

# Functional Outcome of Intramedullary Tens and Plate Osteosynthesis for Mid Shaft Fractures of Clavicle

Dr. Arun K N<sup>1</sup>, Dr. Alawaddin A<sup>2</sup>, Dr. Prashanth Kumar M<sup>3</sup>

<sup>1</sup>Professor and Medical Superintendent, Dept. of Orthopaedics, Navodaya Medical College & Research Centre, Raichur, Karnataka, India, 584103

<sup>2</sup>Post Graduate, Dept. of Orthopaedics, Navodaya Medical College & Research Centre, Raichur, Karnataka, India, 584103

<sup>3</sup>Assistant Professor, Dept. of Orthopaedics, Navodaya Medical College & Research Centre, Raichur, Karnataka, India, 584103

**Abstract:** ***Objectives:** The present study aimed to compare intramedullary fixation using Titanium Elastic Nail System (TENS) with plate osteosynthesis in the management of displaced midshaft clavicle fractures. The objectives were to evaluate and compare demographic characteristics, fracture patterns, time to clinical and radiological union, complication rates, and functional outcomes using the Constant–Murley shoulder score. **Materials and Methods:** Over a period of 18 months, a total of 38 adult patients with displaced midshaft clavicle fractures classified as Robinson type 2B1 and 2B2 were included. Patients were randomly allocated into two equal groups: Group A (n=19) treated with open reduction and internal fixation using pre-contoured locking compression plates, and Group B (n=19) treated with intramedullary fixation using Titanium Elastic Nails. Functional outcomes were evaluated using the Constant–Murley score at 6 weeks, 3 months, and 6 months. **Results:** Closed reduction was achieved in a significantly higher proportion of cases in the TENS group, whereas all plating cases required open reduction. Clinical union occurred significantly earlier in the TENS group compared to the plating group, as did radiological union. **Conclusion:** Both plate osteosynthesis and intramedullary fixation using TENS are effective and safe methods for the management of displaced midshaft clavicle fractures. However, TENS offers advantages in terms of minimally invasive surgery, earlier clinical and radiological union, and superior functional outcomes at six months. Plate fixation remains valuable in cases requiring rigid stability, particularly in comminuted fractures.*

**Keywords:** Clavicle fracture; Titanium elastic nail system; Plate osteosynthesis; Midshaft clavicle fracture; Constant–Murley score; Intramedullary fixation

## 1. Introduction

Clavicle fractures are common injuries of the shoulder girdle, with displaced midshaft fractures accounting for the majority in active adults. Traditionally treated conservatively, recent evidence indicates higher rates of non-union, mal-union, and functional impairment with non-operative management in displaced fractures. Operative fixation has therefore gained prominence, with plate osteosynthesis and intramedullary fixation using Titanium Elastic Nails (TENS) being the most widely used surgical options. Each technique has distinct biomechanical and biological advantages, and comparative evidence is required to guide optimal treatment selection.

## 2. Materials & Methods

**Study Design:** Prospective, randomized, comparative clinical study.

**Study Setting:** Department of Orthopaedics, Navodaya Medical College Hospital & Research Centre, Raichur, Karnataka.

**Study Duration:** 18 months (March 2024 – August 2025)

**Sample Size :** 38 patients (19 in each group)

**Grouping:** Group A (n=19): Open Reduction & Internal Fixation with pre-contoured locking compression plate

(superior placement)

Group B (n=19): Closed / Mini-open Reduction & Internal Fixation with Titanium Elastic Nail System (TENS)

### Inclusion Criteria

- 1) Age  $\geq$  18 years (skeletally mature)
- 2) Closed, displaced midshaft clavicle fracture (Robinson Type 2B1 or 2B2)
- 3) Injury < 14 days old
- 4) Displacement  $\geq$  100% or shortening  $\geq$  15–20 mm or skin tenting threatening skin integrity
- 5) Patient willing for surgical management and regular follow-up.

### Exclusion Criteria

- 1) Proximal third or distal third fractures
- 2) Open fractures (Gustilo-Anderson any grade)
- 3) Floating shoulder (ipsilateral scapula neck + clavicle fracture)
- 4) Pathological fractures
- 5) Associated neurovascular injury (brachial plexus/subclavian vessel)
- 6) Active infection / immunocompromised state.

## 3. Surgical Technique

**Group A – Open Reduction and Internal Fixation with Pre-contoured Locking Plate**

**Position:** Supine with a sandbag/radiolucent wedge

Volume 15 Issue 2, February 2026

Fully Refereed | Open Access | Double Blind Peer Reviewed Journal

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between scapulae to elevate and protract the shoulder. Head turned to contralateral side. **Anaesthesia:** General anaesthesia ± ultrasound-guided interscalene/supraclavicular block.

**Approach:** 6–9 cm longitudinal incision along the superior surface of the clavicle, centred over the fracture (in Langer's lines for better cosmesis).

**Exposure:** Skin → platysma → minimal subperiosteal dissection only at fracture ends to preserve biology. Supraclavicular nerves identified and protected.

