

# Functional outcome and complications of open reduction and internal fixation with plate for displaced midshaft clavicle fractures

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## Abstract

**Background:** Clavicle fractures account for 2.6% of all fractures and for 44% of fractures around the shoulder. Middle third fractures account for 80% of all clavicle fractures. Several fixation methods have been reported including plate fixation, intramedullary pin fixation and placement of intramedullary threaded k-wires and elastic intramedullary nails. The objective of present study was to evaluate clinical and functional outcome in clavicle mid shaft fractures treated with open reduction and internal fixation with clavicular anatomical locking plates. **Material and Methods:** Present study was prospective, observational study conducted in patients 18-60 years with displaced and/or comminuted fracture at middle third clavicle required surgical intervention. The anatomical locking plate was fixed to the medial and lateral fragment with locking screws/ cortical screws and at least three screws in medial and lateral fragment were applied. **Results:** In present study, total 31 patients underwent surgery. 19-29 years age group was most common (45%), followed by 30-39 years age group (26%). Male predominance (71%) was noted as compared to females (29%). Right side was commonly involved (61%). Road traffic Accident (55%) was most common mode of injury. Robinson's fracture type 2B1 was most fracture noted (65%). We noted 100% union rate with  $5.6 \pm 2.3$  months required for complete union. After complete healing, according Constant Murley scoring system, functional outcome was excellent in 81% patients while good and fair outcome was noted in 13% and 9% patients respectively. Complications such as delayed union (3 %) and superficial infection (3 %) were noted in present study. We did not noted any non-union, malunion, deep infection, plate loosening, plate breakage, plate prominence, hypertrophic scar, signs of nerve compression, pain after complete union or restriction of shoulder movement in study patients. **Conclusion:** Open reduction and internal fixation with plate for displaced midshaft fracture clavicle results in high rates of fracture union, increased patient satisfaction, early pain-free movement of shoulder and improves patient- oriented functional outcome.

**Key Words:** mid-shaft Clavicle fracture, plate fixation, anatomical plate, open reduction and internal fixation

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## INTRODUCTION

The clavicle is the only long bone in the body that lies horizontally. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. A fall or a direct blow to the shoulder, giving an axial compressive force on the clavicle, is the most common trauma mechanism of injury for any clavicular fracture.<sup>1</sup> Clavicle fractures account for 2.6% of all fractures and for 44% of fractures around the shoulder. Middle third fractures account for 80% of all clavicle fractures.<sup>2</sup> Earlier conservative treatment was advocated, but there is 15% nonunion rate in widely displaced

fractures of middle-third of the clavicle treated without surgery and all fractures with initial shortening of more than 2cm resulted in nonunion.<sup>3</sup> Other symptoms include neurological complications, restricted shoulder movement, protuberant callus which is cosmetically unfavourable for the patient. Several fixation methods have been reported including plate fixation, intramedullary pin fixation and placement of intramedullary threaded k-wires and elastic intramedullary nails.<sup>4,5</sup> Numerous studies have been conducted still there is no consensus regarding the management of these fractures. A biomechanical study shows that plate fixation provides a more rigid stabilization compared to intramedullary fixation and may provide a stronger construction for early rehabilitation protocols.<sup>6</sup> The objective of present study was to evaluate clinical and functional outcome in clavicle mid shaft fractures treated with open reduction and internal fixation with clavicular anatomical locking plates.

### MATERIAL AND METHODS

Present study was prospective, observational study conducted in clavicle mid shaft fractures. Study was conducted during January 2019 to June 2020 at department of Orthopaedics in XXX medical college and hospital, XXX. Approval was taken from ethical committee for present study.

#### Inclusion criteria

- Patients 18-60 years with displaced and/or comminuted fracture at middle third clavicle required surgical intervention
- Patient willing to participate and follow up.

#### Exclusion criteria

- Fracture in medial or lateral third of clavicle.

### RESULTS

In present study, total 31 patients underwent surgery. 19-29 years age group was most common (45%), followed by 30-39 years age group (26%). Male predominance (71%) was noted as compared to females (29%). Right side was commonly involved (61%). Road traffic Accident (55%) was most common mode of injury. Robinson’s fracture type 2B1 was most fracture noted (65%).

- Pathological fractures, undisplaced fractures, previously operated fractures,
- patients with head injury, fractures associated with acromioclavicular joint dislocation, patients with neuro-vascular injury
- Patients with contraindication to general anaesthesia (heart diseases, renal failure or active chemotherapy)
- Patient not willing to participate, follow up or lost to follow up.

