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Original Article

Open Reduction and Internal Fixation of Midshaft Clavicular Fractures with Pre-contoured Locking Clavicle Plate: A Prospective Study

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Abstract

Background: Fractures of clavicle constitute one of the most common fractures in orthopedic practice and till recently most of these fractures were treated conservatively. The advent of various implants for the fixation of these fractures along with safe surgical practices made the surgery more widely accepted and the definite indications for open reduction and internal fixation were formulated.

Materials and Methods: This prospective study conducted in Postgraduate Institute of Swasthiyog Pratisthan, Miraj, 35 patients operated for fracture midshaft clavicle with open reduction and internal fixation with pre-contoured locking clavicular plate. Patients followed for functional outcome and radiological and clinical union from June 2018 to June 2020. Results compared with other study in literature for validity.

Results: At 6 weeks, 25 (71%) patients fracture clinically united, at 3 months, all (100%) patients got clinically united and 28 (80%) patients radiologically united. At 3 months, Constant–Murley functional score was excellent in 71% of patients good in 26% and maximum patients 17 (49%) return to work in 6–8 weeks, 32 (91%) patients had an uneventful recovery, whereas 3 (9%) suffered one or several complications.

Conclusion: Operative treatment of fracture clavicle offers a definitive method of treatment in some specific instances. It reduces the time of union, stiffness of the adjoining joints and morbidity, and early return to work, patient satisfaction.

Key words: Midshaft clavicle fracture, Open reduction and internal fixation of clavicle, Pre-contoured locking clavicle plate

INTRODUCTION

The clavicle or collar bone is an S-shaped long bone, by its horizontal orientation, forms a strut between the sternum and the scapula, this bony link contributes to movements at shoulder. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position.[1] It is caused by either low-energy or high-energy direct impact. Fracture of the clavicle accounts for approximately 2.6–5% of all fractures and up to 35% of injuries to the shoulder girdle. About 70–80% of these fractures are in the middle third of the bone and less often in the lateral third (12–15%) and medial third (5–8%).[1,2] Conservative treatment has been the treatment of choice for a long time. This treatment policy was based on two studies conducted in the 1960s, which stated non-union percentages <1% after conservative treatment, regardless of the degree of dislocation.[3,4] Although many methods of closed reduction have been described, it is recognized that reduction is practically impossible to maintain and a certain amount of deformity and disability is expected after conservative treatment. More recent data based on detailed classification of fractures, suggest that the incidence of non-union in displaced comminuted clavicular fractures in adults is between 10% and 15%. All fractures with initial shortening of >2 cm resulted in nonunion.[5,6] Several studies have examined the safety and efficacy of primary open reduction and internal fixation for completely displaced fractures

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clavicle and noted high union rate with a low complication rate. There are various methods for treating clavicle midshaft fractures such as pre-contoured clavicular locking plates, reconstruction plates, dynamic compression plates, and intramedullary nails.[7] The purpose of this study is to gain experience with the open reduction and internal fixation of fresh displaced, comminuted, middle third clavicle fractures with pre-contoured locking clavicular plate and screws, and comparing study results with other various study in literature.

MATERIALS AND METHODS

Prospective observational study was conducted in GSK'S Fracture and Orthopaedic Hospital of Postgraduate Institute of Swasthiyog Pratishthan, Miraj, in the Department of Orthopaedics from June 2019 to June 2020. All willing patients attending outpatient department and emergency center of hospital with midshaft clavicle fracture were taken up for study. The patient included for the study was evaluated clinically and radiologically.

Inclusion Criteria

The following criteria were included in the study:

1. Age above 18 years
2. Closed fractures
3. No medical contraindication for anesthesia and surgery
4. Willing for surgery
5. Fracture specific[8]
    a. Displacement >2 cm
    b. Shortening >2 cm
    c. Increasing communition >3 fragments
    d. Segmental fractures
6. Floating shoulder (clavicle and glenoid neck fracture).

Exclusion Criteria

The following criteria were excluded from the study:

1. Age <18 years
2. Open fracture
3. Active infection at operative site
4. Medical contraindication to surgery and anesthesia
5. Non-displaced fracture.