**Reduction:** Direct visualisation, pointed reduction clamps (Weber or lobster), temporary K-wires if needed.

**Fixation:** – 3.5 mm pre-contoured low-profile locking compression plate (stainless steel or titanium) placed on the superior surface.

### Group B – Titanium Elastic Nail System (TENS) – Closed / Mini-open Reduction

**Position:** Beach-chair (preferred) or supine with folded sheet under ipsilateral shoulder. **Anaesthesia:** General anaesthesia ± interscalene block.

**Approach:** 1.5–2 cm longitudinal incision over the medial clavicle, 1.5–2 cm lateral to the sternoclavicular joint (anterior cortex).

**Entry point:** Created with T-handle awl at an angle of 30–45° to the bone, directed laterally.

**Nail selection:** 2.5–3.5 mm pre-bent titanium elastic nail (gentle curve matching clavicular S-shape).

**Insertion:** – Nail mounted on T-handle, introduced antegrade with oscillating movements. – Advanced under C-arm guidance to the fracture site. Nail passed across fracture into lateral fragment, stopping 5–10 mm short of the acromioclavicular joint to avoid penetration. **Final positioning:** Medial nail end cut flush with bone or left 8–10 mm proud and capped (end-cap prevents soft-tissue irritation and migration).



Figure 1: Intra-op plate placement



Figure 2: Intra-op IITV view after plate fixation



Figure 3: TENS nail introduced into the bone with the help of T handle



Figure 4: Intra-op IITV view after TENS insertion.



Figure 5: Pre-Op Xray

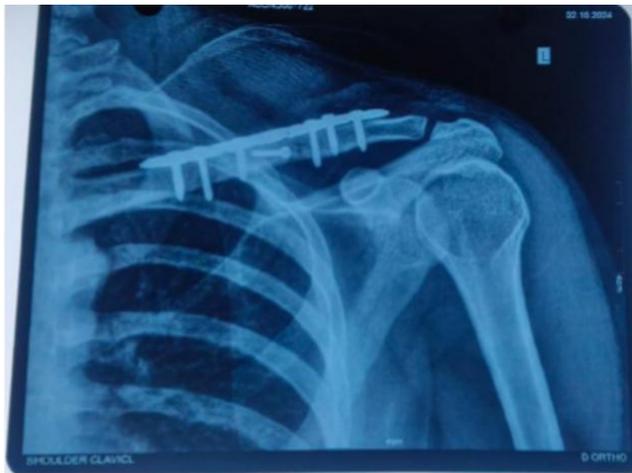


Figure 6: Post-Op Xray Plating



Figure 7: Post-Op Xray TENS

#### 4. Results

Table 1: Distribution of cases according to clinical union in weeks between groups.

		Group I (Plating)		Group II (TENS)		Total		Chi- Square Value	P Value
		No.	%	No.	%	No.	%		
Clinical Union in Weeks	5- 7 Weeks	0	0.0	11	57.9	11	28.9	15.486	0.000< 0.0001
	8- 10 Weeks	14	73.7	6	31.6	20	52.6		
	>10 Weeks	5	26.3	2	10.5	7	18.4		
Total		19	100	19	100	38	100		

Table 2: Distribution of cases according to radiological union in weeks between groups

		Group I (Plating)		Group II (Tens)		Total		Chi- Square Value	P Value
		No.	%	No.	%	No.	%		
Radiological Union in Weeks	8- 10 Weeks	5	26.3	16	84.2	21	55.3	13.448	0.000< 0.0001
	11- 13 Weeks	9	47.4	1	5.3	10	26.3		
	>13 Weeks	5	26.3	2	10.5	7	18.4		
Total		19	100	19	100	38	100		

(p=0.141), a trend attributable to higher exposure to road traffic accidents and sports in males, and this is mirrored in multiple recent reports, including Oar et al. (2025)<sup>[1]</sup> with

70-80% males evenly distributed, and Lu et al. (2023)<sup>[4]</sup> reporting approximately 78% males without influencing treatment comparisons.

Table 3: Comparison of Constant-Murley scores between the groups at 6 months

		Group I (Plating)		Group II (TENS)		Total		Chi- Square Value	P Value
		No.	%	No.	%	No.	%		
Constant Murely Score At 6 months	60- 70	2	10.5	0	0.0	2	5.3	7.509	0.057> 0.05
	70- 80	3	15.8	1	5.3	4	10.5		
	80- 90	7	36.8	3	15.8	10	26.3		
	>=90	7	36.8	15	78.9	22	57.9		
Total		19	100	19	100	38	100		

#### 5. Discussion

The management of displaced midshaft clavicle fractures has undergone a significant paradigm shift in recent years, moving away from predominantly nonoperative approaches toward surgical fixation, particularly for Robinson types 2B1 and 2B2 fractures, which are prone to non-union and malunion when treated conservatively. With no significant differences in age distribution (mean 34.84 years in plating versus 31.42 years in TENS, p=0.244), the cohorts predominantly comprised young adults in their third and fourth decades, a pattern reflective of the high-energy trauma mechanisms typically responsible for these injuries. This age profile is consistently observed across contemporary literature; for instance, a 2025 meta-analysis by Oar et al (2025)<sup>[1]</sup> encompassing over 450 patients reported similar mean ages ranging from 32 to 35 years

without intergroup disparities, underscoring the demographic consistency in modern trials focused on active populations.

