

CLINICAL AND FUNCTIONAL OUTCOME STUDY OF SURGICAL MANAGEMENT OF DISPLACED FRACTURES OF THE MID THIRD CLAVICLE BY ANATOMICAL PLATES IN BENGALURU RURAL

Mahesh Kumar NB¹, Sandeep KM², Deepak V Kurian³, Suhas. D^{4*}

^{1,2,4}Associate Professor, Department of Orthopaedics, Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India.

³Junior Resident, Department of Orthopaedics, Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India,

ABSTRACT

BACKGROUND

Clavicle fractures are common orthopaedic injuries, representing approximately 2.6% to 5% of all fractures, and they involve the middle third of the clavicle in up to 82% of fractures. Traditionally, these fractures were managed non operatively however, more recent literature has shown increased rates of non-union, symptomatic mal-union and unsatisfactory patient outcomes with non-operative management of displaced mid-shaft clavicle fractures. Anatomical clavicle plate is a plating system that is 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. The aim of this study is to evaluate the functional outcome of displaced fractures of the middle third of the clavicle treated with non-operative management and fixation with plating.

METHODS

The present study was carried out from November 2018 to October 2020. During this period 30 patients of clavicular fractures were treated surgically. All patients were operated with open reduction and internal fixation with anatomical clavicle plate. Regular follow up was done periodically to evaluate radiological union with x-rays and functional outcome with constant and Murley scoring.

RESULTS

Among the 30 patients the average patient age was 35.25 years. 40% with left sided fracture and 60% with right sided fracture. Direct injury occurred in 90% and Indirect injury occurred in 10% due to fall on outstretched hand. In this study 80% united at the end of 12 weeks. 20% showed delayed union which united at the end of 16 weeks each. In this study 75% had excellent functional outcome, good functional outcome occurred in 10%, fair in 5% and poor in 10 during third follow-up at 24 weeks

CONCLUSION

In conclusion, bony union could be achieved with pre-contoured locking clavicle plate by reducing the complication rates in mid-shaft comminuted displaced clavicle fractures and functional outcome were satisfactory.

KEYWORDS Functional and clinical outcome; anatomical plate; fracture middle third of clavicle.

BACKGROUND

Clavicle fractures are common orthopaedic injuries, representing approximately 2.6% to 5% of all fractures, and they involve the middle third of the clavicle in up to 82% of fractures. Traditionally, many minimally displaced clavicle fractures can be successfully treated non-operatively with strict immobilization of some type like a sling which has been shown to give the same effect as a figure-of-eight bandage giving more comfort less skin problems and better wound care and early studies reported that conservative treatment led to a high union rate without compromise of patient satisfaction or function. The main objective of the different types of immobilization are as it provides support to the shoulder girdle by raising the lateral fragment in an upward, outward, and backward direction which is provided by a sling. The figure of eight bandage helps to depress the medial fragment. Combination of both the sling and a figure of eight bandage helps to maintain some degree of reduction fracture (both). Which enables the patient to use the ipsilateral hand and elbow with comfort and less pain. Patient will be immobilized for 4 to 6 weeks and during which active range of motion of the elbow, wrist, and hand should be performed. Repeat X-ray evaluation until union is needed to detect later displacement. However, more recent literature has shown regardless of the method of immobilization utilized, some degree of shortening and deformity increased rates of non-union, symptomatic mal-union, and unsatisfactory patient outcomes with non-operative management of displaced mid-shaft clavicle fractures. The incidence of high-energy clavicle fractures is increasing and may contribute to these findings because increased initial fracture displacement, shortening, and comminution have been shown to be predictive of non-union and poor patient outcomes with non-operative care. Consequently, there has been an increasing trend toward operative fixation of displaced mid-shaft clavicle fractures. Numerous clavicle fixation methods exist, but plate and screw constructs lead to predictable outcomes with a low non-union rate. There are several options among the open reduction with internal fixation (ORIF) surgical approach. Today, surgeons have choices of ORIF fixation that include the use of intramedullary pin fixation, generic non-contoured plating devices, and the predominant use of anatomical plating devices specifically designed to address the unique anatomy of the clavicle.

Historically, a variety of non-anatomic plating systems have been used to repair clavicle fractures. Among the earliest utilized, dynamic compression plates are non-anatomic and require bending the plate prior to use in order to attempt to accommodate a patient's clavicle anatomy, a time consuming activity in the operating theatre. Additionally, bending a compression plate may weaken the strength of the plate and because dynamic compression plates are non-clavicle specific, the plates may not fit a patient's unique clavicle anatomy properly. A poorly fitting plate can cause soft tissue irritation and possibly skin erosion at the site of implant.