Thirty-five patients were assessed carefully with detailed history and examined for deformity, swelling, and ecchymosis neurovascular deficit and other skeletal injuries were duly recorded in patient's pro forma. Patients were given appropriate analgesics and arm was immobilized with an arm pouch sling. Standard anteroposterior radiographic views of the clavicle of affected side were taken by carefully positioning the patient.

Fractures were classified using Robinson's classification system.[6] Hematological, biochemical, and other radiological investigation, chest X-ray, and electrocardiogram were done as per requirement for operative fitness, pre-anesthetic check-up and consent for surgery were taken.

Open reduction and internal fixation of indicated fracture done with curvilinear incision along the long axis of S shaped of clavicle, center over the fracture site. Side specific pre-contoured clavicular plate was used according to clavicle size and shape. Plate was placed over superior surface of clavicle.[9]

Rehabilitation of affected extremity was done according to the stage of fracture union and time duration from day of surgery. Pendulum movements exercise started soon after the pain tolerated postoperatively. Approx. 5th day postoperatively, after clinical union, the sling discontinued and unrestricted range of motion exercise allowed. More aggressive and physically demanding activities were started once bony union is evident on radiograph.

The patient was followed on the 14th post-operative day for the 1st time for suture removal after that they were called for follow-up on 6 weeks and monthly for 3 months and 6 months.

Clinical and Radiological Assessment of Fracture Union[10]

In follow-up, the patient evaluated for fracture union clinically as

1. Absence of pain or tenderness on palpation or examination
2. Absence of pain or tenderness when weight-bearing
3. The ability to bear weight.

For radiological union, plain radiograph evaluated for

1. Bridging of the fracture by bone, callus, or trabeculae
2. Bridging of the fracture at three cortices
3. Obliteration of the fracture line and/or cortical continuity.

Functional Assessment

Evaluation of results was carried out Constant–Murley shoulder score as assessment tool.[11]

The patient is assigned cumulative score out of 100 and graded as follows:

1. 0–55 – Poor
2. 56–70 – Moderate
3. 71–85 – Good
4. 86–100 – Excellent.

All data collected and find the correlation between the variables using Excel software.

RESULTS

A total of 35 patients with displaced or comminuted midshaft clavicular fracture were treated surgically with

open reduction and internal fixation with pre-contoured locking clavicular plate and followed for year. Fracture clavicle is common between 18 and 27 years (26%) and 48–57 years (26%) showing bimodal incidence. Mean age was 38 years. Demographic details about age distribution, sex and side predilection, most common mode of injury, and associated fracture given in table [Table 1]. Fracture segregation done with Robinson classification system [Figure 1]. The majority of fractures in the present study were displaced simple midshaft clavicle fracture Robinsons type 2 B1a in 20 patients (57%). Time required for completion of surgical procedure given in Figure 2. Time duration for completion of surgical procedure greatly reduced using pre-contoured plate, 14 (40%) patients took 71–80 min operation time. Maximum patients 17 (49%) return to work in 6–8 weeks, 7 (20%) in 9–11 weeks, and 11 (31%) in 12–15 weeks [Figure 3]. Fracture union studied clinically and radiologically. At the end of 6 weeks, 25 (71%) patients clinically united and 5 (14%) patients radiologically united. In 3 months, all patients (100%) clinically united and 28 (80%) patients got radiological union, other 7 (20%) patients got radiologically united at 6 months [Figure 4]. Functional outcomes assessment was done by Constant and Murley scoring system. At 6 weeks, score was good in 54% of patients and moderate in 37% of patients. At 3 months, score was improved and that was excellent in 71% of patients good in 26% [Figure 5].

Despite proximity of fracture site to neurovascular structures, none of patient got any iatrogenic neurovascular trauma and none non-union or malunion. There was 1 (3%) incidence of superficial infection which was managed by dressing and oral antibiotics, 1 (3%) patient had hardware irritation, after clinical and radiological union implant removal was done. One (3%) patient had hypertrophied scar formation.

