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Original Article

Evaluation of Intramedullary Nailing Versus Plating in the Management of Displaced Midshaft Clavicle Fractures: A Prospective Randomized Comparative Study

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ABSTRACT

Background: Midshaft clavicle fractures account for nearly 70–80% of all clavicle injuries. While non-operative treatment was historically favored, displaced fractures have high nonunion and malunion rates. Surgical fixation has therefore become standard for many cases, with plating and intramedullary (IM) nailing as the two main techniques. Debate persists regarding the optimal approach, particularly in terms of union, function, complications, and cosmesis.

Objective: To compare the clinical, radiological, and functional outcomes of intramedullary nailing versus plating in displaced midshaft clavicle fractures.

Methods: A prospective randomized comparative study was conducted from September 2022 to August 2024 at SMMH Medical College, Saharanpur, India. Sixty patients (aged 18–60 years) with Robinson type 2B1/2B2 displaced midshaft clavicle fractures were randomized to receive either plating (Group A, n = 30) or IM nailing (Group B, n = 30). Operative time, blood loss, incision length, union time, Constant-Murley and DASH scores, complications, and cosmetic satisfaction (Likert scale) were assessed. Statistical analysis was performed using SPSS v26, with $p < 0.05$ considered significant.

Results: Baseline demographics were comparable between groups. IM nailing showed significantly shorter operative time (52.6 ± 8.7 vs 84.3 ± 11.2 min, $p < 0.001$), less blood loss (72.3 ± 18.6 vs 145.8 ± 32.5 ml, $p < 0.001$), and smaller incision length (2.5 ± 0.6 vs 8.6 ± 1.2 cm, $p < 0.001$). Mean union time was earlier with nailing (13.4 ± 2.6 vs 16.2 ± 3.1 weeks, $p = 0.002$). At 3 months, Constant (82.3 vs 75.8, $p = 0.004$) and DASH (18.7 vs 24.6, $p = 0.006$) scores favored nailing; by 6 months, both groups achieved excellent and comparable outcomes. Complication rates differed: plating showed more infections (6.6%) and implant prominence (10%), while nailing had nail migration (3.3%) and skin irritation (6.6%). Cosmetic satisfaction was significantly higher in the nailing group (mean 4.6 ± 0.5 vs 3.8 ± 0.7, $p < 0.001$).

Conclusion: Both plating and IM nailing achieved 100% union and excellent 6-month functional outcomes. However, intramedullary fixation demonstrated advantages in surgical morbidity, early recovery, cosmesis, and patient satisfaction, making it a favorable option for displaced midshaft clavicle fractures in young, active patients.

Keywords: *Midshaft clavicle fracture; Displaced clavicle fracture; Intramedullary nailing*

INTRODUCTION

Clavicle fractures are among the most common injuries of the shoulder girdle, accounting for nearly **2.6–5% of all adult fractures** and up to **44% of injuries to the shoulder girdle**【12,20】. Of these, **midshaft fractures constitute approximately 70–80%**, owing to the bone's natural S-shape, subcutaneous location, and the transmission of axial and

transverse loads through the shoulder【12,17】. These injuries typically occur in young, active individuals following high-energy trauma such as road traffic accidents or sports injuries, but may also affect older adults due to falls. Traditionally, the majority of midshaft clavicle fractures were managed **non-operatively** using slings or figure-of-eight bandages, under the assumption that the clavicle's rich vascular supply conferred high union rates. Early studies suggested satisfactory outcomes with conservative treatment, reinforcing its widespread adoption【12】.

However, more recent prospective studies and systematic reviews have challenged this conventional wisdom. Evidence indicates that **displaced or comminuted midshaft clavicle fractures** treated conservatively are associated with **higher nonunion rates (up to 15–20%)**, symptomatic malunions, shoulder dysfunction, and unsatisfactory cosmetic outcomes【12,19,20.Robinson et al. reported that fracture displacement, comminution, and shortening >2 cm are strong predictors of nonunion【20】. Moreover, younger, high-demand patients often experience significant deficits in strength and endurance after malunion, further justifying the reconsideration of surgical management【12,17】. These findings have led to a paradigm shift in the last two decades, with surgical fixation becoming increasingly accepted, particularly for displaced and shortened fractures.

