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Functional outcomes of displaced midshaft clavicle fractures treated with precontoured locking compression plates. A prospective observational study.

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Abstract

Background:

Displaced midshaft clavicle fractures are common injuries in active adults. Although conservative treatment has been the traditional approach, surgical fixation using precontoured locking compression plates (LCPs) offers potential benefits of anatomical reduction, stable fixation, and early rehabilitation. This study evaluated functional outcomes, union rates, and complications following open reduction and internal fixation with precontoured LCPs.

Methods:

A prospective observational study was conducted on 30 patients aged >18 years with displaced midshaft clavicle fractures (Allman Group I) treated at a tertiary care center between April 2018 and September 2019. Open fractures, proximal or distal third fractures, pathological fractures, neurovascular injury, and nonunion cases were excluded. All patients underwent open reduction and internal fixation with precontoured LCPs. Functional outcomes were assessed using the Constant–Murley score at a minimum of 6 months follow-up. Radiological union was confirmed by callus formation and the absence of a fracture line. Data were analyzed descriptively.

Results:

The mean age was 37.4 years; males comprised 73.3% of cases (male: female ratio 2.75:1). Road traffic accidents were the predominant cause (70%), and the right clavicle was more frequently involved (60%). The mean union time was 10.33 ± 1.2 weeks, with 90% achieving full shoulder range of motion by 6 months. Constant–Murley scores showed 73.3% excellent, 20.0% good, 3.3% fair, and 3.3% poor outcomes. Good-to-excellent results were achieved in 93.3% of cases. No nonunions or implant failures occurred; minor complications were limited to transient stiffness in 10% of patients.

Conclusion:

Precontoured LCP fixation for displaced midshaft clavicle fractures provides high union rates, excellent functional outcomes, and minimal complications. Early mobilization and rigid fixation contribute to favorable results.

Recommendations:

Precontoured LCP fixation should be considered in active adults with displaced midshaft clavicle fractures to optimize recovery and reduce disability.

Keywords: *Midshaft Clavicle Fracture, Locking Compression Plate, Constant–Murley Score, Functional Outcome, Internal Fixation, Union Rate.*
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Introduction

Clavicle fractures represent one of the most frequent skeletal injuries, accounting for approximately 2.6–4% of all adult fractures and up to 44% of shoulder girdle injuries, with the midshaft region involved in nearly 70–80% of cases due to its distinctive S-shaped contour, subcutaneous location, and susceptibility to deforming muscular forces [1–3]. Traditionally, midshaft clavicle fractures have been managed conservatively using figure-of-eight bandages or arm slings, based on the belief that mild displacement has

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little influence on long-term shoulder function [2]. However, recent studies have challenged this assumption, reporting higher rates of nonunion—up to 15%—along with malunion, persistent pain, and functional deficits, particularly in displaced fractures [3,4]. Additionally, conservative treatment may result in cosmetic deformity and delayed return to pre-injury activity levels, which is of particular concern in young, active individuals [2,4].

Operative fixation offers distinct advantages, including anatomical reduction, stable internal fixation, early mobilization, and improved cosmesis [1,3,5]. Precontoured locking compression plates (LCPs) have emerged as a preferred option, offering superior biomechanical stability, reduced periosteal disruption, and precise adaptation to the clavicular anatomy, even in comminuted or osteoporotic bone [1,5]. Despite the growing adoption of surgical fixation, there remains a paucity of region-specific data regarding functional outcomes and complication rates, particularly in the Indian context, where high-energy trauma such as road traffic accidents is a leading cause [3,4].

This prospective study was undertaken to evaluate the functional and radiological outcomes of displaced midshaft clavicle fractures treated with precontoured LCPs, and to analyze union rates, complication patterns, and the proportion of patients achieving satisfactory recovery.

