

Functional Outcome of Surgical Management for Clavicle Fractures by Osteosynthesis using Plate and Screws

Anurag Anand¹, Tushar Pisal², Anirudh Kandari³, Shubham Taori⁴, Ankit Barosani⁵. Dr. D.Y. Patil Medical College, Hospital & Research Centre, Dr D.Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra- 411018

Corresponding Author: Dr Ankit Barosani, Resident, Department of Orthopaedics, Dr. D.Y. Patil Medical College, Hospital & Research Centre, Dr D.Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra- 411018, INDIA.

Abstract :

Clavicle fractures contribute approximately 2.6% among other fractures of the body and account for approximately 44% to 66% of all fractures around shoulder. Middle 1/3rd of the clavicle is most prone for fracture because this area is weakest. Many studies which has been done till now has stated the effectiveness of open reduction internal fixation with plating for displaced clavicle fractures and it was noted to have high union rate and lower risks of complication. Usually locking compression plate are used to get a satisfactory results with low risks of complication in cases of majority of complex clavicle fracture.

Keywords: clavicle, fracture, plating, surgery, outcome

INTRODUCTION

Clavicle fractures contribute approximately 2.6% among other fractures of the body and account for approximately 44% to 66% of all fractures around shoulder. Almost 80 % of clavicle fracture occur at middle 1/3rd of this bone compared to fifteen percent (15%) and five percent (5%) in the lateral and medial thirds, respectively. Clavicle fractures which are not much displaced are managed conservatively by various immobilisation techniques. The clavicle is S-shaped and it acts as a connecting structure between gleno-humeral joint and sternum. It also functions as the suspensory mechanism for the shoulder girdle. The coraco-clavicular ligament provides support for the shoulder in relation to the clavicle.^[1] The system for categorizing clavicular fractures that is most frequently used Allman classification system. Three categories can be found there:^[1]

Group I: Middle-1/3rd fractures.

Group II: Lateral-1/3rd fractures.

Group III: Medial- 1/3rd fractures.

Middle 1/3rd of the clavicle is most prone for fracture because this area is weakest. The clavicle is subjected to many forces of the ligaments and muscles so understanding these various forces is needed to know the type of displacement after the clavicle fracture. This makes us to understand that certain types of fracture can cause problem if not reduced properly and surgical stabilisation is done. As far as mid-clavicular fracture is concerned it accounts for approx. 3 to 5 % of all fractures and 45 percent of injuries around the shoulder joint. 64 per 100,000 people experience a midclavicular fracture each year. Only 0.01% to 1% of cases present as open clavicular fracture, making it extremely uncommon. Men are more than twice involved than women as far as midclavicular fractures are concerned. The third decade of life is when incidence peaks.^[2]

Almost 0.1% to 0.8% midclavicular fracture can undergo non union, and traditionally non surgical treatment has been used. Because of frequent and serious complications, operative management of acute middle 1/3rd clavicle

fractures was avoided. But the studies upon which these data are based, could not properly classify clavicle fractures in terms of patient age and fracture displacement. The incidence of non union in displaced comminuted mid shaft clavicle fracture in adults is approximately 10 to 15 % based on classification of clavicle fractures and some recent data.^[3]

Incidence of mal-union or non-union in displaced mid shaft clavicle fracture is more common than what thought previously especially when conservative management is done in these patients. So fixation techniques has been followed to tackle these cases. Patients usually complain of pain and disability especially those who are managed by conservative methods during the first three to six weeks, this aspect has been overlooked till now. The dislocated fragment can cause pressure on the retro clavicular area of brachial plexus after the conservative management which may cause symptoms. Additionally, a closed reduction that fails is mainly due to persistent wide fragment separation and soft tissue interposition between them. Displaced Middle 1/3rd of the clavicle fractures which are not operated, have a non union rate of approx. 15% and non union occurred in those fracture which had initial shortening of more than 2 cm.^[4]

Since conservative management are now known to be inferior both functionally and clinically, surgical management are preferred these days for clavicle fractures.