Among surgical techniques, **open reduction and internal fixation with plates** and **intramedullary fixation devices** have emerged as the two most widely practiced options. **Plating**, especially with pre-contoured locking compression plates, provides rigid fixation, anatomical reduction, and immediate stability, facilitating early mobilization【5,9,10】. However, it is not without disadvantages. Plating requires extensive soft tissue dissection, periosteal stripping, and longer operative times, which may compromise fracture biology. Reported complications include infection, hardware prominence or irritation, implant failure, refracture after implant removal, and relatively high reoperation rates【5,10,12】.

Intramedullary (IM) fixation, on the other hand, offers a minimally invasive alternative. Devices such as elastic stable intramedullary nails, titanium elastic nails, Knowles pins, and more recently, locked intramedullary nails, are designed to preserve soft tissues, reduce operative time, minimize blood loss, and provide cosmetically superior outcomes【1,3,16,18】. The biological fixation achieved with IM nails allows micromotion at the fracture site, promoting callus formation, and the smaller incision reduces scarring. Patients often report less postoperative discomfort and faster recovery of function. However, IM fixation is technically demanding, and complications such as implant migration, skin irritation, and difficulty in achieving rotational stability have been described【3,7,16】.

Multiple **randomized controlled trials (RCTs), meta-analyses, and systematic reviews** have attempted to compare the efficacy of these two surgical strategies. Zhao et al. in their meta-analysis of randomized and quasi-randomized trials demonstrated that IM fixation was associated with shorter operative time, less intraoperative blood loss, faster union, and lower overall complication rates compared with plating【1】. Similarly, Lu et al. showed that IM fixation led to smaller incisions, shorter hospital stays, and lower infection rates, while long-term functional outcomes were comparable to plating【4】. Hussain et al., in a comprehensive review including both RCTs and observational studies, concluded that while long-term functional scores such as Constant and DASH did not differ significantly, IM fixation carried advantages in early recovery and cosmesis【2】. Houwert et al. further supported the notion that both techniques achieve satisfactory union, but plating has a higher risk of complications requiring secondary surgery【10】. On the contrary, some studies such as Barlow et al. and Ferran et al. have argued that plating provides more rigid fixation and reduces the risk of rotational deformity, suggesting that choice of technique may depend on fracture morphology and surgeon experience【8,18】. Thus, while the existing literature points toward a trend favoring intramedullary fixation for certain displaced fractures, definitive superiority remains debated【13,14,15】.

In India, where clavicle fractures constitute a significant proportion of orthopedic trauma due to high road traffic accident rates, the debate between plating and intramedullary fixation holds particular clinical relevance. Cost-effectiveness, availability of implants, surgeon expertise, and patient expectations regarding cosmesis and return to work are important determinants of treatment choice. Despite the growing body of international literature, **data from Indian centers directly comparing these techniques remain limited**, especially in the form of prospective controlled studies. Additionally, few studies have simultaneously evaluated clinical outcomes, radiological union, complications, and quality-of-life parameters in a single cohort.

Against this background, the present study was undertaken to **evaluate and compare the clinical and radiological outcomes of intramedullary nailing versus plating in midshaft clavicle fractures**. We hypothesize that intramedullary fixation, owing to its minimally invasive nature, will demonstrate comparable or superior union rates, lower complication rates, faster recovery, and better cosmetic and functional outcomes compared to plating. The study also aims to contribute region-specific data that may guide orthopedic practice in India.

MATERIALS AND METHODS

Study Design and Setting

This was a **prospective, comparative, interventional study** conducted in the **Department of Orthopaedics, SMMH Medical College, Saharanpur, Uttar Pradesh, India**. The study period extended from **September 2022 to August 2024**. Ethical clearance was obtained from the **Institutional Ethics Committee**, and all patients provided **written informed consent** prior to enrollment.

Study Population

Inclusion Criteria

1. Patients aged **18–60 years**.
2. Displaced midshaft clavicle fractures (Robinson type 2B1 and 2B2).
3. Closed fractures presenting within **2 weeks of injury**.
4. Patients willing to undergo surgery and provide informed consent.

Exclusion Criteria

1. Open clavicle fractures.
2. Pathological fractures.
3. Associated neurovascular injury.
4. Polytrauma patients with life-threatening injuries.
5. Non-displaced or minimally displaced fractures suitable for conservative management.
6. Patients unfit for anesthesia or declining surgical intervention.