Table 1: Demographic distribution of variable in clavicle fracture

Variable	No. of patients out of 35 (%)
Age distribution (highest)	
17–27 years	9 (26)
48–57 years	9 (26)
Sex distribution	
Male	29 (83)
Female	6 (17)
Side involvement	
Right	17
Left	18
Mode of injury	
RTA	29 (83)
Fall	6 (17)
Associated injury	
Scapula	3
Chest trauma	2
Wrist	1
No associated fracture	30

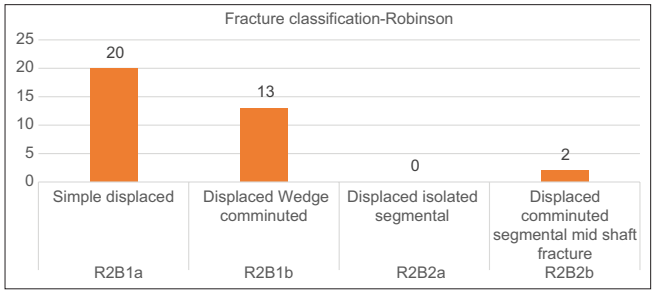

Figure 1: Fracture segregation with Robinson classification system

DISCUSSION

Clavicle fractures continue to be a common traumatic injury encountered by orthopedic surgeon and have received much attention recently. There is momentum growing toward the operative management of displaced fractures. Clavicle fractures are usually treated conservatively. The traditional view that the vast majority of clavicle fractures heal with good functional outcomes following non-operative treatment is no longer valid. Conservative treatment of displaced middle third clavicle fracture studied by Hill et al in1997, 12 Nordqvist *et al.* in 1998,[13] and Robinson *et al.* in 2013,[14] and found poor results following conservative treatment, reported higher non-union and malunion rates (14%-23%). These fractures should be viewed as a spectrum of injuries with diverse functional outcomes, each requiring careful assessment and individualized treatment.

Any displaced comminuted fracture is prone to the poorer outcome and hence operative stabilization is indicated. The patients treated with early, rigid fixation

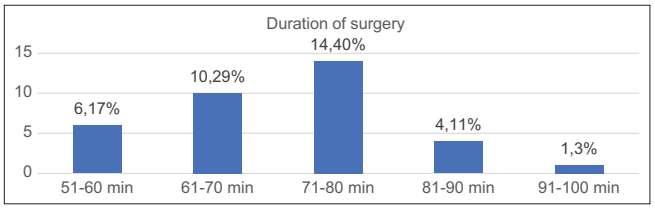

Figure 2: Chart showing the surgical time required for completion of surgery

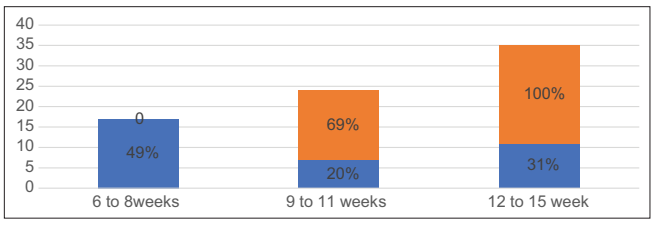

Figure 3: Bar diagram showing time required for no. of patient to return for work after surgery

of their clavicle fractures shared a high post-operative constant score, early pain resolution, early return to activity, and high patient satisfaction rating. Pre-contoured clavicular plating has the advantages of maintaining the length especially in comminuted fractures. Moreover, it anatomically pre-contoured which assists in restoring the original structure of the patient's anatomy with little or no bending of the plate by the surgeon at the time of surgery. Avoiding the need to bend a pre-contoured clavicle plate saves valuable operating room time during the operative procedure. There is little chance for hardware breakdown and migration.[15]

The present prospective study of 35 patients, male preponderance and bimodal age distribution seen (according to Nowak *et al.*[16] and Robinson[6] of epidemiological study, there was male predominance). At 3 months, all (100%) patients got clinically united and 28 (80%) patients radiologically united and functional score was excellent in 71% of patients good in 26% of patients. Maximum patients 17 (49%) return to work in 6–8 weeks. No major complication found in this study, 32 (91%) patients had an uneventful recovery, whereas 3 (9%) suffered some complications. One (3%) patient each had hardware irritation, superficial infection, and hypertrophied scar formation. Bostman *et al.*[17] infection rate was 7.8% and 23% suffered one or several complications. Other comparable studies of open reduction and internal fixation of clavicle fractures demonstrate similar short-term results with minimal complications and early recovery of shoulder functional outcome. Comparison of different study results and complication with the present study done in Table 2 and Table 3, respectively. This technique provides high fracture union rate, good functional outcome with early pain relief, early functional recovery and minimum complications, and less disability rate than does conservative treatment. Functional results improve when the normal bend of the clavicle is restored with pre-contoured plate.

