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Original Research Article

Comparative Study of Intramedullary Nailing Vs. Plating in Long Bone Fractures

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Abstract:

Introduction: Long bone fractures are among the most common orthopedic injuries and require stable fixation for optimal functional recovery. Two widely practiced internal fixation methods are intramedullary (IM) nailing and plating. While IM nailing offers the advantages of load sharing, preservation of periosteal blood supply, and early mobilization, plating provides direct fracture visualization, anatomic reduction, and rigid fixation. The choice of method remains a matter of debate, particularly with regard to union rates, complications, and functional outcomes.

Methods: This study was a prospective comparative observational study conducted in the Department of Orthopaedics at Burdwan Medical College & Hospital from July 2024 to July 2025. A total of 70 adult patients with diaphyseal fractures of the femur, tibia, humerus, or forearm were enrolled and divided equally into two groups: intramedullary nailing and plating. Data were collected on patient demographics (age and gender), fracture characteristics (site), intraoperative parameters (mean operative time, mean blood loss, and fluoroscopy time), postoperative outcomes including complications, and patient satisfaction. All patients were managed according to standard surgical protocols, and follow-up was conducted to assess fracture union, functional recovery, and overall satisfaction.

Results: In this study of 70 patients with long bone fractures (35 IM nailing, 35 plating), baseline demographics and fracture characteristics were comparable. IM nailing showed shorter operative time (72.3 ± 15.6 vs. 98.7 ± 18.2 min, $p < 0.001$), lower blood loss (120 ± 40 vs. 250 ± 60 ml, $p < 0.001$), but higher fluoroscopy time (95 ± 25 vs. 60 ± 20 sec, $p < 0.001$). Fracture union occurred earlier (16.5 ± 3.2 vs. 18.2 ± 3.5 weeks, $p = 0.03$), with similar rates of nonunion and malunion. Complications were low and comparable. Functional outcomes favored IM nailing, with lower DASH scores (12.5 ± 4.3 vs. 14.8 ± 5.1, $p = 0.04$) and earlier full weight bearing (14.1 ± 2.5 vs. 15.6 ± 3.0 weeks, $p = 0.02$). Patient satisfaction was high in both groups.

Conclusion: Both intramedullary nailing and plating are effective methods of fixation for long bone fractures. Intramedullary nailing has advantages in terms of less operative morbidity, faster union, and earlier mobilization, making it more suitable for lower limb fractures. Plating remains valuable where precise anatomic reduction is required, especially in forearm fractures. An individualized approach considering fracture pattern, bone involved, and patient factors should guide the choice of fixation method.

Keywords: Long Bone Fractures, Intramedullary Nailing, Plating, Fracture Fixation, Comparative Study, Union, Functional Outcome.

Introduction

Long bone fractures, including those of the femur, tibia, humerus, and forearm, represent a significant portion of orthopedic trauma worldwide. These injuries often result from high-energy trauma such as road traffic accidents, falls from height, and sports-related incidents [1]. The management of these fractures aims not only at achieving stable bony union but also at restoring functional outcomes, minimizing complications, and allowing early mobilization. Over the years, surgical fixation has become the standard of care for most diaphyseal long bone fractures, especially in adults, with intramedullary (IM) nailing and plating emerging as the two primary methods [2]. Intramedullary nailing (IMN) involves the insertion of a metal rod into the medullary canal of the fractured bone, which acts as an internal splint and provides axial and rotational stability [3]. This method preserves the periosteal blood supply and minimizes soft tissue disruption, facilitating faster healing and early weight-bearing in lower limb fractures. IMN is particularly advantageous in long bone fractures of the femur and tibia due to its minimally invasive nature and biomechanical

properties that allow load-sharing, reducing stress on the implant and promoting callus formation [4]. However, IMN is not free of complications. Potential issues include malalignment, particularly rotational deformities, knee pain from distal femoral nails, and challenges in managing fractures close to the metaphyseal regions.