Sample Size and Allocation

A total of **60 patients** fulfilling the eligibility criteria were enrolled and **randomly allocated into two groups** using a computer-generated randomization sequence:

- **Group A (n = 30):** Treated with **open reduction and plate fixation** (pre-contoured locking compression plate).
- **Group B (n = 30):** Treated with **intramedullary fixation** (elastic stable intramedullary nail or titanium elastic nail).

Randomization was concealed using **sealed opaque envelopes**, and allocation was performed by an independent coordinator.

Surgical Techniques

Plating (Group A)

- Patients were positioned supine with a small sandbag between the scapulae.
- A **transverse or slightly curved incision** was made over the fracture site.
- The fracture was exposed with careful soft tissue handling, and **anatomical reduction** was achieved.
- Fixation was done using a **3.5 mm pre-contoured locking compression plate** or reconstruction plate, with at least three screws on either side of the fracture.
- Wound was closed in layers over a suction drain.

Intramedullary Nailing (Group B)

- Patients were positioned supine on a radiolucent table.
- A **small incision** was made near the lateral end of the clavicle.
- After entry point creation, a **flexible titanium elastic nail** (TEN) of appropriate size was introduced into the medullary canal under fluoroscopic guidance.
- The fracture was reduced closed (or with minimal open reduction if required), and the nail was advanced across the fracture site.
- Proximal end of the nail was bent and buried under the skin to reduce prominence.

Postoperative Protocol

- Both groups were immobilized with an arm pouch sling for **2–3 weeks**.
- **Early pendulum exercises** were initiated after 1 week, followed by gradual range-of-motion exercises.
- Strengthening exercises were started after clinical signs of union, usually by **6–8 weeks**.
- Patients were followed up at **2 weeks, 6 weeks, 12 weeks, and 6 months** postoperatively.

Outcome Measures

1. **Primary Outcome:**
   - **Time to radiological union**, assessed by serial X-rays (defined as bridging callus across at least three cortices).
2. **Secondary Outcomes:**
   - **Functional outcome** assessed using **Constant-Murley Shoulder Score** and **Disabilities of Arm, Shoulder and Hand (DASH) score** at 3 and 6 months.

- **Intraoperative parameters:** operative time, blood loss, incision length.
- **Postoperative complications:** infection, implant prominence, implant failure, delayed/non-union, reoperation rate.
- **Cosmetic satisfaction**, assessed subjectively by patients on a 5-point Likert scale.

Statistical Analysis

Data were analyzed using **SPSS software version 26.0 (IBM Corp., USA)**. Continuous variables (age, operative time, blood loss, union time, scores) were expressed as **mean ± standard deviation (SD)** and compared using the **Independent t-test**. Categorical variables (complications, union rates, satisfaction) were expressed as **frequency and percentage** and compared using the **Chi-square test or Fisher's exact test**. A **p-value < 0.05** was considered statistically significant.

Ethical Considerations

The study was conducted in compliance with the **Declaration of Helsinki (2013 revision)**. Approval was obtained from the **Institutional Ethics Committee of SMMH Medical College, Saharanpur**. All participants provided **written informed consent**, and patient confidentiality was maintained throughout the study.

RESULTS

A total of **60 patients** with displaced midshaft clavicle fractures were enrolled and randomized, with **30 patients assigned to plating (Group A)** and **30 to intramedullary nailing (Group B)**. All patients completed the minimum **6-month follow-up**. The **mean age** of patients in the plating group was **35.2 ± 9.6 years** (range 18–58), while in the nailing group it was **33.9 ± 8.8 years** (range 19–56). The age distribution was not statistically different between groups (**p = 0.58**). The overall study cohort showed a male predominance. In Group A, there were **22 males (73.3%) and 8 females (26.7%)**, giving a male:female ratio of 2.75:1, whereas in Group B there were **21 males (70.0%) and 9 females (30.0%)**, ratio 2.33:1. The sex distribution difference was not significant (**p = 0.77**). With regard to side of injury, **18 right-sided (60.0%) and 12 left-sided (40.0%)** fractures occurred in the plating group, while the nailing group had **16 right-sided (53.3%) and 14 left-sided (46.7%)** fractures (**p = 0.61**). The mechanism of trauma was comparable between groups: in the plating group **20 patients (66.7%) sustained road traffic accidents** and **10 (33.3%) sustained falls**, while in the nailing group **19 (63.3%) were RTAs** and **11 (36.7%) were falls** (**p = 0.79**). Fracture classification according to Robinson's system showed **17 cases (56.7%) of type 2B1 and 13 cases (43.3%) of type 2B2** in Group A, compared with **18 cases (60.0%) of 2B1 and 12 cases (40.0%) of 2B2** in Group B (**p = 0.81**). Thus, baseline demographic and clinical characteristics were comparable between the two cohorts.

