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# Functional Outcome of Surgically Managed Displaced Clavicle Fractures in Adults

**Dr. Nagaraju Honnegowda[1], Dr. Avinash R.[2], Dr. Yogananda Gali Hanumaih[3]**

*[123]Assistant Professor, Department of Orthopaedics, Sri Chamundeshwari Medical College Hospital & Research Institute, Channapatna, Ramanagar District, Karnataka, India.*

**Correspondence:**
***Dr. Avinash R***
*Assistant Professor, Department of Orthopaedics, Sri Chamundeshwari Medical College Hospital & Research Institute, Channapatna, Ramanagar District, Karnataka, India.*

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## Abstract

***Background:*** Clavicle fractures are among the most common skeletal injuries, with the middle third being the most frequently affected site. Traditionally, many clavicle fractures were treated conservatively; however, displaced fractures often lead to complications such as malunion, non-union, and functional impairment. Surgical management has gained acceptance as a primary treatment modality for displaced clavicle fractures due to improved anatomical alignment and early functional recovery. This study was conducted to evaluate the functional outcomes of surgically managed displaced clavicle fractures in adults. ***Methods***: This hospital-based prospective interventional study was conducted in the Department of Orthopaedics at Khaja Bandanawaz Teaching and General Hospital, affiliated with Khaja Bandanawaz University – Faculty of Medical Sciences, Kalaburagi, Karnataka, from March 2021 to August 2022. A total of 60 adult patients with displaced clavicle fractures were included. Demographic details, clinical history, and examination findings were recorded, along with routine investigations. Patients received either closed reduction and internal fixation with the TENS (Titanium Elastic Nailing System) or open reduction and internal fixation with a plate and screws. After surgery, follow-up evaluations were carried out at 2, 4, 6, and 10 weeks as well as six months later. The Constant-Murley scoring system was used to assess functional outcomes. IBM SPSS version 25 was used for statistical analysis. Fisher's exact tests, independent sample t-tests, chi-square tests, and descriptive statistics were used; a p-value of less than 0.05 was deemed statistically significant. ***Results***: Clavicle fractures were most commonly observed in adults aged 41–50 years (60%), with males being more frequently affected (66.67%). Road traffic accidents were the leading cause of injury (68.33%). Spiral fractures (35%) were the most common pattern, followed by comminuted fractures (31.67%). Plate and screw fixation demonstrated better anatomical alignment, compression at the fracture site, and earlier callus formation. However, there was no statistically significant difference in the functional outcomes between plate and screw fixation and TENS ($p>0.05$) based on Constant-Murley scores at final follow-up. ***Conclusion***: Surgical management of displaced clavicle fractures provides satisfactory functional outcomes. Open reduction and internal fixation with plate and screw fixation offers reliable stability and good anatomical restoration, resulting in favourable postoperative functional recovery.

**Keywords:** Clavicle Fracture, Displaced Clavicle Fracture, Functional Outcome, Plate and Screw Fixation, Titanium Elastic Nailing System (TENS).

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## INTRODUCTION

The clavicle is a horizontally placed bone of the shoulder girdle that connects the upper limb to the axial skeleton through the sternoclavicular joint and to the shoulder through the acromioclavicular articulation. Clavicle fractures most commonly involve the middle third of the bone (70–80%), followed by the lateral third (12–15%) and the medial third (5–8%).[1] For many decades, clavicle fractures have traditionally been treated conservatively with satisfactory outcomes in most patients.[2] However, conservative management of displaced clavicle fractures has shown variable results, with complications such as malunion and non-union leading to residual deformity and functional limitations.[3]

In the general population, especially in individuals who do not require frequent overhead shoulder activity, malunion of clavicle fractures may be tolerated without significant functional deficit. However, in manual labourers who frequently perform overhead abduction of the upper limb, deformity and shortening of the clavicle can significantly affect shoulder function and work performance. Additionally, non-union often requires surgical intervention later, which may increase morbidity, prolong recovery time, and impose a greater economic burden due to loss of workdays.[4]