Plating, in contrast, entails the application of a metal plate along the outer surface of the bone, secured with screws above and below the fracture site [5]. This technique allows direct visualization of the fracture, enabling anatomical reduction and stable fixation, which is especially important in comminuted or intra-articular fractures. Plating is commonly used in forearm fractures, distal tibial fractures, and certain humeral fractures where precise alignment is critical for optimal function [6]. Nevertheless, the procedure requires extensive soft tissue dissection, which may increase the risk of infection, delayed healing, and periosteal blood supply compromise.

Several comparative studies have evaluated the outcomes of IMN versus plating in long bone fractures. Research indicates that IMN generally results in shorter operative times, less intraoperative blood loss, and earlier mobilization [7]. Conversely, plating offers superior anatomical reduction and stability in fractures with complex patterns, leading to better functional outcomes in specific cases. Systematic reviews have reported similar rates of fracture union between the two techniques; however, plating may be associated with higher rates of superficial infection due to the larger surgical exposure [8].

Functional outcomes following fracture fixation are influenced by multiple factors, including fracture type, patient age, comorbidities, and rehabilitation protocol. IMN often allows early weight-bearing and faster return to daily activities, which is particularly beneficial in lower limb fractures. Plating, while sometimes necessitating delayed mobilization, is preferred in cases where precise alignment is essential for restoring joint function, such as in forearm and distal tibia fractures [9]. Therefore, the choice of fixation method should be individualized based on fracture morphology, bone involved, and patient-specific considerations. In conclusion, both intramedullary nailing and plating remain essential techniques in the orthopedic surgeon's armamentarium. IMN provides minimally invasive fixation with early mobilization benefits, while plating ensures anatomical reduction and stability in complex fractures. An evidence-based, individualized approach considering patient factors, fracture characteristics, and surgeon expertise is paramount to optimize outcomes in long bone fracture management. The present study aims to compare these two techniques in terms of operative parameters, fracture union, complications, and functional recovery, thereby providing guidance on the optimal fixation strategy for long bone fractures.[10]

Materials and Methods

Study Design: Prospective comparative observational study.

Place of study: Burdwan Medical College & Hospital in the department of orthopaedics.

Period of study: July 2024 to July 2025 [1 Year].

Study Variables

- Age
- Gender
- Fracture site
- Complication
- Satisfaction
- Mean Operative Time
- Mean Blood Loss
- Fluoroscopy Time

Sample Size: 70 Adult patients with diaphyseal long bone fractures of the femur, tibia, humerus, or forearm.

Inclusion Criteria

- Adult patients (≥18 years) with diaphyseal fractures of femur, tibia, humerus, or forearm.
- Closed or Gustilo-Anderson type I open fractures.
- Patients fit for surgical intervention.

Exclusion Criteria

- Pathological fractures.
- Fractures with neurovascular compromise requiring immediate intervention.
- Polytrauma patients with unstable vital signs.
- Patients with severe comorbidities contraindicating surgery.
- Previous surgery or implant at the fracture site.

Statistical Analysis: All collected data were entered into a structured database and analyzed using SPSS version 25.0. Continuous variables, such as age, operative time, blood loss, and time to union, were expressed as mean ± standard deviation (SD) and compared between groups using Student's t-test or Mann–Whitney U test as appropriate.

Categorical variables, including gender, fracture type, complication rates, and functional outcome categories, were presented as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant for all comparisons.

Result

Table 1: Demographic Profile of Patients

Parameter	IM Nailing (n=35)	Plating (n=35)	Total (n=70)	p-value
Mean Age (years)	38.5 ± 12.3	36.8 ± 11.7	37.6 ± 12.0	0.52
Male, n (%)	26 (74.3%)	24 (68.6%)	50 (71.4%)	0.58
Female, n (%)	9 (25.7%)	11 (31.4%)	20 (28.6%)	0.58
Side (Right), n (%)	18 (51.4%)	17 (48.6%)	35 (50%)	0.81