Methodology

Study Design and Setting

This study was a prospective observational cross-sectional study conducted in the Department of Orthopaedics, Mahatma Gandhi Memorial (MGM) Hospital, Hyderabad, Telangana, between April 2018 and September 2019. MGM Hospital is a large government tertiary care teaching hospital affiliated with Osmania Medical College, serving as a referral center for trauma and orthopedic cases from Hyderabad city and surrounding rural districts. The hospital has a capacity of approximately 1,200 beds, with a well-established Orthopaedics Department that manages both elective and emergency musculoskeletal cases. The study population predominantly comprised young and middle-aged adults presenting with high-energy trauma, reflecting the hospital's role as a major trauma center in the region.

Study Population and Sample Size Determination

A total of **30 consecutive patients** with displaced midshaft clavicle fractures meeting the eligibility criteria were included. The sample size was determined pragmatically, based on the average number of clavicle fracture cases presenting to the hospital during the study period, availability of resources, and feasibility for consistent follow-up. As this was a single-center observational study, no formal sample size calculation was applied, but the number was adequate to provide meaningful descriptive outcomes within the given time frame.

Inclusion Criteria:

Age >18 years
Closed fractures of the midshaft clavicle (Allman Group I)
Patients fit for general or regional anesthesia

Exclusion Criteria:

Open fractures
Fractures of the proximal or distal third of the clavicle
Pathological fractures
Undisplaced fractures
Associated head injury or neurovascular injury
Established nonunion or acromioclavicular joint dislocation

Preoperative Assessment

All patients underwent detailed clinical examination, classification of fractures according to Allman's classification, and radiographic evaluation with anteroposterior and 30° cephalic tilt views of the clavicle. Routine hematological and biochemical investigations and anesthetic fitness assessments were performed.

Surgical Technique

All patients underwent open reduction and internal fixation with a precontoured locking compression plate under general or regional anesthesia. A transverse anterior incision over the fracture site was made, preserving the supraclavicular nerve where possible. Fracture fragments were anatomically reduced and fixed with the plate placed superiorly, using at least three screws on either side. C-arm fluoroscopy confirmed fracture reduction and screw length. Wounds were closed in layers, and sterile dressings were applied.

Postoperative Protocol

The operated limb was immobilized in an arm pouch for 3 weeks. Pendulum and gentle range-of-motion exercises were initiated thereafter. Strengthening exercises were added after 6 weeks based on clinical and radiological evidence of union.

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Outcome Measures

Patients were followed at regular intervals up to 6 months. Radiological union was defined by bridging callus formation and the absence of a fracture line. Functional outcome was assessed using the Constant–Murley scoring system at final follow-up.

Bias and Its Management

Potential sources of bias included **selection bias**, since only patients who agreed to undergo surgical fixation were enrolled, and **observer bias** during functional outcome assessment. To minimize bias, consecutive eligible patients were included, standardized surgical and postoperative protocols were followed, and functional outcomes were assessed using a validated scoring system (Constant–Murley score) by an independent assessor not directly involved in the surgery.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS (IBM Corp., Armonk, NY). Continuous variables (e.g., age, union time) were expressed as mean ± standard deviation. Categorical variables (e.g., sex, side involved, type of trauma) were presented as frequencies and percentages. Functional outcomes (Constant–Murley categories) were summarized descriptively.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of Mahatma Gandhi Memorial Hospital, Hyderabad, before the initiation of the study. Written informed consent was obtained from all participants before enrollment, after explaining the nature of the study, surgical procedure, potential risks, and expected benefits. Patient confidentiality was maintained throughout by anonymizing data and restricting access only to the study team.

Results

Participant Recruitment and Flow

During the study period, a total of 36 patients with midshaft clavicle fractures presented to the Orthopaedics Department and were screened for eligibility. Of these:
2 patients had open fractures.
1 patient had a proximal-third clavicle fracture.
1 patient had a pathological fracture.
2 patients declined surgical management and opted for conservative treatment.
Thus, **6 patients were excluded**, and **30 patients met the inclusion criteria** and consented to participate. All 30 underwent open reduction and internal fixation with precontoured locking compression plates and completed six months of follow-up. There were no losses to follow-up (Figure 1).

