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Original Research Article

Prospective study of clavicle fractures treated with pre-contoured locking compression plate

Vimal P Gandhi[1], Pragnesh Patel[1,*]

[1]*Dept. of Orthopedics, GMERS Medical College, Patan, Gujarat, India*

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ABSTRACT

Introduction: We surgically treated acute displaced mid-third diaphyseal clavicle fractures with plate osteosynthesis using a precontoured locking compression plate, to evaluate the functional and radiological outcome and enumerate the complications associated with this modality of treatment.

Materials and Methods: This prospective observational clinical study involving 50 adult patients was conducted in hospital over a period of 2 years. Fractures were classified based on Allman and Robinson classification system. Patients underwent ORIF with 3.5mm precontoured locking compression plate. Regular follow up for a minimum period of 6 months was done clinically and radiologically. Duration required for fracture union was studied, functional outcome was measured using Constant Murley score and complications if any were noted.

Results: The functional outcome is assessed at the end of 6 months by the Constant and Murley scoring system. The mean constant score was 93.32% with a standard deviation of 6.67% and a range of 71% to 100%. In our study, 36 cases had excellent functional outcome, 10 cases had good functional outcome and 4 cases had fair functional outcome. None of the patients had a poor outcome.

Conclusion: Bony union could be achieved with pre-contoured locking compression plate by reducing the complication rates in midshaft comminuted displaced clavicle fractures and functional outcome were satisfactory. Overall operative treatment using precontoured LCP is effective in the treatment of displaced mid-third clavicle fractures. All the fractures achieved union and there were no cases of non-union.

1. Introduction

The clavicle is a S shaped bone that acts as a strut between the sternum and the glenohumeral joint. It also has a suspensory fuction to the shoulder girdle. The shoulder hangs from the clavicle by the coracoacromial ligament. Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at shoulder girdle.[1] 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. Fracture of the clavicle accounts for approximately 5 to 10% of all fractures and upto 44% of injuries to the shoulder girdle. About 70% to 80% of these fractures are in the middle third of the bone and less often in the lateral third (12% to 15%) and medial third (5% to 8%).[2,3]

The most commonly used system of classification of clavicular fractures is that of Allman. It is divided into 3 groups: Group I: Middle-third fractures, Group II: Lateral-third fractures, Group III: Medial- third fractures. Fractures of the clavicle have been traditionally treated non-operatively.[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 in adults.[5]

Most clavicle fractures occur in the mid-diaphyseal region since this represents a potential weak spot. The cross-section of the bone is narrowest here and the enveloping soft

* *Corresponding author*.
E-mail address: poojya007@yahoo.co.in (P. Patel).

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tissue structures which absorb and nullify the force of injury are most scarce here. Multiple muscular and ligamentous forces act on the clavicle, and knowledge of these differing forces is necessary to understand the nature of displacement of clavicle fractures and why certain fracture patterns tend to cause problems if not reduced and surgically stabilized.[6]

Mid-clavicular fracture is one of the most common injuries of the skeleton, representing 3% to 5% of all fractures and 45% of shoulder injuries. The annual incidence of mid-clavicular fracture is 64 per 100 000 population. Breaks of the shaft form 70% to 80% of all clavicular fractures; lateral fractures contribute 15% to 30%, and medial fractures, at 3%, are relatively rare. Open clavicular fracture is an absolute rarity, found in only 0.1% to 1% of 2 cases. The rate of midclavicular fractures is more than twice as high in men as in women. The peak incidence occurs in the third decade of life·[,]

The consensus that great majority of clavicle fractures heal with non-operative treatment is no longer valid. The amount of pain and disability during the first three weeks of conservative treatment has been underrated and the common view that, nonunion does not occur, is wrong.[7] Pressure from a displaced fragment on the retroclavicular part of the brachial plexus may cause symptoms after conservative treatment. Recent studies have shown that higher rate of nonunion and specific deficits of shoulder functions in subgroups of patients with these injuries. Hence they can be treated as a spectrum of injuries requiring careful assessment and individualized treatment.[6]

Non-union after a clavicular fracture is an uncommon occurrence, although the prevalence is higher than previously reported. There are subgroups of individuals who appear to be predisposed to the development of this complication either from intrinsic factors such as age or gender, or from the type of injury sustained. There are various methods of treating clavicle midshaft fractures, such as intramedullary K-wires or Stienmann pins fixation and plate fixation.[8] In particular, plate fixation can help obtain firm anatomical reduction in severe displaced or comminuted fractures. In this study, we surgically treated acute displaced mid-third diaphyseal clavicle fractures with plate osteosynthesis using a precontoured locking compression plate, to evaluate the functional and radiological outcome and enumerate the complications associated with this modality of treatment.