Many studies which has been done till now has stated the effectiveness of open reduction internal fixation with plating for displaced clavicle fractures and it was noted to have high union rate and lower risks of complication.^[5]

Usually locking compression plate are used to get a satisfactory results with low risks of complication in cases of majority of complex clavicle fractures.^[6] A locking compression plate can be used in many complex fractures to achieve a satisfactory result with a low complication.^[7]

Return to function is achieved with internal fixation of displaced comminuted clavicular fractures which are managed by primary internal fixation have predictable and rapid return to function. However, there are risks involved in treating clavicle fractures surgically which include infections, non-union, delayed union, loosening and breakage of implants, hypertrophy of scar, iatrogenic brachial plexus injury which can occur intraoperatively and severe vascular damage.

There is a risk of injuries to the neurovascular bundles, great vessels injury, associated injury to oesophagus or trachea, Injury to the brachial plexus and the pleura or apex of the lung, poor cosmetic appearance, pneumothorax and intra-thoracic injury are all linked to clavicle fractures. Majority of the clavicle fractures are not so dangerous, but depending on where they are, they may be connected to potentially fatal intrathoracic injuries.

Various surgical techniques are available for surgical management of clavicle fracture which include closed reduction and internal fixation with k wires, TENS nailing, Steinmann pin fixation, and open reduction internal fixation with plating.

In cases with severe comminuted fractures, fixation is done using plates to achieve anatomical reduction. Among the different types of plates are dynamic compression plates, locking clavicle plates, semi-tubular plates and Sherman plates. The most popular among these are the clavicle locking compression plate

(LCP), S shaped plate to match with the curvature of the clavicle.

Several braces are available which are used in the conservative management to immobilize the clavicle fractures. The most commonly brace used for conservative management is the figure of eight brace.

AIMS AND OBJECTIVES

AIM:

The primary aim of our study is to assess the functional outcome of Surgical Management for clavicle fractures by osteosynthesis using plate and screws.

OBJECTIVE:

PRIMARY OBJECTIVE:

- Assessment of functional and radiological outcome of management of clavicle fractures by osteosynthesis using plates and screws.

SECONDARY OBJECTIVE:

- To determine the factors affecting outcome of clavicle fracture by osteosynthesis using plates and screws.
- Correlation between functional and radiological outcome of osteosynthesis using clavicle plating.
- Effect of delay in treatment on functional outcome of clavicle plating.

MATERIALS AND METHODOLOGY:

Nature of the study: Prospective Observational Study

Number of patients to be enrolled in study: 30

Place of the Study: Department of Orthopaedics, DR. D. Y. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, PIMPRI, PUNE.

Time Period: 2 YRS

Criteria Of Selection:

Inclusion Criteria:

- Patient above the age of 18 years
- Presenting within 2 weeks of fracture
- Closed fracture
- Displaced fracture
- Comminuted fracture

Exclusion Criteria:

- Age less than 18
- Open Fracture
- Pathological fractures
- Un-displaced fracture
- Unfit for surgery
- Any pre-existing impairment of function of the upper limb of the same side
- Psychiatric and Neurological disorders that can preclude the assessment
- Unwilling patients

At the arrival of the patient, the necessary documentation about the patient was done. A thorough history was taken from the patient including chief complains, mode and mechanism of injury (like road traffic accident etc). Duration of trauma was documented. Patient was examined thoroughly for swelling and tenderness area. Any past medical, surgical history and family history was enquired about and necessary documentation was done. Vitals were taken. General and systemic examination of the patient was done.

LOCAL EXAMINATION:

• **INSPECTION:**

Swelling was present at the fracture site. Local area looked for any contusion, abrasion, laceration or any open injury.

