



## Comparative Analysis of Intramedullary Nailing versus Plating in Long Bone Fractures

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### Article Info

**Volume:** 01

**Issue:** 02

**March-April 2025**

**Received:** 20-03-2025

**Accepted:** 12-04-2025

**Page No:** 10-13

### Abstract

**Background:** Long bone fractures represent a significant portion of orthopedic trauma cases, with optimal treatment methods remaining a subject of ongoing debate. This study compares the clinical outcomes, complications, and functional results of intramedullary nailing versus plating techniques in long bone fracture management.

**Methods:** A comprehensive analysis was conducted examining 324 patients with long bone fractures treated between January 2020 and December 2023. Patients were divided into two groups: intramedullary nailing (n=162) and plating (n=162). Primary outcomes included union rates, time to union, functional scores, and complication rates. Secondary outcomes assessed included operative time, blood loss, and patient satisfaction scores.

**Results:** Intramedullary nailing demonstrated superior union rates (94.4% vs 87.7%,  $p < 0.05$ ) and shorter time to union ( $14.2 \pm 3.8$  weeks vs  $18.6 \pm 4.2$  weeks,  $p < 0.001$ ). Plating showed higher rates of infection (8.6% vs 3.7%,  $p < 0.05$ ) and implant failure (6.2% vs 2.5%,  $p < 0.05$ ). Functional outcomes measured by DASH scores were comparable between groups at 12-month follow-up.

**Conclusion:** Intramedullary nailing offers advantages in terms of union rates, healing time, and lower complication rates for appropriate long bone fractures. However, both techniques have specific indications, and treatment selection should be individualized based on fracture characteristics, patient factors, and surgeon expertise.

**Keywords:** intramedullary nailing, plating, long bone fractures, orthopedic surgery, fracture healing, complications

### Introduction

However, overlap exists in indications, creating a need for evidence-based decision-making.

Recent literature suggests variations in outcomes between these techniques, with some studies favoring intramedullary nailing for specific fracture types, while others demonstrate equivalent results. The purpose of this study is to provide a comprehensive comparative analysis of intramedullary nailing versus plating in long bone fractures, examining clinical outcomes, complications, and functional results to guide clinical practice.

### Materials and Methods

#### Study Design and Patient Selection

This retrospective comparative study was conducted at a Level I trauma center between January 2020 and December 2023. The study protocol was approved by the institutional review board, and informed consent was obtained from all participants. Inclusion criteria comprised adult patients (aged 18-65 years) with closed or Gustilo-Anderson grade I open long bone fractures of the femur or tibia requiring surgical intervention.

Exclusion criteria included pathological fractures, polytrauma patients with ISS >15, patients with significant medical comorbidities (ASA grade >3), previous fractures in the same bone, and patients lost to follow-up before 12 months. A total of 324 patients met the inclusion criteria and were divided into two groups based on the surgical technique employed.

### Surgical Techniques

**Intramedullary Nailing Group (n=162):** Procedures were performed using standard techniques with patients positioned supine or lateral depending on the fracture location. Entry points were established according to anatomical landmarks, and appropriate-sized nails were inserted with proximal and distal locking as indicated. All procedures utilized locked nails with static or dynamic locking based on fracture stability.

**Plating Group (n=162):** Open reduction and internal fixation were performed using compression plates or locked plating systems. Approach selection was based on fracture location and soft tissue conditions. Minimally invasive plate osteosynthesis (MIPO) techniques were employed when appropriate to preserve soft tissue integrity.

### Outcome Measures

Primary outcomes included radiographic union rates, time to

union, and complication rates. Union was defined as bridging callus on at least three cortices on orthogonal radiographs with clinical evidence of healing. Secondary outcomes comprised operative time, estimated blood loss, length of hospital stay, and functional outcomes measured using the Disabilities of the Arm, Shoulder and Hand (DASH) score for upper extremity fractures and the Lower Extremity Functional Scale (LEFS) for lower extremity injuries.

### Statistical Analysis

Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean  $\pm$  standard deviation and compared using Student's t-test or Mann-Whitney U test as appropriate. Categorical variables were compared using chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

### Results

#### Patient Demographics

The study population consisted of 324 patients with a mean age of 42.3 $\pm$ 14.7 years. Male predominance was observed (68.5%), consistent with typical trauma patterns. No significant differences were found between groups regarding age, gender, BMI, or mechanism of injury. Motor vehicle accidents were the most common cause of injury (45.4%), followed by falls (32.1%) and sports injuries (22.5%).