Written informed consent was taken from patients. Demographic details, mode of injury, medical history, clinical examination findings were noted. Laboratory and radiological work up was done in all patients and anaesthetic fitness for general anesthesia was taken. Patients were operated according to departmental standard operating procedures. Fracture fragments were reduced and plate was applied over the superior aspect of the clavicle. The anatomical locking plate was fixed to the medial and lateral fragment with locking screws/ cortical screws and at least three screws in medial and lateral fragment were applied. Standard post-operative care was provided to all patients. Follow up was advised at every 4 weeks in OPD. During each follow up visit, patients were examined for any signs of infection, tenderness, instability, deformity. Range of shoulder movements were noted. X ray examination was done to assess fracture healing. Physiotherapy was advised according to the postoperative time and stage of fracture union. The functional outcome were assessed by Constant and Murley scoring system.<sup>7</sup> Follow up was kept till 6 months. Data was collected in Microsoft excel sheet and statistically analysed with descriptive statistics as percentages, mean and standard deviation.

**Table 1:** Demographic data.

Variables	No. of patients	Percentage (%)
Age in year		
19-29	14	45%
30-39	8	26%
40-49	5	16%
50-60	3	10%
Sex		
Male	22	71%
Female	9	29%
Side affected		
Right	19	61%
Left	12	39%
Mode of injury		

Road traffic Accident	17	55%
Simple fall on Shoulder	4	13%
Fall on outstretched hand (indirect injury)	4	13%
Sports injury	3	10%
Fall from height	3	10%
Robinson type		
2B1	20	65%
2B2	11	35%

Perioperative characteristics are mentioned in table 2. We noted 100% union rate with  $5.6 \pm 2.3$  months required for complete union.

**Table 2:** Perioperative measures and outcome

Characteristic	Mean $\pm$ SD (Range)
Surgery time (min)	55.1 $\pm$ 15.3 (50–82)
Hospital stay (days)	2.4 $\pm$ 1.2 (2–4)
Average blood loss (ml)	100 – 300
Union rate	31 (100 %)
Union time (months)	5.6 $\pm$ 2.3 (3–11)

After complete healing, according Constant Murley scoring system, functional outcome was excellent in 81% patients while good and fair outcome was noted in 13% and 9% patients respectively.

**Table 3:** Outcome based on Constant Murley score

Outcome	Frequency	Percent
Excellent	25	81%
Good	4	13%
Fair	2	6%
Poor	0	0%

Complications such as delayed union (3 %) and superficial infection (3 %) were noted in present study. We did not note any non-union, malunion, deep infection, plate loosening, plate breakage, plate prominence, hypertrophic scar, signs of nerve compression, pain after complete union or restriction of shoulder movement in study patients.

**Table 4:** Complications

Complications	No. of Patients	Percentage
Superficial Infection	1	3%
Delayed union	1	3%

## DISCUSSION

Several prospective comparative studies and meta-analyses recommended surgery for displaced midshaft fracture, to reduce risk of non-union and malunion, which can cause discomfort due to shortening of the global shoulder skeleton. Also functional recovery is faster and pain is alleviated after surgery.<sup>4,8</sup> Displaced fractures of the middle third of the clavicle are common in young, athletic populations and following road traffic accidents. Clavicular fractures have a bimodal age distribution. The first peak occurs in young active adult men, and the second peak occurs in elderly women with osteoporosis.<sup>9</sup> In present study majority of the patients were from age group of 19 to 29 years (45%). The average age was  $33.9 \pm 9.2$  years. Similar findings were noted in the study by Ankur Mittal *et al.*,<sup>10</sup> and Wali PC.<sup>11</sup> Many methods of conservative treatment, namely, triangular sling, cuff and collar sling, three sling method, figure of eight bandage, figure of eight plaster of Paris shoulder Spica, clavicular

brace, arm shoulder pouch, and many others have been described from time-to-time.<sup>12</sup> Hill *et al.*,<sup>13</sup> evaluated 242 fractures of clavicle which had been treated conservatively and found unsatisfactory results with initial shortening of 20mm or more. They recommended open reduction and internal fixation for severely displaced fracture of middle third of clavicle in adult patients. K. Ramkumar *et al.*, noted that majority of the cases are united by the end of 10 weeks (86.6 %) and between 10 – 12 weeks (13.4%). There were no delayed union or nonunion cases. The functional outcome according to Constant and Murley score is excellent in 19 patients (63.3%) and good in 11 patients (36.7%).<sup>14</sup> Similar findings were noted in present study. In study by Ghosh A *et al.*,<sup>15</sup> Constant score was excellent in 26 patients (<11) good in 2 patients (11-20) and fair in 2 patients (21-30). No patients had a poor result (>30) on constant scoring system. Functional outcome was excellent in 87% of cases. The mean time to union was 6.8 months. No patient developed non-union or mal union.<sup>15</sup> In a