Clavicle fractures have been recognized since ancient times, with the earliest description dating back to 3550 BC in Egyptian literature. Early methods of treatment involved positioning techniques aimed at restoring the alignment of the clavicle.[5] Hippocrates later described clavicle fractures around 400 BC and suggested that maintaining reduction without surgical stabilization was difficult.[6-8]

Clavicle fractures account for approximately 2.5–4% of all adult fractures and 44–66% of injuries to the shoulder girdle.[9] The most widely used classification system for clavicular fractures is Allman's classification, which categorizes fractures into three groups: Group I (middle third), Group II (lateral third), and Group III (medial third).[10] Midshaft fractures constitute the majority, while medial fractures are relatively rare.[11]

Although several conservative treatment methods such as slings, figure-of-eight bandages, and clavicular braces have been widely used, maintaining reduction is often difficult, leading to complications such as malunion and non-union.[12-14] Recent evidence suggests that displaced clavicle fractures treated non-operatively have higher rates of complications than previously believed. Consequently, surgical management using techniques such as plate and screw fixation or intramedullary devices has gained acceptance, providing stable fixation, improved anatomical alignment, and earlier functional recovery.[15-20]

## AIMS AND OBJECTIVES

The study aimed to evaluate the functional outcomes of surgically managed displaced clavicle fractures in adults. The objective is to assess postoperative recovery, fracture union, and functional improvement following surgical management using appropriate fixation techniques and to determine the effectiveness of surgical intervention in restoring shoulder function and reducing complications associated with displaced clavicle fractures.

## MATERIALS AND METHODS

### Study Design

This study was a hospital-based prospective interventional study conducted in the Department of Orthopaedics at Khaja Bandanawaz Teaching and General Hospital, affiliated with Khaja Bandanawaz University – Faculty of Medical Sciences, Kalaburagi, Karnataka. The study population included patients admitted with clavicle fractures at the hospital. The research was carried out over a period of 18 months, from 1st March 2021 to 31st August 2022, with the aim of evaluating the clinical and functional outcomes of patients undergoing surgical management for displaced clavicle fractures.

### Inclusion and Exclusion Criteria

Patients aged between 16 and 60 years with displaced closed clavicle fractures, clavicle fractures with shortening greater than 2 cm, bilateral clavicle fractures, and fractures with impending skin perforation were included in the study. Patients were excluded if they were younger than 16 years or older than 60 years, had previously diagnosed pathology involving the shoulder or elbow joints, presented with fractures older than two weeks, or showed scapular malposition with winging on initial examination. Patients with pathological fractures, undisplaced fractures, related head injuries, neurovascular injuries, documented non-union from prior fractures, or floating shoulder injuries were also not allowed to participate in the study.

### Sample Size Calculation

According to the formula for sample size calculation, sample size = (Z (1-apha))2 x p x q/l2
For our study, considering p as 63%22 q=100-p =37
l = relative error (20% of P) = 12.6
Z= Z score for 95% confidence interval = 1.96
The total sample size as per the formula was 58.73 for this study, which has been extended to 60.

### Data Collection Procedure

Data were collected from patients admitted with displaced clavicle fractures who met the inclusion criteria during the study period. After obtaining informed consent, detailed patient information including demographic data, history of injury, clinical examination findings, and radiological investigations, was recorded using a structured proforma. Eligible patients underwent surgical management with appropriate fixation techniques. Postoperative follow-up was conducted at regular intervals to assess fracture healing, complications, and functional outcomes using standard clinical and radiological evaluation methods.

### Statistical Analysis

IBM SPSS version 20.0 software was used to analyse all of the gathered data once it had been placed into a Microsoft Excel spreadsheet. To ascertain statistical significance, qualitative variables were examined using the chi-square test,

whereas quantitative variables were examined using the t-test and ANOVA test. Statistical significance was defined as a p-value of less than 0.05 ($p < 0.05$).

## RESULTS

**Table 1: Age Distribution of Patients**

| Age Group (in years) | Number of Patients | Percentage |
|---|---|---|
| 16–30 | 10 | 16.67% |
| 31–40 | 14 | 23.33% |
| 41–50 | 36 | 60.00% |
| Total | 60 | 100% |

Table 1 illustrates the age distribution of patients with displaced clavicle fractures included in the study. The majority of patients (60%) belonged to the 41–50 years age group, indicating that middle-aged adults were most commonly affected.