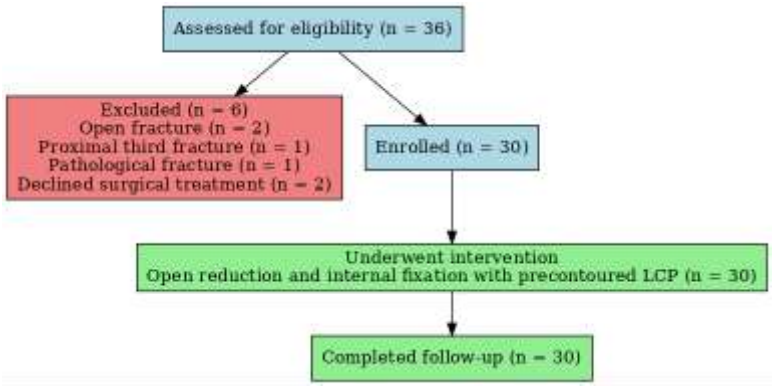

Figure 1. Participant Flow Diagram

A total of 30 patients with displaced midshaft clavicle fractures who underwent open reduction and internal fixation using precontoured locking compression plates were evaluated over a follow-up period of six months. All patients completed the study protocol, and no losses to follow-up were recorded.

Demographic Profile

The age of the patients ranged from 19 to 65 years, with a mean age of approximately 37.4 years. The majority were between 31–40 years (30.0%), followed by 18–30 years (26.7%) and 41–50 years (23.3%). Fewer patients were in

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the 51–60 years (13.3%) and above 60 years (6.7%) categories. Males comprised 73.3% of the study cohort (n=22), and females 26.7% (n=8), yielding a male-to-female ratio of 2.75:1 (Table 1).

Table 1: Demographic Profile of Patients (n = 30)

Parameter	Category	No. of Patients	Percentage (%)
Age Group	18–30 years	8	26.7
	31–40 years	9	30.0
	41–50 years	7	23.3
	51–60 years	4	13.3
	>60 years	2	6.7
Gender	Male	22	73.3
	Female	8	26.7

Injury Characteristics

Road traffic accidents (RTAs) were the predominant cause of injury, accounting for 70.0% (n=21) of cases. Falls constituted 23.3% (n=7), while direct blows to the shoulder were noted in 6.7% (n=2). The right side was affected more often (60.0%) than the left side (40.0%), a difference that was consistent across most age groups (Table 2).

Table 2: Injury Characteristics

Parameter	Category	No. of Patients	Percentage (%)
Nature of Trauma	Road Traffic Accident	21	70.0
	Fall	7	23.3
	Direct Blow	2	6.7
Side Involved	Right	18	60.0
	Left	12	40.0

Union Time and Functional Mobility

Fracture union was achieved in all patients within the follow-up period. The mean time to radiological union was 10.33 ± 1.2 weeks. Most patients achieved union between 11–12 weeks (50.0%), followed by 8–10 weeks (40.0%); only three patients (10.0%) required more than 12 weeks for union (Table 3).

Table 3: Duration for Union and Functional Mobility

Parameter	Category	No. of Patients	Percentage (%)
Union Time	8–10 weeks	12	40.0
	11–12 weeks	15	50.0
	>12 weeks	3	10.0
Mean ± SD	—	10.33 ± 1.2	—
Range of Movements	Full Range	27	90.0
	Mild Restriction	2	6.7
	Moderate Restriction	1	3.3

At six months, 27 patients (90.0%) regained full shoulder range of motion, while two patients (6.7%) had mild restriction and one patient (3.3%) had moderate restriction. Restriction of movement was more often seen in patients with slightly prolonged union times.

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Functional Outcomes

On functional assessment using the Constant–Murley scoring system, 22 patients (73.3%) achieved excellent results, 6 patients (20.0%) had good results, and 1 patient each (3.3%) had fair and poor outcomes (Table 4).