• **Palpation:**

Palpation of the involved clavicle was done to look for tenderness, crepitus or any unusual mobility

• **Movements:**

Movement at the shoulder joint of the same side was not possible due to pain at the fracture site. Neurovascular examination of the limb was done and any associated injuries was looked for. To know the details of the fracture (like site and type), radiograph of the clavicle with shoulder was taken in Antero posterior view. Allman's classification system was used to categorize the fractures. Shoulder arm pouch was used to immobilize the upper limb.

PRE-OP WORKUP:

All patients were admitted and underwent a pre-operative workup in accordance with the protocol listed below:

- Hemogram with ESR and blood grouping.
- BSL and HbA1C
- PT INR
- LFT, RFT, Serum electrolytes
- Serology Status (HIV, HbSAg, HCV)
- Bleeding and clotting time
- ECG and X-ray PA view of the chest.
- Medical and surgical references, if needed for operative fitness.

After anaesthesia fitness patient were posted for surgery after:

- Written, valid, and informed consent for surgery from the patient and any concerned family members.
- Extensive preoperative planning, including classification of fractures and fixation option selected.
- Following the test dose, Inj. cefotaxime 1gm was administered to all patients prior to surgery and subcutaneous xylocaine sensitivity test was performed.

INSTRUMENTS:



- 7-9 hole clavicle locking compression plate (pre-contoured) (3.5 mm)
- 2.8 mm drill bit and 2.5 mm drill bit for 3.5 mm locking cortical screws and 3.5 mm cortical screws respectively of varying sizes.
- Power Drill.
- Depth gauge.
- Screw driver (Hexagonal).
- General instruments like reduction clamps, periosteal elevator, bone lever and
- Retractor.

SURGICAL TECHNIQUE:

- Patient was taken in beach chair position. A towel was kept between his scapula. Entire upper limb, from the base of the neck to the hand, was prepared and draped under sterile aseptic precautions.
- About 6-8 cm incision was taken on the anterior aspect of the clavicle, centred over the fracture area.
- Subcutaneous tissue and platysma were divided without compromising the edges.
- Limited dissection of periosteum and soft tissue was done.
- Reduction of the fragments was done under C-arm guidance and plate was fixed with screws at the superior aspect of the bone.
- While drilling for screws through the plate holes, some safety device is put below the bone to avoid damage to neurovascular structures especially at the junction of medial 1/3rd and middle 1/3rd.

• At least three locking screws or cortical screws were used to fix the locking compression plate to the medial and lateral fragments.

• Thorough wash was given and suturing was done in layers

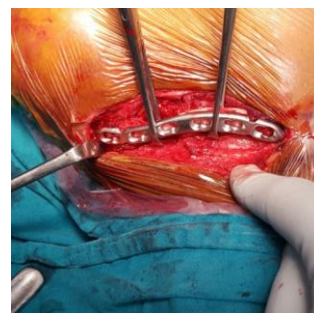
Position of the patient after painting and draping:



Exposure of the fracture site after incision of skin, subcutaneous tissue, muscle and fascia:



Osseous ends were made free from the surrounding tissue. Reduction of the fracture was done and plate was put on the bone:



Locking compression plate was fixed over superior aspect of the bone with locking screws:



Suturing was done in layers and wound was closed:



Post operative Protocol:

- Oral feeds was started after approx. 6 hours of the surgery, till then IV fluids were administered.
- Immobilisation of the limb was done in the shoulder arm pouch.
- Radiographs were taken for the post-operative check.

- Patients were started on IV antibiotics i.e. Inj. Cefuroxime IV 1.5 gm every 12 hour for 5 days, Inj. Gentamycin 80 mg IV every 12 hour for 3 days, Inj. Metronidazole 100cc IV every 8 hour for 3 days were administered. On discharge patients were started on oral antibiotics Tab. Cefuroxime + Clavulanic Acid combination twice a day for 5 days.