2. Materials and Methods

The present is the observational study done over 50 patients, both male and female aged above 18 years with displaced mid-third diaphyseal clavicle fractures admitted to during the study period of 2 years and treated by Open Reduction and Internal Fixation with plate osteosynthesis in our institution were included in the study. Approval from the Institutional ethical committee for the study was obtained. The functional outcome was assessed using Constant Murley score (CMS), radiologically time to union was studied and complications, if any, were noted.

2.1. Sample size calculation

Based on the convenience sampling method, sample size was calculated by considering average hospital statistics of displaced mid-third diaphyseal clavicle fractures in age group 18 years and above based on past records of medical hospital and proportion of clavicle fractures. By confidence interval approach with alpha = 5% and absolute difference of 8% with prevalence of 2-5%.The estimated inflated sample size is 25 cases.

2.2. Inclusion criteria

Age more than 18 years and less than 60 years, patient had Acute, Closed fractures, Mid-third diaphyseal fractures (Allman Type 1) and Patients who are willing and give consent to participate in the study.

2.3. Exclusion criteria

Age less than 18 years**,** open fractures, fracture in proximal or distal third of clavicle, pthological fractures, undisplaced fractures, associated head injury, associated with neuro-vascular injury**,** Established non-union from previous fracture.

General information like name, age, sex, occupation and address were noted. Detailed history was elicited regarding mode of injury like fall on the shoulder, fall from motorbike, Road traffic accident, indirect injury to shoulder and fall on outstretched hand, self fall. Enquiry was made to note site of pain and swelling over the affected clavicle.

Abnormal swelling was present in the middle third for middle third clavicle fracture and in the lateral third for lateral third clavicle fracture. The fractured clavicle was also palpated for any abnormal mobility and crepitus. The distal neurovascular status of the affected upper limb was examined and also the associated injuries along with fractured clavicle were noted.

Plain radiograph of clavicle with shoulder in anteroposterior view was taken to assess the site of fracture and the fracture type. The fractures were classified according to Robinson's classification. Routine investigation like Hb%, Total count, Differential count, ESR, Blood urea, Sugar, Serum creatinine and ECG were done. HBsAg and HIV test were done before surgery on all patients.

All patients were operated as early as possible once the general condition of the patients were stable and the patients were fit for surgery as assessed by the physician. All patients were operated under brachial plexus block. Regular follow up was done post-operatively for a minimum of 6 months duration. Local examination of the affected clavicle for

tenderness, instability deformity and shoulder movements were assessed. The functional outcome was assessed by Constant and Murley score at the end of 6 month

The patients are graded as follows

2.4. Subjective

1. Pain: No pain- 15, Bearable pain- 10, Disabling pain- 5
2. Activities of daily living: Ability to perform full work- 04, Ability to perform Leisure activities/Sports- 04, Unaffected sleep- 02

Level at which work can be done:

Up to Waist- 02, Up to Xyphoid- 04, Up to Neck- 06, Up to Head- 08, Above head- 10

2.5. Objective

Range of movements

2.5.1. Active flexion without pain

00 - 30 Degrees: 00, 31- 60 Degrees: 2, 61-90 Degrees: 4, 91-120 Degrees: 6, 121-150 Degrees: 8, > 151 Degrees: 10

2.5.2. Functional external rotation

Hand behind head with elbow forwards- 2, Hand behind head with elbow backwards- 4, Hand above head with elbow forwards- 6, Hand above head with elbow backwards- 8, Full elevation from on top of head- 10

2.5.3. Active abduction without pain

With dorsum of hand on back, head of third metacarpal reaches 0 – 30 Degrees: 00, 31-60 Degrees: 2, 61-90 Degrees: 4, 91-120 Degrees: 6, 121-150 Degrees: 8, > 151 Degrees: 10

2.5.4. Functional internal rotation

Ipsilateral buttock: 2, S1 spinous process: 4, L3 spinous process: 6, T12 spinous process: 8, T7 spinous process: 10.