Figure 1. Pre OP X Ray

Figure 2. After three weeks

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Figure 3. After six weeks

Figure 4. Three Months

Table 4: Functional Outcomes (Constant–Murley Score)

Result Category	No. of Patients	Percentage (%)
Excellent	22	73.3
Good	6	20.0
Fair	1	3.3
Poor	1	3.3

Patients with excellent or good outcomes typically demonstrated early union and near-complete ROM recovery, whereas the two patients with suboptimal results had associated soft tissue stiffness and delayed initiation of physiotherapy.

Overall Findings

The integrated summary of key findings is provided in Table 5. Good-to-excellent outcomes were observed in 93.3% of the cohort, highlighting the effectiveness of precontoured locking compression plating in the management of displaced midshaft clavicle fractures. There were no cases of nonunion, implant failure, or deep infection during the follow-up period. Minor complications were limited to transient stiffness, which resolved with physiotherapy. The procedure demonstrated predictable union rates, high functional recovery, and a low complication profile, supporting its role as a reliable fixation method in appropriately selected patients.

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Table 5: Overall Summary of Key Findings

Key Parameter	Finding
Mean age of patients	37.4 years (approx.)
Male: Female ratio	2.75: 1
The most common cause of injury	Road Traffic Accident (70%)
The most common side involved.	Right (60%)
Mean union time	10.33 weeks
Patients achieving full ROM	90%
Good to excellent functional result	93.3% of cases
Complication rate	Very low, no non-union reported

Discussion

Midshaft clavicle fractures in adults are predominantly associated with high-energy trauma, with road traffic accidents representing the leading cause in developing countries where increasing vehicular density and inadequate traffic safety measures contribute to higher incidence rates [6,8]. In the present study, most patients were young to middle-aged males, reflecting a demographic distribution consistent with earlier reports [9,12].

The observation that 70% of fractures were due to road traffic accidents parallels findings from other Indian cohorts and supports the role of high-energy impact as the predominant mechanism [6,8]. The mean union time in this study was 10.33 ± 1.2 weeks, which corresponds to the 10–12 weeks reported for plate fixation in previous studies [6,7]. Importantly, all fractures in this series achieved radiological union, with no cases of nonunion or implant failure, similar to outcomes described in prospective studies [7,8].

Functional recovery was satisfactory in the majority of cases, with 93.3% of patients achieving good-to-excellent results based on the Constant–Murley score. This finding aligns with earlier studies on plate fixation, which consistently demonstrated high functional recovery rates [6–8]. While meta-analyses of randomized controlled trials have suggested that early functional gains following operative treatment may be modest [10], the present study demonstrated that 90% of patients regained full shoulder range of motion within six months, supporting the importance of early mobilization in optimizing functional recovery [8,11].

The complication profile in this cohort was minimal, with transient stiffness observed in 10% of patients, all of which resolved with physiotherapy. No deep infections, hardware failures, or refractures were noted. These findings are consistent with the low complication rates documented in systematic reviews of intramedullary and plate fixation devices [11].

Overall, the results of this study reinforce current evidence that precontoured locking compression plate fixation provides predictable union, excellent functional recovery, and a low complication rate for displaced midshaft clavicle fractures [6–12].

Generalizability

The findings of this prospective observational study, though derived from a single tertiary trauma center, apply to similar populations in developing regions where road traffic accidents are a leading cause of clavicle fractures. Standardized surgical techniques and validated outcome measures enhance external validity for wider clinical practice.

Conclusion

This prospective study demonstrates that open reduction and internal fixation of displaced midshaft clavicle fractures with precontoured locking compression plates achieves excellent functional outcomes, high union rates, and minimal complications. The majority of patients regained full shoulder range of motion within six months, with good-to-excellent Constant–Murley scores in over 93% of cases. The mean union time was 10.33 weeks, and no cases of nonunion or implant failure occurred. The procedure's rigid fixation and anatomical contouring facilitated early mobilization and predictable recovery. Precontoured LCP fixation should be considered the preferred option for active adults with displaced midshaft clavicle fractures to optimize functional restoration and reduce long-term disability.

Strengths and Limitations

Strengths include a clearly defined cohort of displaced midshaft clavicle fractures, uniform inclusion and exclusion criteria, standardized surgical technique using precontoured locking compression plates, and the use of a validated

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functional outcome measure (Constant–Murley score) with consistent follow-up to six months.