multicenter prospective randomized study by the Canadian orthopaedic trauma society in 132 patients with displaced midshaft fracture, in which 65 patients were managed by plates and 67 by slings. Constant and DASH scores were significantly better, consolidation time was shorter, and non-union and symptomatic malunion rates were lower; at 1-year post-trauma, functional and esthetic satisfaction rates were significantly higher in the plate group.<sup>4</sup> Similarly, Gilde<sup>16</sup> found good functional results with isolated locking plate in 32 patients, 13 of whom with more than 1 year's follow-up; no revision of internal fixation or other surgery was required.

Nayak A.J. *et al.*,<sup>17</sup> assessed functional outcome and noted that 85% had excellent outcome, 10% had good functional outcome and 5% had fair outcome. While in study by Panthi S *et al.*,<sup>18</sup> noted that Constant and Murley score 45 (90%) of the study subjects showed excellent results, 4 (8%) showed good results, 1 (2%) showed good results. Mean Constant and Murley score was 96.0±5.20. Similar findings were noted in present study Proponent of early fixation of fresh clavicle fracture is to prevent complication, like non-union, malunion, shoulder stiffness, cosmesis; emphasize the value of accurate reduction and rigid fixation in offering quick pain relief. Disadvantages of plate fixation include the necessity for increased exposure and soft tissue stripping, potential injury to the supraclavicular nerves, higher infection rates and the re-fracture after plate removal these complications can be reduced by careful soft tissue handling, minimal periosteal stripping and meticulous plate fixation.<sup>8</sup> Risks associated with operative management of the fractured clavicle include neuropathy of the supraclavicular nerve, infection, pneumothorax, implant failure and the need for hardware removal due to hardware-related complaints.<sup>19</sup> Leroux *et al.* retrospectively evaluated rate and risk of reoperation of a cohort of 1350 patients who had undergone open reduction and internal fixation with at least two years of follow-up. They reported 24.6% reoperation rate. Isolated implant removal was the most common cause of reoperation accounting for 18.8% reoperations. They reported lower rates of other complications such as non-union (2.6%), deep infection (2.6%), pneumothorax (1.2%) and malunion (1.1%).<sup>20</sup> M. Ropars *et al.*,<sup>21</sup> concluded that internal fixation should be considered on a case-by-case basis in clavicle fracture. Emergency surgery is mandatory in complicated fracture, skin opening of whatever grade, or primary neurovascular complications. In young patients with > 15 mm clavicle shortening in the frontal plane, and especially in case of comminutive fracture, surgery should be considered. The current gold standard in operative treatment is Open Reduction Internal Fixation (ORIF) using plates and screws. An alternative to this technique is internal fixation

using intramedullary fixation devices. These devices aim to reduce the displaced mid-shaft clavicle fractures (DMCF) in a minimally invasive manner and thereby improving cosmetic satisfaction and union rates while lowering infection rates.<sup>22</sup>

Biomechanically, plate fixation is superior to intramedullary fixation because it better resists the bending and torsional forces that occur during elevation of the upper extremity above shoulder level.<sup>23</sup> Short-term data show that ORIF using plates and screws results in a more rapid return to normal function compared with conservative treatment. Shoulder function after six weeks may therefore play a role in choosing operative management.<sup>24,25</sup> Conservative management need longer duration for producing union at fracture site, so longer duration of useful work days loss which put more economic and financial burden. In Non-union end results, operative treatment done to achieve union, further increases morbidity and more work days loss and more economic burden. Present study had small sample size, institution-based study with single method of fracture fixation. Larger studies comparing conservative treatment and various fixation methods for displaced midshaft clavicle fractures are needed.

## CONCLUSION

Open reduction and internal fixation with plate for displaced midshaft fracture clavicle results in high rates of fracture union, increased patient satisfaction, early pain-free movement of shoulder and improves patient-oriented functional outcome. Use of anatomical contoured clavicle plate provides fixation of clavicle to its normal contour and provides better fixation and stability.

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