Anatomical clavicle plate is a plating system that is 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. The comprehensive system of plates replicates the anatomical contours of the clavicle and act as templates when reconstructing a mal-union, non-union or a highly comminuted fracture to maximize support and accurately reduce the fracture.

ANATOMY

The clavicle is S-shaped, with the medial end convex anterior and the lateral end concave anterior. Medial end is wide and thin laterally. The medial and lateral ends are flat that are linked by a tubular middle, which has less medullary bone. The clavicle is a strut and acts as a bracing for the shoulder from the trunk and allows the shoulder to function at optimal efficiency. The brachial plexus, the subclavian and axillary vessels, and the superior lung is protected by the medial one-third of the clavicle. The clavicle is the first bone to ossify (fifth week of gestation) and the last (sternal end) to fuse, at 22 to 25 years of age. It is resilient in axial load. The junction between the in the middle third constitutes the vulnerable area to fracture, especially with axial loading as it lacks reinforcement by muscles or ligaments. The coracoclavicular ligaments consisting of two components are the trapezoid and conoid ligaments are located at the distal clavicle. They provide vertical stability to the acromioclavicular (AC) joint.

MECHANISM OF INJURY

Falls onto the affected shoulder leading to a bending force account for most (87%) of clavicular fractures, with direct impact accounting for only 7% and falls onto an outstretched hand accounting for 6%. Although rare, clavicle fractures can occur secondary to muscle contractions during seizures or secondary to minimal trauma due to pathologic bone or as stress fractures.

AIMS AND OBJECTIVES

The aim of this study is to evaluate the clinical and functional outcome of displaced fractures of the middle third of the clavicle treated with operative management and fixation with anatomical plating in Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India.

STUDY DURATION

November 2018 to October 2020 in Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India.

MATERIALS & METHODS

The present study was carried in out from November 2018 to October 2020 in Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India. During this period 30 patients of clavicular fractures were treated surgically.

Inclusion criteria:

1. Age >18years

2. Closed fractures
3. Robinson Classification 2B1 and 2B2(displaced fractures)
4. No medical contradictions to general Anaesthesia
5. Patients who present to Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India.

Exclusion criteria:

1. Age < 18 years
2. Open fractures
3. Fracture in proximal or distal third of clavicle.
4. Pathological fractures
5. Un-displaced fractures
6. Associated head injury.
7. Associated with neuro vascular injury
8. Established non-union from previous fracture
9. Associated acromioclavicular joint dislocation.

General information like name, age, sex, occupation and address were noted. Then a detailed history was elicited regarding mode of injury like fall on the shoulder, Road traffic accident, direct injury to shoulder and fall on outstretched hand. Enquiry was made to note site of pain and swelling over the affected clavicle. Past medical illness and family history were also recorded. General condition of the patients was examined for pallor, pulse rate and blood pressure. Respiratory and cardio vascular system were examined for any abnormalities.

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 (displacement and comminution).The fracture were classified according to Robinson's classification. The affected upper limb was immobilized in an arm pouch. 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

OPERATIVE PROCEDURE

- 1) Patient in supine on OT table in beach chair position with one towel in between the scapula.
- 2) Entire upper limb from base of neck to hand were prepared and draped.
- 3) About 6-8cms, incision was made in the anterior aspect centring of clavicle over the



- 4) fracture site.
- 5) The skin subcutaneous tissue and platysma were divided without undermining the edges.
- 6) The overlying fascia and periosteum were next divided. The osseous ends were freed from surrounding tissue.
- 7) Minimal soft tissue and periosteum dissection was done.



- 8) Fracture fragments were reduced and anatomical locking compression plate was applied over the superior aspect of the clavicle.
- 9) At the junction of the medial and middle third of the clavicle, the inferior surface is exposed so that a protective instrument can be inserted during drilling to prevent injury to neurovascular structure underneath it.
- 10) The anatomical locking compression plate was fixed to the medial and lateral fragment with 4.0 mm locking screw and at least three screws in medial and lateral fragment were applied.
- 11) Wound was closed in layers after ensuring meticulous haemostasis and sterile dressing applied.



Follow up

Regular follow up for every 4 weeks was done. Local examination of the affected clavicle for tenderness, instability, deformity and shoulder movements were assessed. X-rays were taken at each follow up visits to know about progressive fracture union and implant position. Rehabilitation of the affected extremity were done according to the stage of fracture union and time duration from day of surgery. Patients were followed up till radiological union. The functional outcome was assessed by Constant and Murley score.



Statistical Analysis

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions.