Intraoperative findings revealed significant differences. The **mean operative time** in the plating group was **84.3 ± 11.2 minutes**, compared to **52.6 ± 8.7 minutes** in the nailing group, a highly significant reduction (**p < 0.001**). The **mean intraoperative blood loss** was also greater in Group A, measured at **145.8 ± 32.5 ml**, while Group B recorded a mean of **72.3 ± 18.6 ml**, again highly significant (**p < 0.001**). In terms of incision size, plating required a **mean length of 8.6 ± 1.2 cm**, whereas the nailing technique used a minimal entry incision averaging **2.5 ± 0.6 cm** (**p < 0.001**). These findings demonstrated that intramedullary fixation was less invasive, quicker, and associated with markedly lower intraoperative morbidity.

Fracture healing was assessed radiologically. The **mean time to union** in Group A was **16.2 ± 3.1 weeks**, while in Group B it was **13.4 ± 2.6 weeks**, showing a statistically significant earlier union with nailing (**p = 0.002**). By 6 months, **100% of fractures in both groups had united**, with no cases of nonunion. Thus, both techniques were effective in achieving union, but intramedullary fixation allowed consolidation on average **2.8 weeks earlier** than plating.

Functional outcomes, evaluated with the **Constant-Murley Shoulder Score** and **Disabilities of Arm, Shoulder and Hand (DASH) Score**, revealed interesting patterns. At the **3-month follow-up**, the plating group had a mean Constant score of **75.8 ± 7.4**, while the nailing group scored **82.3 ± 6.8**, a significant difference favoring nailing (**p = 0.004**). By **6 months**, the mean Constant score improved to **92.1 ± 5.2** in Group A and **94.5 ± 4.8** in Group B, but the difference was no longer significant (**p = 0.11**). Similarly, DASH scores at **3 months** were **24.6 ± 6.3** in the plating cohort versus **18.7 ± 5.9** in the nailing cohort (**p = 0.006**), again favoring intramedullary fixation in the early phase. At **6 months**, DASH scores were **6.8 ± 2.5** for plating and **5.9 ± 2.2** for nailing, which was not statistically significant (**p = 0.17**). These results showed that intramedullary fixation led to faster functional recovery in the first three months, but by six months both groups reached similarly excellent outcomes.

The pattern of complications differed between groups. In the plating group, **2 patients (6.6%) developed superficial infections**, which were managed with oral antibiotics and dressings without requiring implant removal. **Three patients (10.0%) complained of implant prominence** at the plate site, of which 2 elected for removal after fracture union. **One patient (3.3%) developed a hypertrophic scar** over the incision. In contrast, no cases of deep infection, implant breakage, or delayed union were observed. In the nailing group, there were **no infections**. However, **1 patient (3.3%) experienced nail migration**, which required minor revision, and **2 patients (6.6%) had skin irritation at the nail entry site**, which resolved after implant removal. No cases of nonunion or implant failure were observed in either group. Thus,

plating was associated more with implant prominence and infection, while nailing carried risks of migration and entry site irritation.

Patient-reported cosmetic satisfaction, assessed on a **five-point Likert scale** (1 = poor, 5 = excellent), showed clear differences. In Group A (plating), the mean cosmetic satisfaction score was **3.8 ± 0.7**, with most patients rating their outcome as "good" but expressing dissatisfaction with scar length or implant prominence. In Group B (nailing), the mean score was **4.6 ± 0.5**, with the majority of patients rating their outcome as "excellent," largely due to the smaller scar and less visible hardware. The difference was statistically significant (**$p < 0.001$**).

In terms of return to work and daily activities, patients in the nailing group resumed light activities on average by **4–6 weeks** postoperatively, while those in the plating group typically resumed by **6–8 weeks**. Return to full, unrestricted activity occurred around **12–13 weeks** in the nailing group versus **16–18 weeks** in the plating group. This faster recovery trajectory in the nailing cohort correlated with earlier radiological union and superior early functional scores.

