



FUNCTIONAL OUTCOMES OF PLATE OSTEOSYNTHESIS VERSUS INTRAMEDULLARY NAILING IN ADULT DIAPHYSEAL FOREARM FRACTURES: A PROSPECTIVE COMPARATIVE STUDY

Orthopaedics

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ABSTRACT

Background: Diaphyseal fractures of the radius and ulna are common orthopaedic injuries that can substantially compromise forearm function if not managed appropriately. The primary objective of surgical treatment is to restore anatomical alignment, maintain rotational stability, and facilitate early functional recovery. Although plate osteosynthesis remains the established standard because of its ability to achieve accurate reduction and stable fixation, intramedullary nailing has gained popularity as a less invasive technique that minimizes soft-tissue disruption while providing satisfactory clinical outcomes. **Aim:** To compare the functional and radiological outcomes of plate osteosynthesis and intramedullary nailing in adult patients with diaphyseal fractures of the forearm. **Methods:** This prospective comparative study was conducted in the Department of Orthopaedics, District Hospital, Tumakuru, Karnataka, between August 2022 and December 2023. Sixty adults with closed diaphyseal fractures of the radius and ulna were enrolled and assigned equally to two treatment groups. Group A (n = 30) underwent open reduction and internal fixation using dynamic compression plates, whereas Group B (n = 30) was treated with closed reduction and internal fixation using the Titanium Elastic Nailing System (TENS). Clinical and radiological assessments were performed at 6, 12, and 24 weeks after surgery. Functional recovery was evaluated using forearm pronation and the Modified Grace-Eversmann criteria. **Results:** The mean age of the study population was 36.08 ± 9.2 years, and males accounted for 70% of the participants. Road traffic accidents represented the predominant mechanism of injury (86.7%). At the 24-week follow-up, two-thirds of patients in both treatment groups achieved a full range of forearm motion, and excellent functional outcomes were documented in 66.7% of cases in each group. No statistically significant difference in overall functional outcome was observed between the two interventions ($p > 0.05$). However, radiological evaluation demonstrated earlier callus formation and fracture union among patients treated with plate fixation. **Conclusion:** Both plate osteosynthesis and intramedullary nailing provided satisfactory functional and radiological outcomes in the management of adult diaphyseal forearm fractures. Plate fixation was associated with earlier radiographic healing, whereas intramedullary nailing offered a minimally invasive approach with comparable functional recovery at final follow-up. Selection of the surgical technique should be individualized based on fracture characteristics, surgeon expertise, and patient-specific considerations.

KEYWORDS

Diaphyseal Forearm Fracture, Forearm Fracture, Radius, Ulna, Plate Osteosynthesis, Intramedullary Nailing, Tens

INTRODUCTION:

Fractures of the radius and ulna are common injuries encountered in orthopaedic practice and can have a substantial impact on forearm function if not managed appropriately. Because coordinated movement of these bones is essential for pronation and supination, accurate restoration of their anatomical alignment is critical. Even small degrees of malalignment may restrict rotational movement and result in long-term functional impairment. In adults, conservative treatment of diaphyseal forearm fractures has been associated with higher rates of malunion and reduced range of motion, making surgical fixation the preferred approach in most displaced fractures.^{1,2}

Open reduction and internal fixation (ORIF) with compression plating has long been considered the standard treatment for adult forearm shaft fractures because it provides precise anatomical reduction and stable fixation, allowing early mobilization and reliable fracture healing. Nevertheless, the procedure requires considerable soft-tissue dissection and periosteal exposure, which may disrupt the local blood supply and potentially affect the biological healing process.³

Intramedullary nailing has emerged as an increasingly popular alternative owing to its minimally invasive nature and preservation of the fracture biology. By limiting soft-tissue disruption and maintaining the fracture hematoma, this technique may facilitate healing while reducing surgical trauma and operative time. Improvements in implant design and surgical techniques have further expanded its use, making intramedullary fixation a practical option for selected diaphyseal forearm fractures.^{4,5}

Given the advantages and limitations of both techniques, the present

study was undertaken to compare the functional outcomes, radiological union, and postoperative complications associated with plate osteosynthesis and intramedullary nailing in adults with diaphyseal fractures of the radius and ulna.