Continuous data was represented as mean and standard deviation.

RESULTS

In this study 35% were in the age group 19-29years. The youngest patient was 19 years old and the oldest patient was 58 years old. The average patient age was 35.25 years. Out of 30 patients, 17 patients were Male and 13 patients were female. In this study, there were 12 patients (40%) with left sided fracture and 18 patients (60%) with right sided fracture. Direct

injury occurred in 27 patients (90%) among them 9 patients (30%) were due to fall on shoulder from vehicle, 12 patients (40%) were due to road traffic accident, 6 patients (20%) were due to simple fall on shoulder after slipping. Indirect injury occurred in 3 patients (10%)

FUNCTI ONAL OUTCO ME	1ST FOLL OW UP	2ND FOLL OW UP	3RD FOLL OW UP
EXCELLE NT	11	15	22
GOOD	8	9	3
FAIR	6	3	2
POOR	5	3	3

due to fall on outstretched hand. Plain radiograph of clavicle with shoulder in anteroposterior view to assess the site of fracture and the type of fracture (like displacement, angulation, comminution).

In this study Robinson classification was followed.

2A2	5
2B1	12
2B2	13

In this study, 27 patients (90%) were operated in the first 5 days and 3 patients (10%) were operated in the 5-10days interval. All patients were operated under general anaesthesia in 12 patients (40%) 6 holed locking compression plates were used. In 13 patients (45%) 7 holed locking compression plate were used and in another 5patients (15%) 8 holed locking compression plates were used. Locking and cortical screws of following sizes 12-18 mm were used. The fracture was considered to be united when clinically there was no tenderness, radiologically the fracture line was not visible and full unprotected function of the limb was possible. In this study 16 patients (80%) united at the end of 12 weeks. In 4 patients (20%) delayed union occurred which united at the end of 16 weeks each. In this study 3 patient (10%) had hypertrophic skin scar and in 2 patients (6%) had plate prominence and in another 4 patients (13%) delayed non-union occurred. In this study 11 patients (36.6%) had excellent functional outcome, good functional outcome occurred in 8 patients (26.6%), fair in 6 patients (20%) and poor in 5 patients (16.6%) during first follow-up at 6 weeks. In this study 15 patients (50%) had excellent functional outcome, good functional outcome occurred in 9 patients (30%), fair in 3 patients (10%) and poor in 3 patients (10) during second follow-up at 12 weeks. In this study 22 patients (75%) had excellent functional outcome, good functional outcome occurred in 3 patients (10%), fair in 2 patients (5%) and poor in 3 patients (10) during third follow-up at 24 weeks. In this study, comparing functional outcome at regular three follow-ups, shows that improvement in functional outcome

DISCUSSION

In this study the patients with middle third clavicle fracture the mechanism of injury was due to fall on the shoulder from vehicle in 9 patients (45%), road traffic accident in 5 patients (25%), simple fall on the shoulder in 4 patients (20%), fall on outstretched hand in 2 patients (10%). In Bostman et al.²⁶ study the mechanism of injury was due to fall from the two wheeler in 38 Patients (36.8%), slipping and fall in 24 Patients (23.30%), motor vehicle accident in 19 patients (18.45%) and sports in injury 22 patients (21.36%). In Cho et al¹⁶ study, in reconstruction plate group there were 13 patients who sustained road traffic accident, 3 patients with slip down, 1 patient with sports injury, 1 patient with fall down and 1 patient with miscellaneous mode of injury. In locking compression plate group there were 7 patients with road traffic accident, 3 patients with slip down, 1 patient with fall down and 1 patient with miscellaneous mode of injury.

In VanBeek et al¹⁷ study, the most common mechanism of injury was fall in 19 patients, sports related injuries in 17 patients and motor vehicle trauma in 6 patients. This shows direct injury to the shoulder is the common cause of this fracture.

Age Incidence:

In this study middle third clavicle fracture commonly occurred between the age group of 19 to 29 years in 7 patients (35%). The youngest patient age was 19 years and oldest patient age was 58 years. The average patient age was years.

In Bostman et al.²⁶ 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 al¹⁶ study, in reconstruction plate group the mean age was 45 years (range 22-70 years) and that of locking compression plate group was 46 years (range 19-69 years).

In VanBeek et al¹⁷ study, average age of patients in pre-contoured plating group was 36 years (range 13-68years) and in non-contoured plating group was 28.9 years (range 19-50years).

From this we can infer that clavicle mid-shaft fractures occur in young patients.

Sex Incidence:

In this study majority of patients were male, 19 patients (95%) and 1 female patient (5%).