**Table 2: Gender Distribution**

| Gender | Number of Patients | Percentage |
|---|---|---|
| Male | 40 | 66.67% |
| Female | 20 | 33.33% |
| Total | 60 | 100% |

Table 2 shows the gender distribution of patients. The study observed that males (66.67%) were more commonly affected than females (33.33%), suggesting a higher exposure of males to trauma-related activities.

**Table 3: Mode of Injury**

| Mode of Injury | Number of Patients | Percentage |
|---|---|---|
| Road Traffic Accident | 41 | 68.33% |
| Fall from Height | 19 | 31.67% |
| Total | 60 | 100% |

Table 3 demonstrates the mode of injury leading to clavicle fractures. Road traffic accidents were the most common cause (68.33%), followed by falls from height (31.67%).

**Table 4: Type of Fracture Pattern**

| Fracture Pattern | Number of Patients | Percentage |
|---|---|---|
| Spiral | 21 | 35.00% |
| Comminuted | 19 | 31.67% |
| Transverse | 10 | 16.67% |
| Oblique | 8 | 13.33% |
| Others | 2 | 3.33% |
| Total | 60 | 100% |

Table 4 illustrates the distribution of fracture patterns among the patients. The spiral fracture pattern (35%) was the most common, followed by comminuted fractures (31.67%).

**Table 5: Type of Surgical Procedure Performed**

| Surgical Method | Number of Patients | Percentage |
|---|---|---|
| Plate and Screw Fixation | 36 | 60% |
| TENS Fixation | 24 | 40% |
| Total | 60 | 100% |

Table 5 shows the surgical techniques used in the management of displaced clavicle fractures. Plate and screw fixation was performed in the majority of patients (60%), while TENS fixation was used in 40% of patients.

**Table 6: Fracture Union Outcome**

| Outcome | Plate & Screw | TENS | Total |
|---|---|---|---|
| Union Achieved | 34 | 22 | 56 |
| Delayed Union | 2 | 2 | 4 |
| Total | 36 | 24 | 60 |

Table 6 depicts fracture union outcomes following surgical treatment. The majority of fractures achieved successful union in both groups, with slightly better results observed in the plate and screw fixation group.

**Table 7: Functional Outcome (Constant-Murley Score)**

| Outcome Category | Number of Patients | Percentage |
|---|---|---|
| Excellent | 12 | 20% |
| Good | 28 | 46.67% |
| Fair | 16 | 26.67% |
| Poor | 4 | 6.66% |
| Total | 60 | 100% |

Table 7 illustrates the functional outcomes of patients evaluated using the Constant-Murley scoring system. The majority of patients demonstrated good to excellent functional outcomes, indicating satisfactory recovery following surgical management of displaced clavicle fractures.

## DISCUSSION

Clavicle fractures have traditionally been managed conservatively, but several studies have reported unsatisfactory outcomes in displaced fractures. "Hill et al.,[3] Nordqvist et al.,[21] and Robinson et al., reported poor results following conservative treatment of displaced middle-third clavicle fractures, including malunion and non-union." These limitations have led to increased preference for surgical management, especially in fractures with significant displacement or comminution.

In the present study, males outnumbered females in a ratio of 40:20. "Similar male predominance has been reported by Postacchini et al,[10] Paladini et al,[8] Mishra et al.,[22] Madhukar et al.,[23] and Pranav et al.,[24] where approximately 65% of clavicle fracture cases occurred in males." Postacchini et al.,[10] also reported a male-to-female ratio of 68:32. This higher incidence in males may be attributed to greater involvement in outdoor activities, heavy work, and road traffic accidents.

Clavicle fractures are more commonly observed in younger individuals. Studies by Kim and McKee et al.,[25] Paladini et al.,[8] Mishra et al.,[22] Madhukar et al.,[23] and Pranav et al.,[24] reported higher incidence in individuals below 40 years of age. Kim and McKee et al.,[25] further noted that clavicle fractures occur most frequently in individuals younger than 40 years or older than 70 years. In our study, the majority of patients were young adults, which may be due to increased exposure to high-energy trauma and occupational activities.