In summary, the study revealed several key findings. Both techniques achieved a **100% union rate at 6 months**, confirming their reliability. However, intramedullary nailing demonstrated several advantages: **shorter operative time (52.6 vs 84.3 minutes)**, **less blood loss (72.3 ml vs 145.8 ml)**, **smaller incision (2.5 cm vs 8.6 cm)**, **earlier union (13.4 vs 16.2 weeks)**, **better functional outcomes at 3 months (Constant 82.3 vs 75.8; DASH 18.7 vs 24.6)**, and **higher cosmetic satisfaction (4.6 vs 3.8 on Likert scale)**. At 6 months, functional results were comparable, with both groups reaching excellent Constant scores above 90 and low DASH scores below 7. Complication profiles differed, with plating showing more infection and implant prominence, while nailing was associated with nail migration and skin irritation, but both sets of complications were minor and manageable.

Thus, the overall evidence from this study suggests that intramedullary nailing provides a **biologically friendly, cosmetically superior, and functionally advantageous option**, particularly in the early phase of recovery, while plating remains a **stable and reliable method** with equally good long-term outcomes.

The baseline characteristics of the two groups were comparable (Table 1), with no statistically significant differences in age (35.2 ± 9.6 years for plating vs 33.9 ± 8.8 years for nailing, $p = 0.58$), sex distribution (male:female ratio 2.75:1 vs 2.33:1, $p = 0.77$), side of involvement (right:left 18:12 vs 16:14, $p = 0.61$), mode of injury (RTA:fall 20:10 vs 19:11, $p = 0.79$), or fracture type (2B1:2B2 17:13 vs 18:12, $p = 0.81$). Intraoperative findings (Table 2) clearly favored intramedullary nailing, which required significantly shorter operative time (52.6 ± 8.7 min vs 84.3 ± 11.2 min, $p < 0.001$), less blood loss (72.3 ± 18.6 ml vs 145.8 ± 32.5 ml, $p < 0.001$), and smaller incisions (2.5 ± 0.6 cm vs 8.6 ± 1.2 cm, $p < 0.001$). Union analysis (Table 3 and Figure 1) showed that all fractures united by 6 months in both groups, but the mean time to union was significantly shorter with nailing (13.4 ± 2.6 weeks vs 16.2 ± 3.1 weeks, $p = 0.002$). Functional outcome assessment with Constant-Murley scores (Table 4 and Figure 2) demonstrated better recovery at 3 months with nailing (82.3 ± 6.8 vs 75.8 ± 7.4, $p = 0.004$), although by 6 months both groups achieved excellent, comparable outcomes (94.5 ± 4.8 vs 92.1 ± 5.2, $p = 0.11$). DASH scores (Table 5) showed a similar pattern, with superior early results for nailing at 3 months (18.7 ± 5.9 vs 24.6 ± 6.3, $p = 0.006$), but no significant difference at 6 months (5.9 ± 2.2 vs 6.8 ± 2.5, $p = 0.17$). Complication profiles (Table 6 and Figure 3) differed: plating was associated with superficial infection in 2 patients (6.6%), implant prominence in 3 (10%), and hypertrophic scar in 1 (3.3%), while nailing had no infections but showed nail migration in 1 patient (3.3%) and entry site irritation in 2 (6.6%). Cosmetic satisfaction (Table 7) was significantly higher in the nailing group (mean 4.6 ± 0.5 vs 3.8 ± 0.7, $p < 0.001$), with 60% of nailing patients rating their result "excellent" compared to only 26.7% in the plating group. Together, these results show that while both plating and nailing achieve 100% union and excellent 6-month function, intramedullary nailing offers significant perioperative advantages, faster union, better early function, fewer wound-related complications, and superior cosmetic satisfaction.