- Drugs to treat pain and inflammation were administered intravenously. Injection Diclofenac IV in 100 ml NS every 12 hour for the first five days which was shifted to oral analgesics Tablet Aceclofenac + Paracetamol combination was given according to the patient's needs. Multivitamins and calcium supplements were given for 4 weeks in addition to the therapy.

- Dressings were done on day 2nd, 5th, 8th, and 12th following surgery and sutures were taken out on day 15.

- Physiotherapy for finger, wrist, and elbow movements began on post-operative day 2, and pendulum and isometric/isotonic exercises (for the triceps and rotator cuff) began on day 5. Passive shoulder range of motion (ROM) began at week 2 and active shoulder ROM began at week 4.

**CONSTANT AND MORLEY
SCORING:**

The patients were graded as follows:

CATEGORY:**A) SUBJECTIVE:**

- 1) Pain - 15 Points
 - No pain - 15
 - Bearable pain – 1
 - Disabling pain - 5
- 2) Activities of daily living: - 20 Points
 - Ability to perform full work - 04
 - Ability to perform Leisure activities/ Sports - 04
 - Unaffected sleep - 02
- 3) Level at which work can be done:
 - Up to Waist - 02
 - Up to Xiphoid - 04
 - Up to Neck - 06
 - Up to Head - 08
 - Above head - 10

B) OBJECTIVE:**RANGE OF MOVEMENTS: 40 POINTS:****a) Active flexion without pain**

- 0 – 30 Degree: 0
- 31-60 Degree: 2
- 61-90 Degree: 4
- 91-120 Degree: 6
- 121-150 Degree: 8
- > 151 Degree: 10

b) 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

c) Active abduction without pain:

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

d) Functional internal rotation:

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

e) Strength of abduction: 25 Points

An average 25-year-old man's shoulder can easily withstand 25 pounds of weight. Normal power receives 25 points, with less power receiving proportionately fewer points.

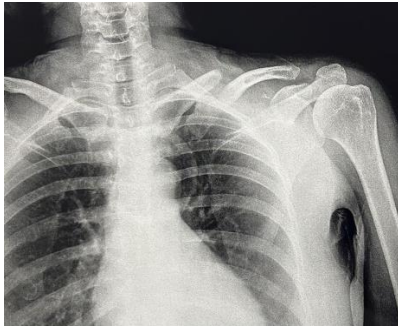
With a maximum of 100 points, patients will be graded as follows:

Total score Result:

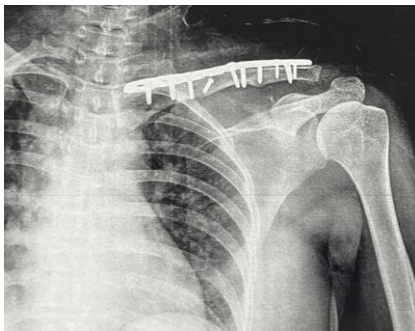
- 90-100 Excellent
- 80-89 Good
- 70-79 Fair
- 0-70 Poor

Radiological Evaluation:

Pre-Operative Radiograph:



Post Operative Radiograph:



Functional Range of motion was assessed at 5 weeks of surgery:



Table-1: Age distribution

Age groups (years)	Number	Percentage
20-40	19	63.3
41-60	8	26.7
>60	3	10.0
Total	30	100.0

Above table describes about age distribution among the study group. Maximum number of cases (19 cases) were in the age group of 20 to 40 years with 63.3%, 8 cases were in age group of 41 to 60 years with 26.7% and 3 cases were more than 60 years of age with 10 %.

Table:2: Gender

Gender	Number	Percentage
Male	23	76.7
Female	7	23.3
Total	30	100.0

This table shows the sex distribution in the study group. Males were more involved in the fracture (76.7%) than female (23.3%)

Side	Number	Percentage
Right	18	60.0
Left	12	40.0
Total	30	100.0

Table:3 :Side

Table-4: Mode of injury

Mode of injury	Number	Percentage
Blunt Trauma	4	13.3
RTA	22	73.3
Sports Injury	4	13.3
Total	30	100.0

This table tells about various mode of injury in the study group. Road traffic accident was involved in 73.3% of cases, blunt trauma and sports injury contributed as the mode in 13.3% of cases each.