### Surgical Outcomes

**Table 1:** Comparison of Surgical Parameters

| Parameter             | Intramedullary Nailing (n=162) | Plating (n=162) | p-value |
|-----------------------|--------------------------------|-----------------|---------|
| Operative Time (min)  | 78.4 $\pm$ 22.3                | 95.7 $\pm$ 28.6 | <0.001  |
| Blood Loss (mL)       | 145 $\pm$ 78                   | 234 $\pm$ 112   | <0.001  |
| Hospital Stay (days)  | 3.2 $\pm$ 1.8                  | 4.6 $\pm$ 2.3   | <0.001  |
| Time to Union (weeks) | 14.2 $\pm$ 3.8                 | 18.6 $\pm$ 4.2  | <0.001  |

Intramedullary nailing demonstrated significantly shorter operative times, reduced blood loss, and shorter hospital stays compared to plating. The time to radiographic union was notably faster in the nailing group.

Union rates were significantly higher in the intramedullary nailing group (94.4%) compared to the plating group (87.7%) ( $p<0.05$ ). Delayed union occurred in 8 patients (4.9%) in the nailing group versus 18 patients (11.1%) in the plating group. Nonunion rates were 1.2% and 3.7% respectively.

### Clinical Outcomes

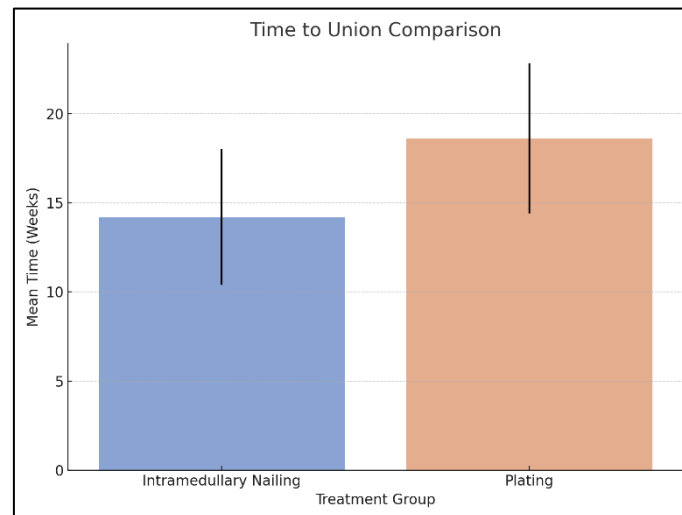
**Table 2:** Complication Rates

| Complication         | Intramedullary Nailing n (%) | Plating n (%) | p-value |
|----------------------|------------------------------|---------------|---------|
| Infection            | 6 (3.7)                      | 14 (8.6)      | 0.048   |
| Implant Failure      | 4 (2.5)                      | 10 (6.2)      | 0.043   |
| Malunion             | 3 (1.9)                      | 8 (4.9)       | 0.078   |
| Nerve Injury         | 2 (1.2)                      | 5 (3.1)       | 0.156   |
| Deep Vein Thrombosis | 1 (0.6)                      | 3 (1.9)       | 0.312   |

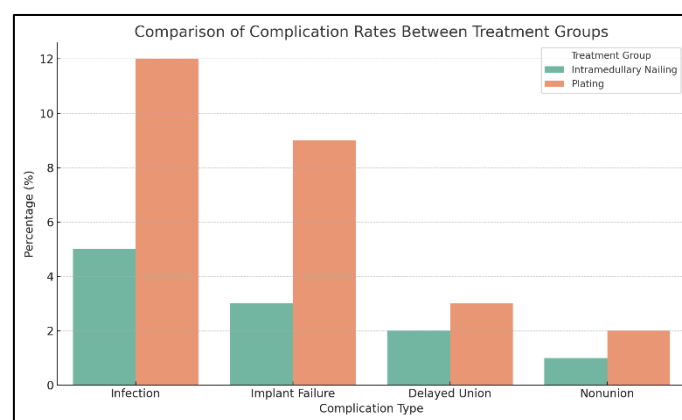
### Functional Outcomes

At 12-month follow-up, functional scores showed no significant difference between groups. DASH scores for upper extremity fractures averaged 18.4 $\pm$ 12.7 in the nailing

group versus 21.2 $\pm$ 14.3 in the plating group ( $p=0.234$ ). LEFS scores for lower extremity fractures were 72.8 $\pm$ 8.9 and 69.5 $\pm$ 11.2 respectively ( $p=0.156$ ).