Table 1. Baseline Characteristics of Patients (n = 60)

Variable	Plating (n = 30)	Nailing (n = 30)	p-value
Mean Age (years)	35.2 ± 9.6	33.9 ± 8.8	0.58
Sex (M : F)	22 : 8	21 : 9	0.77
Side (Right : Left)	18 : 12	16 : 14	0.61
Mode of Injury (RTA : Fall)	20 : 10	19 : 11	0.79
Robinson Type (2B1 : 2B2)	17 : 13	18 : 12	0.81

Table 2. Intraoperative Parameters

Parameter	Plating (n = 30)	Nailing (n = 30)	p-value
Operative time (min)	84.3 ± 11.2	52.6 ± 8.7	<0.001
Blood loss (ml)	145.8 ± 32.5	72.3 ± 18.6	<0.001
Incision length (cm)	8.6 ± 1.2	2.5 ± 0.6	<0.001

Table 3. Fracture Union

Variable	Plating (n = 30)	Nailing (n = 30)	p-value
Mean time to union (weeks)	16.2 ± 3.1	13.4 ± 2.6	0.002
Union at 6 months	30 (100%)	30 (100%)	—

Table 4. Functional Outcomes (Constant-Murley Score)

Follow-up	Plating (n = 30)	Nailing (n = 30)	p-value
3 months	75.8 ± 7.4	82.3 ± 6.8	0.004
6 months	92.1 ± 5.2	94.5 ± 4.8	0.11

Table 5. Functional Outcomes (DASH Score)

Follow-up	Plating (n = 30)	Nailing (n = 30)	p-value
3 months	24.6 ± 6.3	18.7 ± 5.9	0.006
6 months	6.8 ± 2.5	5.9 ± 2.2	0.17

Table 6. Complications

Complication	Plating (n = 30)	Nailing (n = 30)
Superficial infection	2 (6.6%)	0
Implant prominence	3 (10%)	0
Hypertrophic scar	1 (3.3%)	0
Nail migration	0	1 (3.3%)
Skin irritation	0	2 (6.6%)

Table 7. Cosmetic Satisfaction (Likert Scale, 1–5)

Parameter	Plating (n = 30)	Nailing (n = 30)	p-value
Mean score	3.8 ± 0.7	4.6 ± 0.5	<0.001
Excellent (score 5)	8 (26.7%)	18 (60%)	—
Good (score 4)	14 (46.7%)	10 (33.3%)	—
Fair/Poor (≤3)	8 (26.7%)	2 (6.7%)	—

Figure 1. Mean Time to Union in Weeks (Plating vs Nailing)

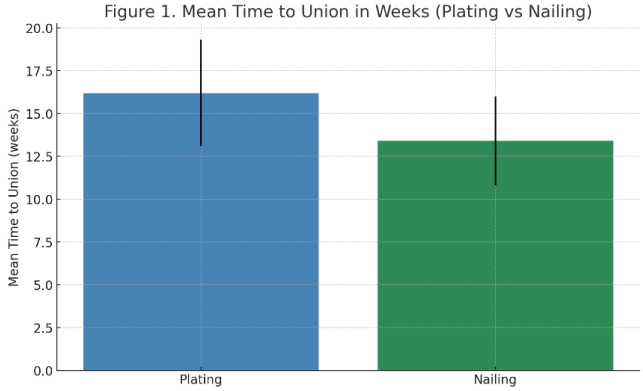
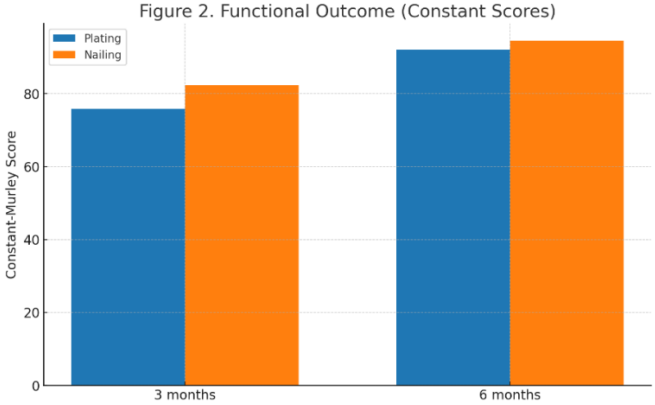
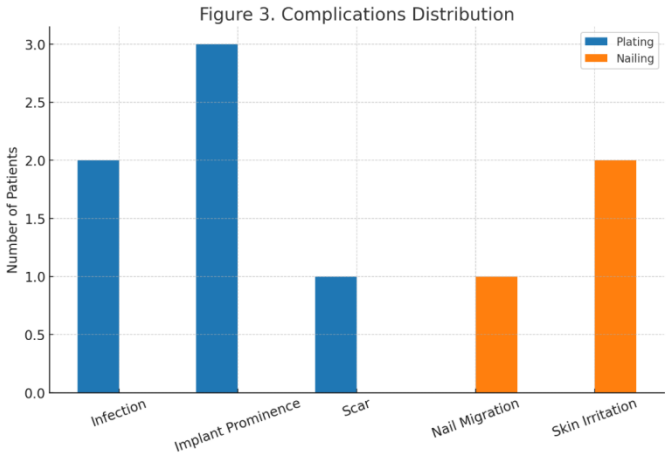