Table-5: Classification

Classification	Number	Percentage
Allman type 1	26	86.67
Allman type 2	3	10
Allman type 3	1	3.33
Total	30	100.0

This table tells about the type of fracture distribution as per Allman classification. Allman type 1 was involved in 86.67% of cases. 10% of cases were of Allman type 2 and 3.33% cases were of Allman type 3.

Table-6: Descriptive statistics

Parameter	Mean	SD	Median	Minimum	Maximum
Duration between trauma and surgery in days	4.1	2.4	3	1	9
Hospital stays in days	8.9	3.1	8	5	16
Time till return of functional range of motion (in weeks)	5.9	1.3	6	4	8
Time of Union (in Weeks)	12.0	2.7	11.5	8.0	20.0
Constant and Morley Score at 3 weeks	75.7	5.5	77	62	84
Constant and Morley Score at 6 weeks	83.6	5.8	86	66	90
Constant and Morley Score at 12 weeks	90.9	6.2	93	72	98

Above table tells about the other parameters. The mean duration between trauma and surgery was 4.1 with SD of 2.4. Mean hospital stay was 8.9 days with SD of 3.1. The mean time till return of functional range of motion was 5.9 with SD 1.3. The mean time of union was 12 weeks with SD 2.7. The mean Constant and Morley Score at 3 weeks, 6 weeks and 12 weeks was 75.7 with SD 5.5, 83.6 with SD 5.8 and 90.9 with SD 6.2 respectively.

Table-7: Results

Results	Number	Percentage
Excellent	24	80.0
Good	4	13.3
Fair	2	6.7
Total	30	100.0

This table tells about the final outcome. 24 cases (80%) showed excellent outcome. 4 cases (13.3%) showed good outcome. 2 cases (6.7%) showed fair outcome.

Table 8: Functional results and outcome

Outcomes	Mean functional scores	SD	P value
Excellent	5.8	1.2	0.062
Good	5.8	1.5	
Fair	8	0	
Oneway-ANOVA; P value (not significant)			

Comparison	Pearson Correlation coefficient (r)	P value
Functional scores and outcome scores	-0.41	0.026

Table-9: Correlation between functional scores and outcome scores (Constant and Morley Score at 12 weeks)

Correlation between functional scores and outcome scores (Constant and Morley Score at 12 weeks) was done which showed Pearson Correlation coefficient (r) as -0.41 and P value of 0.026 which was statistically significant.

DISCUSSION

This study was aimed to assess the functional outcome of management of clavicle fractures by using plates and screws along with factors affecting outcome of clavicle fracture by osteosynthesis using plates and screws, correlation between functional and radiological outcome of osteosynthesis using clavicle plating and effect of delay in treatment on functional outcome of clavicle plating.

Of total 30 patients 19 patients (63%) were in the age group 20 to 40 years, 8 patients (26.7%) were in the age group 41 to 60 years and 3 patients (10%) were in the age more than 60 years (Table 1). Shen WJ, Liu TJ, Shen YS. (1999) had operated on 251 completely displaced mid-third clavicle fractures in adults. There were 150 men and 82 women and the median age was 37.3 years.^[28]

23 Males (76.7%) were proportionately more involved as compared to 7 females (23.3%) in the clavicle fractures (Table 2). Cesare

Faldini, Matteo Nanni, Danilo
Leonetti, Francesco Aciri, Claudio
Galante, Deianira Luciani, Sandro Giannini
(2010) reported the results of treating closed displaced midshaft clavicle fractures nonoperatively. One hundred clavicle fractures aged between 18 and 67 years were enrolled with male proportion was 78% and females were 22% which is similar to our study finding.

Right side (60 %) was more involved than the left side (40%) (Table 3).

