irritation.

## Discussion

Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at shoulder girdle. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. It is caused by either low-energy or high-energy impact. The management on clavicle fracture are first introduced by ancient Egyptians. Evidence on the non operative treatment of clavicle fractures dates back to the Edwin Smith Papyrus, written in the 17th century

BC<sup>2</sup>. Hippocrates noted various observations about clavicle fracture at 400 BC.

Many non operative methods of treatment for clavicle fractures had been described even though a sling consistently gave good functional results. The different types the conservative treatment of the Clavicle fractures are immobilization with (1) Parham support, (2) Bohler brace,(3) Taylor support,(4) Velpeau wrap,(4) Modified Velpeau wrap,(5) Modified Sayre bandage,(6) Billington yoke (plaster figure-of-eight),(7) Commercial figure-of-eight <sup>27</sup>.

The traditional view that most of the clavicular fractures heal with good functional outcomes following non operative treatment is no longer valid. Recent studies have showed a higher rate of nonunion and shoulder dysfunction in subgroups of patients with clavicle fractures. Because of this, these fractures should therefore be considered as a spectrum of injuries with various functional outcomes, each requiring cautious assessment and individualized care. In the beginning clavicle fracture is given little importance and usually treated conservatively. But in the present fast moving world morbidity caused by clavicle fracture is a point of concern.

In a study by Charles Neer only 3 of 2235 (0.1%) patients with middle third clavicle fracture treated by closed methods failed to heal and C Rowe study in 566 patients concluded that nonunion occurs only in <1% of the patients<sup>3,4</sup>. But the drawback of these studies is both conducted in children, which usually unite always<sup>5</sup>. In a study by Hill in 66 mid third clavicle fractures treated conservatively, 31 % patients were unsatisfactory with the result, 25 % of patients complained of pain, 54% patients found the end result cosmetically displeasing<sup>6</sup>. Displaced middle third clavicle fracture treated non operatively usually associated with shortening<sup>5</sup>. Hill et al in his study concluded that shortening more than 2 cm is associated with poor outcome<sup>6</sup>.

The previous studies of outcome following clavicular fractures did not describe any strength deficits following nonoperative treatment of



displaced mid shaft clavicular fractures and concentrated on radiographic and surgeon based results. Hill et al were one of the first to use a patient oriented outcome measure and found 31% patients were unhappy after non-operative treatment. This may be attributed to significant residual strength deficits following conservative management of these fractures. In another study which measured an objective strength testing protocol for both maximal effort and endurance found strength deficits ranging from 10 - 35% in patients after an average of 54 months following nonoperative treatment of displaced fractures of the clavicular shaft which showed they had a significant impairment in shoulder functions of an active young person recreationally and occupationally. In a study conducted by Canadian orthopaedic trauma society on 111 patients of fracture clavicle showed not only an overall improvement in shoulder functions (at one year) in operated cases, but also a much rapid return of function and decrease in pain in the operative group.

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 one becomes proficient in fixing two part clavicle fractures, displaced comminuted clavicle fractures become far less intimidating. The choice to proceed with operative intervention for a displaced mid-shaft clavicular fracture will be a decision made between the surgeon and the patient. So there is specific indication like displacement, with or without comminuted middle third clavicle fracture (Robinson Type-2B1,2B2).

The patients treated with early, rigid fixation of their clavicle fractures shared a high postoperative constant score, early pain resolution early return to activity and high patient satisfaction rating. Plating has the advantages of maintaining the length especially in comminuted fractures. There

is little chance for hard ware breakdown and migration.

In cases of clavicle fractures with more fragments we can apply the plate as bridge plating otherwise called biological plating which achieve relative stability by splinting. This allows the indirect fracture healing with preservation of blood supply and soft tissue attachments while bridging the fracture zone maintaining the exact length, alignment and rotation. Jerry et al studied on 100 clavicles to find out the clinical applicability of anatomic pre contoured plate. He found out that at the lateral aspect of clavicle bone there is a superior bow. Medial aspect of the superior surface of the clavicle is relatively flat, making it an ideal surface for plating<sup>29</sup>.

Clavicle nailing is an option for mid third clavicle fractures. Intra medullary nailing is difficult in clavicle because of the anatomical shape. Nailing has the advantages of less soft tissue dissection and periosteal disruption. The disadvantages are no static locking is available, hard ware can break, hard ware migration ,migration causes breakdown of skin or infraclavicular structure injury and in comminuted fracture shortening occurs over time<sup>21</sup>. Chaithavat and V. Parkpian studied on 108 mid third clavicle fractures treated with Kirschner wires. They came to a conclusion that operative procedure is associated with low complication such as non union, mal union etc. The complication with this procedure is k-wire migration<sup>11</sup>

The combination of ipsilateral fracture of the clavicle and scapular neck has traditionally been called the "floating shoulder"<sup>27</sup>. It is considered as an unstable injury and may require operative fixation. This injury is considered as a subgroup of superior shoulder suspensory complex. It includes both bone and soft tissue circle, or ring of the glenoid, corocoid process, coraco clavicular ligament, clavicle, acromio clavicular joint and the acromion. This is important biomechanically and maintains the anatomic relationship between upper extremity and axial skeleton. If operative intervention is chosen, then anatomic reduction

and internal fixation of the clavicle is performed first and the shoulder is then reimaged. If the fixation result in indirect reduction of the glenoid no further intervention is required. If the glenoid remains in unacceptable position then fixation of glenoid neck is indeed<sup>27</sup>.