Figure 2. Functional Outcome (Constant Scores)





DISCUSSION

The present prospective, randomized comparative study evaluated the clinical, radiological, and functional outcomes of **intramedullary nailing versus plate fixation in displaced midshaft clavicle fractures** among 60 patients. Our findings demonstrated that both methods achieved excellent union rates, with all patients in both groups showing radiological healing by six months. However, important distinctions emerged in perioperative parameters, early functional recovery, complication profiles, and patient satisfaction. In particular, intramedullary nailing was associated with shorter operative time, reduced intraoperative blood loss, smaller incisions, faster radiological union, and better early functional outcomes, along with significantly higher cosmetic satisfaction scores. While long-term functional outcomes at six months were comparable between the groups, the advantages observed in the early postoperative period with nailing are clinically meaningful, especially for young, active patients eager to return to work and sports.

Our results are consistent with the growing body of literature that highlights the limitations of conservative treatment for displaced midshaft clavicle fractures and emphasizes the role of surgical fixation. Historically, these injuries were managed non-operatively, based on early studies suggesting high union rates with conservative care. However, contemporary evidence, including the landmark systematic review by Zlowodzki et al. encompassing over 2,000 fractures, has shown nonunion rates approaching **15–20%** with displaced fractures treated non-operatively, along with persistent pain, shoulder dysfunction, and cosmetic deformity【12,20】. These findings catalyzed the paradigm shift toward operative management in appropriately selected patients, particularly young adults and those with high functional demands.

When considering operative techniques, **plate fixation has traditionally been regarded as the gold standard** because it provides rigid fixation and allows for precise anatomical reduction. This approach is particularly valuable in comminuted or markedly displaced fractures where rotational control is critical. Our study confirmed that plating achieves excellent long-term functional outcomes, with mean Constant scores exceeding 92 at six months, comparable to previously published results. However, the disadvantages of plating were evident in our cohort: longer operative time (**84.3 minutes versus 52.6 minutes with nailing**), greater blood loss (**145.8 ml versus 72.3 ml**), longer incisions (**8.6 cm versus 2.5 cm**), and more complications related to soft tissue, such as infection and implant prominence. These observations are well documented in the literature. For instance, Wang et al. reported that plating, while mechanically stable, is associated with higher rates of wound complications, hardware irritation, and refracture following implant removal【5】.

In contrast, **intramedullary fixation has emerged as a minimally invasive alternative**, designed to preserve periosteal blood supply and fracture biology while offering adequate stability. Our study demonstrated a significantly shorter mean time to union with nailing (**13.4 weeks**) compared to plating (**16.2 weeks**), echoing findings from Zhao et al.'s meta-analysis, which showed faster union and lower overall complication rates with intramedullary fixation【1】. The smaller incision and less invasive technique also translated into significantly higher cosmetic satisfaction, with mean patient ratings of 4.6 out of 5, compared to 3.8 in the plating group. This is a critical consideration in younger patients and in regions where cosmetic outcomes influence quality of life.

Our results further showed superior early functional outcomes with nailing. At three months, the mean Constant score was **82.3** for nailing versus **75.8** for plating, and the mean DASH score was **18.7** versus **24.6**, respectively, both statistically significant differences. This suggests that the biological fixation of nailing allows earlier mobilization and faster functional recovery. By six months, however, both groups achieved excellent and comparable outcomes (Constant scores above 90 and DASH scores below 7), indicating that plating ultimately catches up in terms of functional recovery. This aligns with the meta-analysis by Hussain et al., who concluded that while long-term functional results are equivalent between plating and intramedullary fixation, early recovery is generally superior with the latter【2】.