MATERIALS AND METHODS

Study Design and Setting: A prospective comparative study was conducted in the Department of Orthopaedics, District Hospital, Tumakuru, Karnataka, from August 2022 to December 2023.

Sample Size and Grouping: Sixty adult patients with closed diaphyseal forearm fractures were enrolled and allocated into two equal groups. Group A (n=30) underwent ORIF with dynamic compression plating, and Group B (n=30) underwent CRIF using the Titanium Elastic Nailing System (TENS).

Inclusion Criteria: Patients aged 20–60 years with closed diaphyseal fractures of the radius and/or ulna who were willing to undergo surgery and comply with follow-up.

Exclusion Criteria: Open fractures, pathological fractures, neurovascular injuries, and patients unwilling to participate.

Follow-up and Outcome Assessment: All patients were followed up at 6, 12, and 24 weeks. Functional outcomes were assessed using forearm pronation range of motion and the Modified Grace-Eversmann criteria (Excellent, Good, Fair, Poor). Radiological assessment included evaluation of callus formation and fracture union. Complications were graded using the Clavien-Dindo classification.

Statistical Analysis: Data were analyzed using SPSS Version 20.

Categorical variables were expressed as frequencies and percentages. The Chi-square test was used to assess associations between groups. Improvement in functional outcomes across time points was evaluated using Friedman's test. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 60 patients were included, with 30 in each treatment group. The mean age was 36.08 ± 9.2 years. The majority of patients (40%) were in the 30–40-year age group, and males comprised 70% of the study population (Table 1). The left forearm was more frequently injured (55%). Road traffic accidents accounted for 86.7% of injuries, with self-falls responsible for the remaining 13.3% (Table 2).

Table 1: Baseline Demographic Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	20–30	13	21.7
	30–40	24	40.0
	>40	23	38.3
Sex	Male	42	70.0
	Female	18	30.0
Side of Injury	Left	33	55.0
	Right	27	45.0

Functional outcomes improved progressively in both groups across all time points (p < 0.05, Friedman's test). At 24 weeks, 66.7% of patients in both groups achieved full range of motion. Excellent final outcomes were observed in 66.7% of patients in each group, with no statistically significant difference between groups (Chi-square = 4.000; p = 0.261) (Table 3).

Table 2: Radiological Outcomes — Callus Formation and Bone Union

Parameter	6 Weeks	12 Weeks	24 Weeks
Callus Formation — Plating	9 (30%)	30 (100%)	30 (100%)
Callus Formation — TENS	3 (10%)	24 (80%)	30 (100%)
Bone Union — Plating	1 (3.3%)	24 (80%)	30 (100%)
Bone Union — TENS	0 (0%)	15 (50%)	30 (100%)

Radiological assessment revealed earlier callus formation and fracture union in the plating group. By 24 weeks, all patients in both groups achieved complete union (Table 2). Complication rates were comparable between groups (p = 0.261). Superficial infection was more common following plating (13.3% vs 6.7%), while deep infection was observed more frequently in the TENS group (26.7% vs 13.3%). Compartment syndrome occurred in 6.7% of plating patients and in no TENS patients (Table 3).