Likewise, Bindal et al. (2025)<sup>[2]</sup> systematic review described mean ages around 33 years in both fixation arms, aligning closely with our findings and suggesting that younger patients may particularly benefit from minimally invasive techniques due to robust healing potential. In contrast, some deviations appear in studies like Zahid et al. (2024)<sup>[3]</sup> where plating groups tended toward slightly older patients (mean 38 years versus 34 years for nailing), possibly introducing subtle biases related to bone quality, though not statistically impactful on overall results.

Gender distribution in our study showed a clear male predominance (73.7% overall), with 84.2% males in the

plating group and 63.2% in TENS

A striking difference in our study was the reduction technique, with closed reduction internal fixation (CRIF) utilized in 73.7% of TENS cases versus 0% in plating, and open reduction internal fixation (ORIF) in 100% plating versus 26.3% TENS ( $p < 0.001$ ), emphasizing the minimally invasive hallmark of intramedullary nailing. This aligns with Bindal et al. (2025)<sup>[2]</sup> who documented significantly shorter operative times (mean difference -22 minutes) and reduced blood loss for intramedullary methods. Deviations occur in Fuglesang et al. (2017)<sup>[5]</sup>, where more open reductions were required for elastic nailing in comminuted fractures, akin to our plating dominance but reversed for TENS benefits.

Union times represented one of the most pronounced advantages for TENS in the present study, with clinical union achieved at a mean of 7.42 weeks versus 9.68 weeks for plating ( $p < 0.001$ ), including 57.9% uniting in 5-7 weeks for TENS compared to none in plating, and radiological union at 9.58 weeks versus 12.21 weeks ( $p < 0.001$ ), with 84.2% in 8-10 weeks for TENS versus 26.3% for plating. Hussain et al. (2016)<sup>[6]</sup> meta-analysis also leaned toward faster union with intramedullary approaches. Complication profiles remained low and statistically comparable ( $p = 0.308$ ), with delayed union higher in plating (15.8% versus 5.3% in TENS), alongside 106 scattered instances of implant failure, migration, irritation, and infection. Functional outcomes, assessed via Constant-Murley scores, further underscored TENS superiority at 6 months, with means of 92.58 versus 86.00 for plating ( $p = 0.013$ ), and 78.9% excellent grades in TENS versus 31.6% in plating ( $p = 0.030$ ), though early assessments at 6 weeks and 3 months showed no differences.

Overall, the present study's findings position TENS as the preferable option for displaced midshaft clavicle fractures in adults, offering faster union, better 6-month function, and equivalent safety, particularly when closed reduction is feasible. These results harmonize with recent meta-analyses advocating intramedullary benefits in operative efficiency and healing speed (Bindal et al. 2025<sup>[2]</sup>; Lu et al. 2023)<sup>[4]</sup>, while diverging from studies emphasizing plating rigidity in highly comminuted scenarios (Fuglesang et al. 2017)<sup>[5]</sup>.

Nonetheless, both techniques markedly surpass nonoperative management in active adults, facilitating earlier return to work and sport while minimizing malunion and symptomatic non-union risks.

## 6. Conclusion

The present prospective comparative study evaluating surgical management of displaced midshaft clavicle fractures (Robinson types 2B1 and 2B2) in 38 adult patients offers clear insights into the relative merits of plate fixation versus Titanium Elastic Nail System (TENS) intramedullary nailing. The two groups were demographically balanced, showing no significant differences in age, gender distribution, affected side, mode of injury, fracture classification, or time from injury to surgery, which strengthens the validity of outcome

comparisons.

TENS demonstrated distinct advantages in healing timelines, with clinical union achieved at a mean of 7.42 weeks compared to 9.68 weeks for plating, and radiological union at 9.58 weeks versus 12.21 weeks. Notably, over half the TENS cases achieved clinical union within 5-7 weeks, while none in the plating group did so early. Functional recovery at 6 months further favored TENS, reflected in higher Constant-Murley scores (mean 92.58 versus 86.00) and a significantly greater proportion of excellent outcomes (78.9% versus 31.6%).

In conclusion, TENS emerges as the preferred option for most displaced midshaft clavicle fractures in adults, providing faster union, better functional recovery at 6 months, and equivalent safety compared to plating. This supports prioritizing minimally invasive intramedullary techniques to optimize healing and cosmesis, especially in younger, active patients. Plating should be reserved for complex cases demanding rigid fixation. Despite limitations such as small sample size and short-term follow-up, these findings reinforce operative intervention as superior to conservative management for displaced fractures, markedly reducing risks of mal-union and non-union while enhancing quality of life.

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