Road traffic accidents were the most common mode of injury in our study, followed by falls from height, with males being more frequently affected. Oliver et al.,[26] and Pranav et al.,[24] also reported that most clavicle fractures involve the middle third of the bone and are commonly caused by indirect trauma. In our study, spiral fractures (35%) and comminuted fractures (31.67%) were the most common fracture patterns, followed by transverse (16.67%) and oblique fractures (13.33%).

Historically, conservative methods such as slings and figure-of-eight bandages were used, but these methods often failed to maintain reduction, leading to malunion, non-union, shortening, and deformity that affect shoulder function and cosmetic appearance.[12-14] As a result, surgical fixation has become increasingly accepted. Various surgical methods have been described, including Kirschner wire fixation by Kona et al.,[6] Ballmer et al.,[27] and Yamaguchi et al.,[28] plate fixation by Poigenfurst et al.,[7] and Venkatachalam et al.,[29] and intramedullary fixation by Wu et al.[30]

In the present study, 24 patients were treated with closed reduction and internal fixation using TENS, while 36 patients underwent open reduction and internal fixation using plates and screws. Union was achieved in most cases in both groups, though two cases of non-union were observed in each group. "Previous studies by Wu CC et al.,[30] Mueller et al.,[31] and Hartmann et al.,[32] reported faster healing with intramedullary fixation, and similar findings were reported by Gao et al."[33] Postoperative complications observed in our study included superficial infection, implant prominence, pin migration, and non-union. Superficial infection occurred in six patients in the TENS group and eight patients in the plating group, while two patients in the plating group developed deep infection. Implant prominence and unsightly scars were observed mainly in the plating group, while pin migration occurred in the TENS group. Similar complications have been reported by Gao et al.[33]

Plate fixation provides rigid stabilization and better resistance to bending and torsional forces, particularly in comminuted fractures. Zeng et al.,[34] reported that plating allows earlier mobilization and stable fixation, although it may require larger incisions and extensive soft tissue dissection. Intramedullary fixation, on the other hand, is a less invasive technique that preserves the soft tissue envelope and periosteum, promoting fracture healing.

Functional outcomes in the present study were assessed using the Constant-Murley scoring system. Similar findings were reported by Sahu et al.,[35] who observed no significant difference between plating and intramedullary fixation after one

year of follow-up. Overall, both surgical techniques provided satisfactory outcomes in the management of displaced clavicle fractures. However, plate and screw fixation provided better stability and slightly better functional outcomes, particularly in comminuted fractures, while TENS fixation offered advantages such as minimal invasiveness and better cosmetic results.

**Limitations**

There are several restrictions on this study. The study was carried out at a single location and had a rather small sample size, which may have limited the results' generalisability and introduced response bias. Patient follow-up depended on their willingness to return for functional assessment, which may have affected data completeness. Selection bias may also have influenced the results since 24 patients underwent CRIF/ORIF with TENS, while 36 patients underwent ORIF with plate and screw fixation. Additionally, the effects of patient co-morbidities on functional outcomes were not evaluated. Another restriction is the lack of long-term follow-up to evaluate clinical and functional outcomes following surgery; more research with larger sample sizes and longer follow-up is necessary.

## CONCLUSION

The functional results of 60 patients with displaced clavicle fractures were assessed in this study after surgical treatment with either closed reduction and internal fixation with TENS or open reduction and internal fixation with plate and screw fixation. Both surgical procedures produced satisfactory functional outcomes with high fracture union rates. Although the mean Constant-Murley scores at 12 months were comparable between the two groups, plate and screw fixation demonstrated slightly better functional outcomes and a marginally higher union rate. However, plating was associated with greater intraoperative and postoperative complications such as increased blood loss, longer operative time, infection, implant prominence, and unsightly scars compared to TENS. Overall, surgical management of displaced clavicle fractures provides good functional recovery, with open reduction and internal fixation using plate and screw fixation offering reliable stability and favourable outcomes.

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