Table 3: Complications by Treatment Group

Outcome	Plating n (%)	TENS n (%)	Total n (%)
Excellent	20 (66.7)	20 (66.7)	40 (66.7)
Good	6 (20.0)	2 (6.7)	8 (13.3)
Fair	2 (6.7)	6 (20.0)	8 (13.3)
Poor	2 (6.7)	2 (6.7)	4 (6.7)
Total	30 (100)	30 (100)	60 (100)

Chi-square = 4.000; p = 0.261

Table 4: Final Functional Outcome at 24 Weeks (Modified Grace-Eversmann Criteria)

Complication	Plating n (%)	TENS n (%)	Total n (%)
Asymptomatic union	20 (66.7)	20 (66.7)	40 (66.7)
Superficial infection	4 (13.3)	2 (6.7)	6 (10.0)
Deep infection	4 (13.3)	8 (26.7)	12 (20.0)
Compartment syndrome	2 (6.7)	0 (0.0)	2 (3.3)
Total	30 (100)	30 (100)	60 (100)

Chi-square = 4.000; p = 0.261

DISCUSSION

The present study evaluated and compared the functional outcomes, radiological healing, and postoperative complications associated with plate osteosynthesis and intramedullary nailing in adults with diaphyseal fractures of the forearm. Most patients were young to middle-aged males, with the highest incidence occurring in the third and fourth decades of life. Similar demographic trends have been

reported by Köse et al., Venkataraman et al., and Saini et al., reflecting the greater involvement of this population in occupational activities, sports, and high-energy trauma.^{4,8,9}

Road traffic accidents were the leading cause of injury in the present series, accounting for 86.7% of cases. This finding is consistent with previous studies by Ramkumar et al. and Biswas et al. and highlights the significant contribution of high-velocity trauma to adult diaphyseal forearm fractures, particularly in developing countries.^{6,9}

Functional recovery improved steadily in both treatment groups during follow-up. By 24 weeks, excellent outcomes were observed in 66.7% of patients treated with plate fixation as well as those managed with intramedullary nailing, with no statistically significant difference between the groups. These findings are in agreement with the reports of Lee et al. and Çevik et al., who also demonstrated comparable long-term functional outcomes with both fixation techniques.^{2,7} The results suggest that when appropriate surgical principles are followed, either method can achieve satisfactory restoration of forearm function.

Radiological evaluation showed earlier callus formation and fracture union in the plating group, likely because plate fixation provides rigid mechanical stability and facilitates accurate anatomical reduction. Similar observations have been described by Saka et al. and Kim et al.^{3–10} Despite this early advantage, all fractures in the intramedullary nailing group achieved union by the final follow-up, resulting in outcomes comparable to those of the plating group. Preservation of the fracture hematoma and reduced periosteal disruption associated with intramedullary fixation may contribute to effective biological healing despite slower initial radiographic progression.

The incidence of postoperative complications was comparable between the two treatment modalities. Superficial wound infections were observed more frequently after plate fixation, which may be related to the greater degree of surgical exposure required. In contrast, deep infections occurred more often in patients treated with TENS, although the overall difference was not statistically significant. These findings are broadly consistent with previously published literature, including the study by Westacott et al.¹

Overall, the findings of this study indicate that both plate osteosynthesis and intramedullary nailing are reliable treatment options for adult diaphyseal forearm fractures. While plate fixation may provide faster radiological healing and precise anatomical restoration, intramedullary nailing offers the advantages of a less invasive procedure with comparable functional recovery by the end of follow-up. Therefore, the choice of fixation should be individualized according to fracture configuration, patient characteristics, and the surgeon's expertise.

CONCLUSION

Both plate osteosynthesis and intramedullary nailing demonstrated satisfactory clinical and radiological outcomes in the treatment of adult diaphyseal fractures of the radius and ulna. At 24 weeks, patients in both groups achieved similar functional recovery, range of motion, and overall fracture union rates. Plate fixation showed a tendency toward earlier radiographic union, whereas intramedullary nailing provided the benefits of a minimally invasive approach with comparable long-term outcomes. These findings suggest that either technique can be successfully employed when selected appropriately based on fracture pattern, patient factors, and surgical expertise. Further multicenter studies with larger sample sizes and longer follow-up periods would help strengthen the evidence and clarify the long-term advantages of each treatment strategy.

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