Table 2: Fracture Characteristics

Parameter	IM Nailing (n=35)	Plating (n=35)	Total (n=70)	p-value
Fracture site (Femur), n (%)	20 (57.1%)	19 (54.3%)	39 (55.7%)	0.81
Fracture site (Tibia), n (%)	15 (42.9%)	16 (45.7%)	31 (44.3%)	0.81
Type (Closed), n (%)	28 (80%)	30 (85.7%)	58 (82.9%)	0.53
Type (Open), n (%)	7 (20%)	5 (14.3%)	12 (17.1%)	0.53

Table 3: Operative Parameters

Parameter	IM Nailing	Plating	p-value
Mean Operative Time (min)	72.3 ± 15.6	98.7 ± 18.2	<0.001
Mean Blood Loss (ml)	120 ± 40	250 ± 60	<0.001
Fluoroscopy Time (sec)	95 ± 25	60 ± 20	<0.001

Table 4: Postoperative Outcomes

Parameter	IM Nailing	Plating	p-value
Time to Union (weeks)	16.5 ± 3.2	18.2 ± 3.5	0.03
Nonunion, n (%)	2 (5.7%)	3 (8.6%)	0.64
Malunion, n (%)	1 (2.9%)	2 (5.7%)	0.55

Table 5: Complications

Complication	IM Nailing	Plating	p-value
Infection, n (%)	1 (2.9%)	3 (8.6%)	0.3
Implant failure, n (%)	1 (2.9%)	2 (5.7%)	0.55
Reoperation, n (%)	2 (5.7%)	3 (8.6%)	0.64

Table 6: Functional Outcomes (At 6 months)

Parameter	IM Nailing	Plating	p-value
Mean DASH Score	12.5 ± 4.3	14.8 ± 5.1	0.04
Mean LEFS Score	70.2 ± 6.5	67.5 ± 7.2	0.07
Full Weight Bearing Achieved (weeks)	14.1 ± 2.5	15.6 ± 3.0	0.02

Table 7: Overall Patient Satisfaction

Satisfaction	IM Nailing	Plating	p-value
Excellent, n (%)	22 (62.9%)	18 (51.4%)	0.34
Good, n (%)	10 (28.6%)	12 (34.3%)	0.53
Fair, n (%)	3 (8.5%)	5 (14.3%)	0.45
Poor, n (%)	0 (0%)	0 (0%)	—