Limitations include the relatively small sample size, single-center design, absence of a control group receiving conservative management, and lack of long-term follow-up to assess implant-related issues, refracture risk, or late functional decline.

Recommendations

Early surgical intervention with precontoured LCP fixation should be considered in active adults with displaced midshaft clavicle fractures to optimize anatomical reduction, facilitate early mobilization, and achieve predictable functional recovery. Preoperative counselling should clearly communicate expected timelines for return of function and potential complications. Structured postoperative physiotherapy programs focusing on early passive motion, gradual strengthening, and restoration of full shoulder range of motion are essential to maximize recovery. Regular follow-up with functional assessment using validated tools such as the Constant–Murley score should be incorporated into standard care. Multidisciplinary collaboration between orthopaedic surgeons, physiotherapists, and nursing teams will ensure comprehensive management and improved long-term outcomes.

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Abbreviations

AP – Antero-Posterior
LCP – Locking Compression Plate
ROM – Range of Motion
SD – Standard Deviation
RTA – Road Traffic Accident
PROM – Patient-Reported Outcome Measure
CMC – Constant–Murley Score
ORIF – Open Reduction and Internal Fixation

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

DS-Concept and design of the study, results interpretation, review of literature, and preparation of the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. **TPK**- design of the study, results interpretation, review of literature, preparing the first draft of the manuscript, and revision of the manuscript.

Data availability

Data available on request

Author Biography

Dr. D. Sneha is an Assistant Professor in the Department of Orthopaedics at Mediciti Institute of Medical Sciences, Ghanpur (V), Medchal–Malkajgiri District, Telangana, India (June 2025–present). She earned her MBBS from Gandhi Medical College, Secunderabad (2008–2013) and completed her internship at the same institution (2013–2014). She obtained her MS in Orthopaedics from Kakatiya Medical College, Warangal (2017–2020).

Her professional experience includes senior residencies at Government Medical College, Mahbubnagar (Aug 2020–May 2021), Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar (Apr 2022–Aug 2022), and Osmania General Hospital, Hyderabad (Mar 2024–May 2025). She completed a fellowship in Spine Surgery at Yashoda Hospitals, Somajiguda, Hyderabad (Feb 2023–Jan 2024).

Her expertise spans musculoskeletal disorders, trauma care, spine surgery, and joint reconstruction. She is actively engaged in research on arthroplasty outcomes, fracture management, and orthopaedic innovations, and is dedicated to evidence-based practice, patient-centered care, and mentoring future orthopaedic surgeons. **ORCID ID:** https://orcid.org/0009-0004-2166-0670

Dr.Thatipamula Praful Kumar, MBBS, DNB ORTHOPAEDICS, is a highly talented orthopedic surgeon with over 5 years of clinical experience and commitment to medical education. He began his academic career as a senior resident in the Department of Orthopaedics at MNR Medical College, Sangareddy, serving from 2020 to 2021. He was promoted as Assistant Professor in 2021, where he played a key role in training undergraduate and postgraduate students till 2023. Since 2023 to date, he has been working as an assistant professor in Mediciti Medical College, Ghanpur, Medchal, where he continues to mentor future orthopedic surgeons with dedication and insight. Dr.T.Praful Kumar is

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renowned for his exceptional surgical skills, encompassing complex trauma fixation, joint replacement, arthroscopic procedures & deformity correction, soft tissue repair and reconstructions, all performed with meticulous precision and an evidence-based approach.

He has authored several publications in reputed peer-reviewed journals, with his research Articles Indexed in leading international databases such as Directory of Open Access Journals (DOAJ), reflecting the scientific rigor, credibility, and impact of his scholarly work in advancing the field of orthopaedics. Highly regarded for his clear, methodical teaching style and his ability to instill both confidence and competence in his trainees, Dr.T.Praful Kumar embodies professionalism, integrity, and excellence in every facet of his clinical and academic endeavours.

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