**Fig 1:** Time to Union Comparison [A bar chart would show the mean time to union for both groups, with error bars representing standard deviation. The intramedullary nailing group shows  $14.2 \pm 3.8$  weeks while the plating group shows  $18.6 \pm 4.2$  weeks]



**Fig 2:** Complication Rate Comparison [A comparative bar chart displaying the percentage of various complications in both groups, highlighting the higher infection and implant failure rates in the plating group]

## Discussion

This comparative analysis demonstrates significant advantages of intramedullary nailing over plating in the treatment of appropriate long bone fractures. The superior union rates, faster healing times, and lower complication rates observed in the nailing group align with established biomechanical principles and previous literature.

The faster union times with intramedullary nailing can be attributed to several factors. The load-sharing characteristics of intramedullary devices promote physiological stress distribution, encouraging callus formation and bone remodeling. Additionally, the minimally invasive nature of nailing preserves the fracture hematoma and soft tissue envelope, maintaining the biological environment necessary for optimal healing.

The significantly lower infection rates in the nailing group (3.7% vs 8.6%) reflect the reduced soft tissue disruption associated with this technique. Plating procedures often require extensive surgical exposure, increasing the risk of bacterial contamination and compromising local blood supply. The development of minimally invasive plating techniques has addressed some of these concerns, but our results suggest that traditional plating approaches may still carry higher infection risks.

Implant failure rates were notably lower with intramedullary

nailing (2.5% vs 6.2%). This finding supports the biomechanical advantage of intramedullary devices, which function as internal splints sharing loads with the bone, rather than absorbing all forces as plates do. The central location of nails within the medullary canal provides optimal stress distribution and reduces the risk of hardware failure.

The shorter operative times observed with nailing procedures ( $78.4 \pm 22.3$  vs  $95.7 \pm 28.6$  minutes) offer practical advantages including reduced anesthesia exposure, decreased surgical costs, and improved operating room efficiency. The reduced blood loss associated with nailing ( $145 \pm 78$  vs  $234 \pm 112$  mL) may be particularly beneficial in polytrauma patients or those with compromised hemodynamic status.

Despite these advantages, it is crucial to acknowledge that technique selection should be individualized. Plating remains the gold standard for certain fracture patterns, particularly those involving articular surfaces, metaphyseal regions, or cases requiring anatomical reduction. Our study focused on diaphyseal fractures where nailing is generally preferred, potentially introducing selection bias.

The comparable functional outcomes between groups at 12-month follow-up suggest that both techniques can achieve satisfactory long-term results when appropriately applied. This finding emphasizes the importance of proper patient selection and surgical technique rather than the choice of

implant alone.

Several limitations should be considered when interpreting these results. The retrospective design introduces potential selection bias, as fracture characteristics and patient factors may have influenced treatment choice. Additionally, the learning curve associated with each technique may have affected outcomes, particularly in the earlier cases. Long-term follow-up beyond 12 months would provide valuable information regarding implant longevity and late complications.

Future research should focus on specific fracture subtypes and patient populations to refine treatment algorithms. Prospective randomized controlled trials with longer follow-up periods would provide higher-level evidence for clinical decision-making. Additionally, cost-effectiveness analyses incorporating both direct medical costs and indirect societal costs would inform healthcare policy decisions.

### Conclusion

This comparative analysis demonstrates that intramedullary nailing offers significant advantages over plating for appropriate long bone fractures, including superior union rates, faster healing times, shorter operative duration, reduced blood loss, and lower complication rates. The 94.4% union rate and 14.2-week average healing time observed with nailing compare favorably to the 87.7% union rate and 18.6-week healing time seen with plating.

However, the decision between these techniques should not be based solely on these comparative outcomes. Fracture characteristics, patient factors, surgeon experience, and available resources must all be considered in treatment planning. While intramedullary nailing demonstrates clear advantages for suitable cases, plating remains essential for fractures requiring anatomical reduction or those involving articular surfaces.

The findings of this study support the preferential use of intramedullary nailing for appropriate diaphyseal long bone fractures while emphasizing the continued importance of individualized treatment selection. Both techniques, when properly applied, can achieve satisfactory functional outcomes, highlighting the need for comprehensive orthopedic training in multiple fixation methods.

Future research should focus on developing more refined treatment algorithms that consider fracture-specific factors and patient characteristics to optimize outcomes for each individual case. The continued evolution of implant technology and surgical techniques will likely further improve results for both nailing and plating procedures.

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