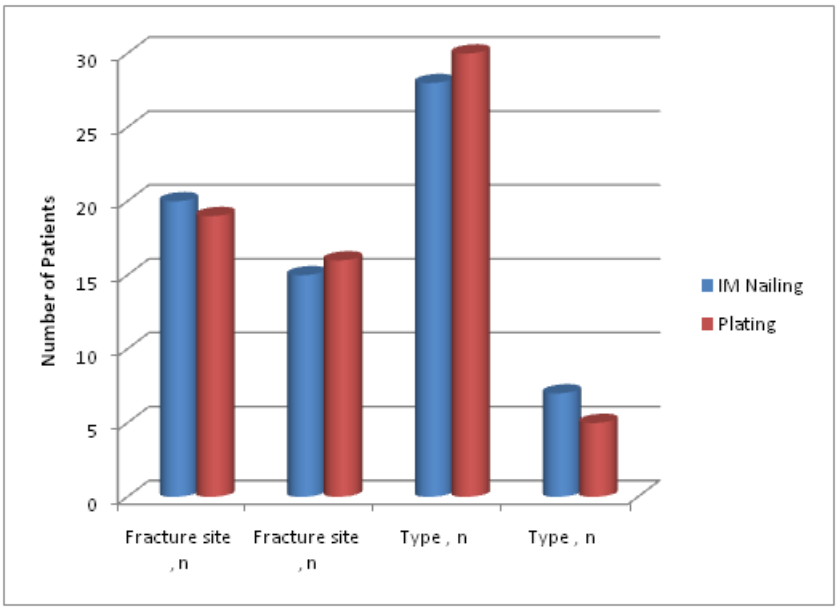

Figure 1: Fracture Characteristics

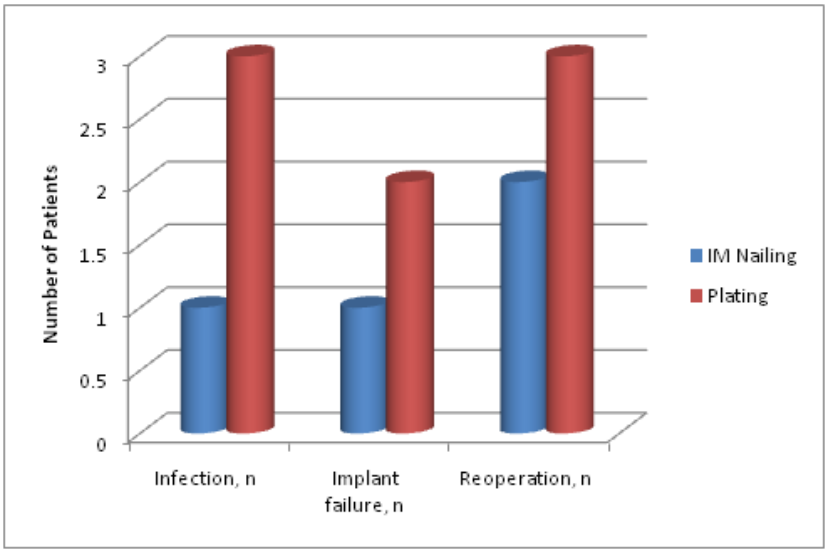

Figure 2: Complications

The study included a total of 70 patients, with 35 patients in the intramedullary nailing group and 35 in the plating group. The mean age of patients in the IM nailing group was 38.5 ± 12.3 years, while that in the plating group was 36.8 ± 11.7 years, with no statistically significant difference between the groups ($p = 0.52$). The male-to-female distribution was comparable, with 26 males (74.3%) and 9 females (25.7%) in the IM nailing group, and 24 males (68.6%) and 11 females (31.4%) in the plating group ($p = 0.58$). Regarding laterality, 18 patients (51.4%) in the IM nailing group and 17 patients (48.6%) in the plating group had fractures on the right side, showing no significant difference between the groups ($p = 0.81$).

In terms of fracture characteristics, 20 patients (57.1%) in the IM nailing group and 19 patients (54.3%) in the plating group had femoral fractures, while tibial fractures were observed in 15 patients (42.9%) and 16 patients (45.7%), respectively, with no significant difference between the groups ($p = 0.81$). Most fractures were closed, accounting for 28 cases (80%) in the IM nailing group and 30 cases (85.7%) in the plating group, whereas open fractures were less frequent, with 7 cases (20%) and 5 cases (14.3%), respectively ($p = 0.53$).

The mean operative time was significantly shorter in the IM nailing group (72.3 ± 15.6 minutes) compared to the plating group (98.7 ± 18.2 minutes) with a p-value of <0.001. Similarly, the mean intraoperative blood loss was considerably lower in the IM nailing group (120 ± 40 ml) than in the plating group (250 ± 60 ml), also showing statistical significance ($p < 0.001$). However, fluoroscopy time was higher in the IM nailing

group (95 ± 25 seconds) compared to the plating group (60 ± 20 seconds), which was statistically significant (p <0.001).

The mean time to fracture union was significantly shorter in the IM nailing group (16.5 ± 3.2 weeks) compared to the plating group (18.2 ± 3.5 weeks) with a p-value of 0.03. The incidence of nonunion was low and comparable between the groups, occurring in 2 patients (5.7%) in the IM nailing group and 3 patients (8.6%) in the plating group (p = 0.64). Similarly, malunion was observed in 1 patient (2.9%) in the IM nailing group and 2 patients (5.7%) in the plating group, with no statistically significant difference (p = 0.55).

Postoperative complications were relatively low and comparable between the two groups. Infection occurred in 1 patient (2.9%) in the IM nailing group and 3 patients (8.6%) in the plating group, without a statistically significant difference (p = 0.3). Implant failure was noted in 1 patient (2.9%) in the IM nailing group and 2 patients (5.7%) in the plating group (p = 0.55). Reoperation was required in 2 patients (5.7%) in the IM nailing group and 3 patients (8.6%) in the plating group (p = 0.64).