The complication profile in our series highlighted the distinct risks associated with each technique. In the plating group, **two patients developed superficial infections (6.6%)**, three experienced implant prominence (10%), and one had a hypertrophic scar (3.3%). These findings are similar to those reported by Houwert et al., who observed a higher rate of reoperations in plating patients due to hardware irritation【10】. In the nailing group, no infections occurred, but **one patient experienced nail migration (3.3%)** and two reported skin irritation at the entry site (6.6%). These complications are characteristic of intramedullary fixation, as described by Kettler et al. in their early series, where nail migration was noted as a key drawback【16】. Importantly, all complications in our study were minor, manageable, and did not compromise final outcomes.

Cosmetic satisfaction deserves special emphasis. The mean score of 4.6 in the nailing group compared to 3.8 in the plating group reflects the smaller incision and less visible implant associated with intramedullary devices. Barlow et al. and Ferran et al. similarly reported that patients treated with intramedullary nails expressed higher cosmetic satisfaction and were less likely to request implant removal【8,18】. In our setting, where many patients are young and socially active, this advantage may be particularly impactful in terms of patient-reported outcomes and overall quality of life.

When comparing our findings with existing systematic reviews and meta-analyses, strong parallels emerge. Zhao et al. demonstrated that intramedullary fixation resulted in shorter operative times, smaller incisions, faster union, and lower complication rates compared to plating【1】. Lu et al. confirmed these observations and additionally noted that infection rates were lower in the nailing group【4】. Shi et al., in a large-scale meta-analysis, showed that intramedullary devices resulted in earlier functional recovery and fewer wound complications【6】. Conversely, some studies such as Virtanen et al. argued that plating provides superior control in complex fractures and may be preferable in highly comminuted patterns【11】. This suggests that the choice of fixation method should be individualized based on fracture morphology, patient expectations, and surgeon expertise.

The **strengths** of our study lie in its prospective design, randomized allocation, and direct head-to-head comparison of plating and intramedullary fixation in a relatively homogenous cohort of displaced midshaft clavicle fractures. We employed both objective clinical measures (Constant, DASH) and patient-centered outcomes (cosmetic satisfaction), providing a holistic evaluation. Furthermore, all patients completed the follow-up, ensuring completeness of data.

However, several **limitations** warrant discussion. First, the study was conducted at a single center with a modest sample size of 60 patients, which may limit the generalizability of the findings. Second, the follow-up period was restricted to six months, precluding evaluation of long-term outcomes such as refracture after implant removal or persistent shoulder dysfunction. Third, while union times were measured radiologically, no advanced imaging was used, which might have provided more precise assessments of callus maturation. Fourth, the use of different types of intramedullary devices (elastic nails, titanium nails) could introduce variability, although all were flexible nails designed for clavicle fixation. Finally, cost analysis was not performed, though this is an important consideration in resource-limited settings such as India.

The **clinical implications** of our findings are clear. For young, active patients with displaced midshaft clavicle fractures, intramedullary fixation offers faster recovery, superior cosmesis, and less intraoperative morbidity. However, plating remains a robust technique that ensures rigid fixation, particularly in comminuted fractures where intramedullary devices may not provide sufficient stability. Surgeons should therefore adopt a patient-specific approach, considering factors such as fracture pattern, soft tissue condition, patient preference, and economic constraints.

Future research should focus on multicentric randomized controlled trials with larger sample sizes and longer follow-up to evaluate the durability of these outcomes. Specific areas of interest include the rate of refracture after implant removal, long-term functional deficits, cost-effectiveness analyses, and patient-reported quality of life outcomes. Additionally, newer locked intramedullary devices may overcome some of the traditional limitations of nails, such as migration, and warrant further investigation.

In conclusion, our study confirms that both plating and intramedullary nailing are safe and effective methods for managing displaced midshaft clavicle fractures, with union achieved in all patients by six months. Intramedullary nailing, however, demonstrated distinct advantages in terms of shorter operative time, reduced blood loss, smaller incisions, earlier union, superior early functional outcomes, and higher cosmetic satisfaction. While plating ultimately achieves equivalent long-term function, its association with more invasive surgery and higher implant-related complications must be weighed. These findings, consistent with global literature, support the growing preference for intramedullary fixation as the treatment of choice in selected cases, particularly in young patients seeking rapid recovery and improved cosmetic results.

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