Mode of injury were road traffic accident, blunt trauma and sports injury which included 22 cases (73.3%), 4 cases (13.3%) and 4 cases (13.3%) respectively (Table 4). Shachar Shapira, Zeevi Dvir, Uri Givon, Ariel Oran, Amir Herman, Moshe Pritsch (2011) determined whether clavicle malunion affects functional results. Among 15 patients included in the study 7 had motor vehicle accident, 3 had bicycle accident and 2 had fall.³⁵ Chul-Hyun Cho, Kwang-Soon Song, Byung-Woo Min, Ki-Cheor Bae, Kyung-Jae Lee, (2012) compared the outcomes of reconstruction plate and reconstruction locking compression plate (LCP) for the treatment of clavicle midshaft fractures. 19 case underwent operative procedure with reconstruction using plate among which 13 had traffic accident, 4 had fall and one had sports injury.¹⁵¹

26 cases (86.67%) were of clavicle midshaft fracture Allman type 1, 3 cases (10%) were of Allman type 2 and 1 case (3.33 %) was of Allman type 3 (Table 5).

As far as complications are concerned delayed union was present in 3 patients (10%), skin scars in 3 patients (10%), plate prominence in 2 patients (6.7%), plate loosening in 1 patient (3.3%). Restriction of shoulder range of movement in 1 patient (3.3%)(Table 7).

The mean duration (in Days) between trauma and surgery was 4.1 with SD of 2.4. Lesser the time interval between trauma and surgery, better the outcome. The mean duration of hospital stay (in Days) was 8.9 with SD of 3.1. Mean duration after which functional range of motion was attained (In weeks) was 5.9 with SD of 1.3.

Mean time of union (in weeks) was 12 with SD of 2.7. The mean constant and Morley score at 3 weeks, 6 weeks and 12 weeks were 75.7 with SD 5.5, 83.6 with SD 5.8 and 90.9 with SD of 6.2 (Table 6).

Excellent outcome was noticed in 24 cases (80%), good outcome in 4 cases (13.3%) and fair in 2 cases (6.7%) (Table 7).

CONCLUSION

- Complete functional range of motion after surgery for clavicle fracture was seen approximately after 4 to 5 weeks.
- Average time for union after clavicle fracture surgery was less than 12 weeks.
- Better outcome in patients who got operated early.

SUMMARY

Functional outcome of Clavicle fractures by Osteosynthesis using plates and screws was assessed. Factors affecting outcome of clavicle fracture by osteosynthesis using plates and screws were looked for. Correlation between functional and radiological outcome of osteosynthesis using clavicle plating was done. Effect of delay in treatment on functional outcome of clavicle plating was assessed.

- 20 to 40 years of age group was the most common for age group for clavicle fractures. Males were predominantly more

affected with clavicle fractures as compared to females.

- Motor vehicle accident was the most common cause for clavicle fractures. Other causes were sport injury and blunt trauma.
- Majority of the cases were operated within 5 days interval of trauma. Duration of stay was 8 to 11 days among majority of the cases.
- Functional range of motion was seen after 4 to 5 weeks among 13 cases and 17 cases had after 6 to 8 weeks.
- Time for union after clavicle fracture surgery was up to 14 weeks among 26 cases and in 4 cases union appeared after 14 weeks.
- Delayed union (10 %) and skin scars (10 %) was seen in seen as most common complication followed by malunion, plate prominence.
- Excellent outcome after surgery was seen among 24 cases, good outcome was seen among 4 cases and 2 cases had fair outcome.
- Time interval was significantly associated with level of outcome in the study. Lesser the time interval between trauma and surgery, better was the outcome.
- Time to return to functional range of motion was not significantly associated with outcome among the cases with mid shaft clavicle fracture.
- Age was not significantly associated with time till return to functional range of motion in the study group.
- Constant and Morley score was significantly improved after 6 and 12 weeks post operatively after surgery for clavicle fracture.

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