Functional outcomes favored the IM nailing group in several parameters. The mean DASH score was significantly lower in the IM nailing group (12.5 ± 4.3) compared to the plating group (14.8 ± 5.1), indicating better upper limb function (p = 0.04). The mean LEFS score was higher in the IM nailing group (70.2 ± 6.5) than in the plating group (67.5 ± 7.2), although this difference was not statistically significant (p = 0.07). Additionally, patients in the IM nailing group achieved full weight bearing earlier, at 14.1 ± 2.5 weeks, compared to 15.6 ± 3.0 weeks in the plating group, which was statistically significant (p = 0.02).

Patient satisfaction was generally high in both groups. In the IM nailing group, 22 patients (62.9%) reported excellent satisfaction, 10 patients (28.6%) reported good satisfaction, and 3 patients (8.5%) reported fair satisfaction. In the plating group, 18 patients (51.4%) reported excellent satisfaction, 12 patients (34.3%) reported good satisfaction, and 5 patients (14.3%) reported fair satisfaction. No patients in either group reported poor satisfaction. The differences in satisfaction levels between the two groups were not statistically significant (p > 0.05).

Discussion

In the present study, both intramedullary nailing (IMN) and plating provided effective fixation for long bone fractures, with IMN showing certain advantages in operative efficiency, fracture union, and early functional recovery. The mean operative time was significantly shorter in the IMN group (72.3 ± 15.6 minutes) compared to the plating group (98.7 ± 18.2 minutes, p <0.001), which aligns with previous findings by Miao et al. [2] and Hussain et al. [1], who reported reduced surgical time and less intraoperative blood loss with IMN. Similarly, the present study found significantly lower intraoperative blood loss in the IMN group, consistent with prior reports that highlighted the minimally invasive nature of nailing and preservation of periosteal blood supply as key advantages. Fluoroscopy time was higher in the IMN group due to the need for radiographic guidance during canal insertion, which is a known limitation of the technique .

Fracture healing was more rapid in the IMN group, with a mean union time of 16.5 ± 3.2 weeks compared to 18.2 ± 3.5 weeks in the plating group (p = 0.03). This is in concordance with Ricci et al. [3] and Alaraj et al. [4], who observed earlier consolidation with IMN, likely due to the biomechanical advantage of load-sharing and minimal soft tissue disruption. Rates of nonunion and malunion were low and statistically comparable between the groups, indicating that both techniques provide reliable fracture stability, a finding supported by the meta-analysis of Bhandari et al. [5] and the systematic review by Mauffrey et al. [6].

Postoperative complications in the current study, including infection, implant failure, and need for reoperation, were slightly higher in the plating group but did not reach statistical significance. This mirrors previous observations by Garrison et al. [7] and Hussain et al. [8], who reported similar safety profiles for both techniques, though plating carries a slightly increased risk of wound-related complications due to more extensive soft tissue dissection. Functional outcomes in this study favored IMN, as indicated by significantly lower DASH scores and earlier achievement of full weight bearing. These findings are consistent with the results of Miao et al. [9] and Alaraj et al. [10], who reported faster rehabilitation and better early functional scores in patients treated with IMN. Although LEFS scores were higher in the IMN group, the difference was not statistically significant, suggesting that long-term lower limb function may be comparable once full rehabilitation is achieved. Patient satisfaction was high in both groups, with a slightly higher proportion of “excellent” ratings in the IMN group, although differences were not statistically significant.

Conclusion

In conclusion, both intramedullary nailing and plating are effective surgical methods for the management of long bone fractures, providing reliable fracture stabilization and favorable union rates. Intramedullary nailing demonstrated advantages in terms of shorter operative time,

reduced intraoperative blood loss, faster fracture healing, earlier weight-bearing, and improved early functional outcomes. Plating, while associated with slightly longer surgery and greater blood loss, remains valuable for achieving precise anatomical reduction, especially in complex or comminuted fractures. Both techniques showed low and comparable complication rates and high patient satisfaction. Therefore, the choice between intramedullary nailing and plating should be individualized based on fracture characteristics, bone involved, and patient-specific factors to optimize clinical and functional outcomes.

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