2.5.5. Strength of abduction

A normal shoulder in a 25-year-old man resists 25 pounds without difficulty. The score given for normal power is 25 points, with proportionately less for less power.

Patients were graded as below with a maximum of 100 points.

1. 90-100 Excellent
2. 80-89 Good
3. 70-79 Fair
4. 0-70 Poor

2.6. Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

3. Results

The following observations were noted from the data collected during the study of 50 cases of acute displaced mid-third diaphyseal clavicle fractures operated with 3.5 mm pre-contoured locking compression plate at Department Of Orthopedics associated with the medical hospital.

Most of the patients were between 21-40 years. Mean Age was 32.6 years with standard deviation of 9.24. There were 40 male patients and were 10 female patients. There were 26 patients with right sided mid-clavicular fracture and 24 patients with left sided mid-clavicular fracture. The most common mode of injury in our study was due to fall from motorbike accounting for 28 cases. The second most common cause was due to Road traffic accident accounting for 18 cases and 4 cases was due to self fall.

The mean duration of hospital stay is 9 days with a standard deviation of 2.59 and range of 5 days to 14 days. Post operatively the wound was inspected on day 3 and then subsequently on suture removal. All patients were discharged with their operated limb immobilized in a sling with shoulder held in adduction and internal rotation. Elbow is maintained in 900 of flexion. At 2 weeks post-operatively, gentle passive shoulder movements and pendulum exercises as tolerated by the patient was advised.

Table 1: Functional outcome of the study

S. No.	Functional outcome	No. of cases
1.	Excellent	36
2.	Good	10
3.	Fair	4
4.	Poor	0
5.	Total	50

4. Discussion

Mid-third diaphyseal clavicle fractures account for more than 80% of clavicle fractures. It was traditionally treated conservatively. Either an arm sling or a figure of 8 bandages was widely used. Arm sling demonstrated better patient satisfaction. Figure of 8 bandages were associated with more complications such as axillary pressure ulcer, compression of neurovascular structures.[9]

Neer[10] reported a nonunion rate of 1% in displaced midshaft clavicle fractures treated conservatively but recent studies have shown that this is much higher. Non-union rate of conservatively treated displaced midshaft clavicle fractures was 4.5-9% in study by Robinson et al,[11] 15% in study by Hill et al.[12] Plate osteosynthesis imparts immediate

rigid stabilization, pain relief, and early mobilization and return to pre-injury activity levels. Superior placement of plate provides more biomechanical stability compared to anterior plate placement especially in the presence of inferior cortical comminution but is associated with greater risk of injury to underlying neurovascular structures and plate prominence which may necessitate its removal.[13]

The functional outcome was assessed using the Constant and Murley Scoring System. In the present study, 50 patients of acute displaced mid-third diaphyseal clavicle fracture treated with plate osteosynthesis using 3.5mm pre-contoured LCP, 36 cases had excellent functional outcome, 10 cases had good functional outcome and 4 cases had fair functional outcome. None of the patients had a poor outcome. The mean constant score was 93.31% with a standard deviation of 6.72% and a range of 71% to 100%. The advantage of rigid internal fixation and early mobilization of fresh displaced clavicle fracture is that it gives immediate pain relief and prevents the development of shoulder stiffness and non-union. In Mohammed et al. study, the mean Constant score was 95.33 with SD 3.4 in 1 year follow up. In Dhoju et al. study, the mean Constant score was 97.45 with 1 year follow up.

5. Conclusion

The conclusions drawn from this analysis cannot be generalized because of the smaller number of cases. In conclusion, bony union could be achieved with pre-contoured locking compression plate by reducing the complication rates in midshaft comminuted displaced clavicle fractures and functional outcome were satisfactory. Overall operative treatment using precontoured LCP is effective in the treatment of displaced mid-third clavicle fractures. All the fractures achieved union and there were no cases of nonunion.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that there is no conflict of interest.

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Author biography

Vimal P Gandhi, Assistant Professor

Pragnesh Patel, Assistant Professor

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