In Bostman et al²⁶ study also commonly males were affected, 76 patients (73.79%) compared to 27 female patients (26.21%).

In Cho et al¹⁶ study, the reconstruction plate group 12 male and 7 female patients and in locking compression plate group it was 17 males and 5 female patients.

In VanBeek et al¹⁷, study, in pre-contoured plate group 22 male and 6 female patients and in non-contoured plate group it was 10 male and 4 female patients.

This shows male predominance in mid-shaft clavicle fracture.

Associated Injuries:

In this study, 2 patients (10%) had associated injuries among them 1 patient (5%) had pelvic fracture and 1 patient (5%) had contralateral Colles fracture.

In Bostman et al study, there were no associated injuries.

In Cho et al¹⁶ study, an associated injury was found in 16 cases: hemothorax and rib fracture in 5 cases, scapular fracture in 3 cases (floating shoulder was observed in 2 of them) and rotator cuff tear in 1 case.

In VanBeek et al study, there were no associated injuries.

Type of fracture:

In this study all patients with mid-shaft clavicle fractures were of closed type.

This is comparable to Bostman et al, Cho et al¹⁶ study and VanBeek et al study which also showed all their patients were closed fractures.

CONCLUSION

Fracture Classification:

In this present study, Robinson Type- 2B1 (displaced with simple or butterfly fragment) were common and there were 16 patients (80%), Type-2B2 (displaced with comminution) occurred in 4 patients (20%).

In Bostman et al²⁶ study also Robinson Type- 2B1 was common in 81 patients (78.64%). Robinson Type- 2B2 occurred only in 22 patients (21.36%).

In Cho et al study, in reconstruction plate group there were 7 patients with Robinson Type-2B1 and 12 patients with Robinson Type-2B2 and that of locking compression plate group had 9 patients with Robinson Type-2B1 and 13 patients with Robinson Type-2B2 fractures.

In VanBeek et al study 20 patients had Robinson Type-2B1 and 25 patients had Robinson Type-2B2 fractures

Duration of union:

In this study, majority of the middle third clavicle fractures 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 stated radiological union occurred approximately between 6 to 12 weeks. In Cho et al¹⁶ study, bony union for reconstruction plate was 14.6 weeks and that for locking compression plate was 13.2 weeks

Functional outcome:

According to Constant Murley Scoring in this study of total 20 patients of middle third clavicle fracture fixed with locking compression plate and screws showed excellent results in 16 patients (80%) and good functional outcome in 3 patients (15%). Fair functional outcome in 1 patient (5%). The advantage of rigid internal fixation and early mobilization of fresh displaced clavicle fracture is that it (displaced comminuted middle third and displaced lateral third clavicle fracture) gives immediate pain relief and prevents the development of shoulder stiffness and non-union.

Clavicle fractures are usually treated conservatively but there are specific indications for which operative treatment is needed like comminuted, displaced middle third clavicle fractures and displaced lateral third clavicle fracture.

Among the internal fixation methods intramedullary fixation with K-wire or Stienmann pin do not control rotation and have low resistance to torque, carry risk of pin loosening and infection, so they require longer period of immobilization till union.

Open reduction and internal fixation with plates, such as Sherman plates, dynamic compression plates, and semi-tubular plates can be effective in obtaining anatomical reduction, applying direct compression to fracture site and producing resistance to torque. However, it is disadvantageous in achieving firm fixation because it is difficult to hold plates to the clavicle in severely comminuted fracture cases.

In contrast, reconstruction plates can be manipulated to fit the contour of the clavicle and fracture pattern to obtain firm fixation, are lighter and thinner than dynamic compression plates and are durable to multidirectional mechanical stress imposed on the fracture site.

In this study pre-contoured locking plates were used as it is contoured to the shape of the clavicle. It is necessary to put the plate superiorly and at least three screws to be applied medially and three screws laterally.

The advantages of locking plates include strong fixation due to locking between the screw and plate, blood supply preservation due to minimal contact between plate and cortical bone, reduced risk of injury to subclavian vessels and brachial plexus as tip of the screw need not reach the opposite cortex, periosteal stripping is minimized to promote rapid union and contouring of plate not needed and hence surgical time is reduced and post-operative plate prominence and hardware related problems are also reduced. Unfortunately, surgical treatments for clavicle fractures leave distinct scars on the clavicle. 1 of our patients had hypertrophic scar after surgery. Surgical techniques should be improved to address this problem.

This study has some limitations. 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 clavicle plate by reducing the complication rates in mid-shaft comminuted displaced clavicle fractures and functional outcome were satisfactory.

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