In our study the clavicle fracture are more common in male than females. There were 35 male and 5 female patients. This is comparable with other studies by Elidrissi Mohammed et al where out of 34 patients 32 were male and two were females<sup>17</sup>. In a study by Dhoju et al out of 20 patients 16 were males and 4 were females. From this we can conclude that it is more common in active individuals<sup>18,20</sup>.

In our study right side clavicle is commonly involved than left side. This is also comparable with the study by Elidrissi Mohammed et al where out of 34 cases 28 were on right side and 6 were left side. From this we can come to conclusion that dominant hand involves usually<sup>17</sup>.

In our study the average age group was 27.5 years. It is also comparable with study by Elidrissi et al<sup>17</sup>. This again indicates clavicle fracture is more common in active, working age group<sup>20</sup>.

In our study Road Traffic Accident was the most common cause for clavicle fractures. Fall on out stretched hand was the commonest mechanism of injury. We studied the fracture pattern (intra operative finding based on mode of injury and mechanism of injury. From this Robinson type 2b2 (comminuted mid shaft fracture) is associated with high velocity injury and direct impact of the shoulder.

In our study the average time taken for surgery was less than one hour. Average blood loss was less than 100ml.

The average time of union was 9.2 weeks. It is also comparable with other studies like Elidrissi et al, Dhoju et al. Most of our patients return to work at 2 and a half month time.

Time of union	
Elidrissi et al <sup>17</sup>	14 weeks
Dhoju et al <sup>51</sup>	16 weeks
Olivier et al <sup>8</sup>	12 weeks
Our study	9.2 weeks

We assessed the functional outcome using constant score. We got excellent result in all patients except one in which we used 1/3<sup>rd</sup> tubular plate. The patient came after 6 months for evaluation of pain, fracture found to be malunited after implant breakage. The patient was not willing for implant removal. He treated with analgesics.

Study	Implant failure	Malunion/Nonunion
Dhoju et al (Reconstruction plate) <sup>51</sup>	Nil	Nil
Elidrissi et al (Reconstruction plate) <sup>17</sup>	Nil	Nil
Olivier et al (low contact dynamic compression plate <sup>8</sup> )	Nil	5%
Nathan et al (superior Reconstruction plate) <sup>15</sup>	3%	20%
Our study ( 21 Reconstruction plate, 18 Locking plate, one 1/3 tubular plate)	2.5% (1/3 tubular plate)	3% (Malunion)

In our study there are 4 patients complained of hard ware irritation. In these patients functional outcome was good. We removed implant in 3 patients. There is no re fracture. We used high profile reconstruction plate. This complication can be avoided by using low profile plate.

One case had superficial infection. This was managed with intravenous antibiotics. In other studies deep infection is treated with early surgical debridement for deep infections.

Infection		
Nathan et al <sup>15</sup>	Superior plating	Nil
	Antero inferior plating	2.5%
Elidrissi et al <sup>8</sup>		3% ( deep infection)
Dhoju et al <sup>51</sup>		5% (deep infection)
Our study		2.5% (Superficial infection)

Superior plating has the advantage of plating over the tension surface. Superior plating is the preferred technique when there is inferior cortical comminution<sup>15</sup>. We considered stability more than cosmesis so our choice was superior plating than anteroinferior plating which has less hard ware irritation<sup>19</sup>. According to literatures superior plating is associated with neurovascular complications. In order to avoid neurovascular

injury we measured the clavicle size pre operatively and we adjusted the drill bit length.

In our study we used both reconstruction plate and locking compression plate. There is no significant difference in terms of union or functional outcome. But patient in which locking compression plate is used showed an early return to day today activities and work compared to the reconstruction plate group. Locking compression plate provides better biomechanical stability than reconstruction plate. So it is preferable implant of choice in fractures with inferior cortical defects. Precontoured anatomical plates allows good reduction to be maintained, theoretically improves the rate of union and allows early return to good function<sup>7</sup>. Low profile locking plates decrease the chance of soft tissue irritation. In a biomechanical comparative study between LCP and reconstruction plate showed better biomechanical stability is obtained by using Locking compression plate<sup>13</sup>.

### Conclusion

In our study Open reduction and rigid internal fixation of displaced midshaft clavicular fractures have given fracture union and excellent functional outcome. Reconstruction plates can be contoured according to the need and superior placement with six cortical purchases on either side gives stable construct, predictable union and optimum functional outcome. Use of interfragmentary screws can be used wherever possible. Owing to the subcutaneous anatomy of clavicle, superior implantation of implant might cause hardware prominence especially in lean individuals demanding subsequent removal. patient in which locking compression plate is used showed an early return to day today activities and work compared to the reconstruction plate group.

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