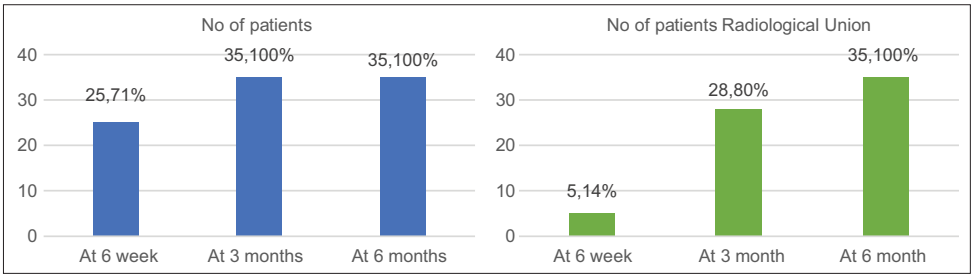

Figure 4: Bar diagram showing time required for no. of patient for clinical and radiological fracture union

Table 2: Comparison of different study results with the present study

Study	No. of cases	Study type	Average time of union	Follow-up duration	Constant score
Ethiraj *et al.*, 2016[18]	60	Prospective	12 weeks	12 months	Excellent 76.7%
Kumar and Harsha, 2016[19]	20	Prospective	10–12 weeks	12 months	Excellent 80%
Mulmani *et al.*, 2016[20]	20	Prospective	9.3 weeks	Till radiological union	Excellent 80%
Ramanathan and Kumar[21]	20	Prospective	9–13 weeks	11 months	ULCA score 31.35
Naidu and Anand, 2017[22]	50	Prospective	11–12 weeks	6 months	Excellent 32%
Ravi *et al.*, 2017[23]	30	Prospective	12 weeks	6 months	Excellent 77%
Present study	35	Prospective	3 months Clinical –100% Radiological – 80%	6 months	At 3 months Excellent 71% Good in 26%

Table 3: Comparison of different study complication with the present study

Study	Infection	Non-union	Delayed union	Implant breakage	Implant irritation/ prominence	Screw loosening
Ethiraj *et al.*, 2016	Nil	Nil	3	1	Nil	Nil
Kumar and Harsha, 2016	Nil	Nil	1	1	1	Nil
Mulimani *et al.*, 2016	Nil	Nil	2	0	3	Nil
Ramanathan *et al.*	2	Nil	Nil	Nil	Nil	Nil
Naidu and Anand, 2017	Nil	Nil	Nil	Nil	Nil	Nil
Ravi *et al.*, 2017	Nil	2	Nil	Nil	3	Nil
Present study	1	Nil	Nil	Nil	1	Nil

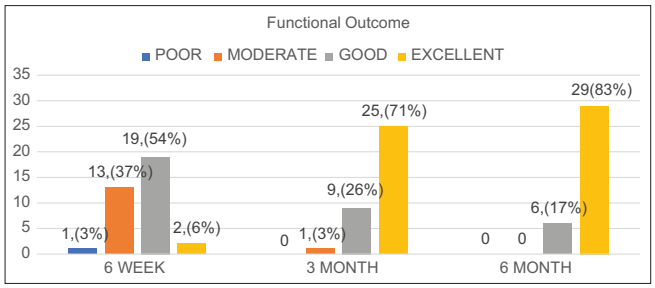

Figure 5: Bar diagram showing functional outcome in no. of patients with time duration

The success of pre-contoured locking compression plate for fractures of clavicle requires careful assessment of fracture pattern, selection of patients, meticulous operative technique, appropriate fixation, careful post-operative monitoring, and early rehabilitation because final functional result of treatment clavicle fractures depends on these parameters.

CONCLUSION

We inferred that open reduction and internal fixation with pre-contoured locking compression clavicular plate can be a good option in the treatment of displaced and/or comminuted clavicle fractures. With the data of this study and our experience of the present study, we recommend that this is a valuable option in management of clavicle fracture.

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ETHICAL APPROVAL

The study was approved by the Institutional Ethical Committee.

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