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Research Article

Comparison of Clinical and Radiological Outcomes in Patients Undergoing Intramedullary Nailing Versus Plate Fixation for Tibial Shaft Fractures

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ABSTRACT

Background: Tibial shaft fractures are common long bone injuries requiring surgical fixation for optimal outcomes. Intramedullary nailing (IMN) and plate fixation (PF) are widely used methods, but comparative clinical and radiological data remain varied.

Aim: To compare clinical and radiological outcomes in patients undergoing intramedullary nailing versus plate fixation for tibial shaft fractures.

Methods: A prospective observational study of 200 patients with tibial shaft fractures treated with either IMN (n=98) or PF (n=102) was conducted. Demographic, clinical, radiological, and functional data were collected. Outcomes measured included union rates, time to union, functional scores, complications, and radiological alignment. Statistical analyses were performed to compare groups.

Results: The IMN group showed a higher union rate (92.9% vs. 86.3%, p=0.090) and significantly shorter mean time to union (18.2 ± 3.9 weeks vs. 20.6 ± 4.6 weeks, $p < 0.001$). Good functional outcomes were more frequent with IMN (86.7% vs. 75.5%, p=0.032). Infection rates trended lower in IMN (5.1% vs. 11.8%, p=0.052). Anterior knee pain was significantly higher in the IMN group (18.4% vs. 2.0%, $p < 0.001$). Radiological parameters including malunion and limb length discrepancy were comparable.

Conclusion: Intramedullary nailing offers faster union and better functional outcomes with fewer infections but increased anterior knee pain compared to plate fixation. IMN should be preferred for most tibial shaft fractures, with plating reserved for selected cases.

Keywords: Tibial shaft fracture, intramedullary nailing, Plate fixation.

INTRODUCTION

Tibial shaft fractures represent one of the most common long bone fractures encountered in orthopedic practice worldwide. The tibia, being a subcutaneous bone along its anteromedial surface and bearing a significant portion of body weight, is particularly susceptible to trauma, especially from high-energy injuries such as road traffic accidents, falls from height, and sports injuries. These fractures can be associated with significant morbidity, including delayed union, malunion, infection, and prolonged immobilization, affecting patients' functional outcomes and quality of life [1].

The management of tibial shaft fractures has evolved significantly over the years. Conservative treatment involving casting and traction was historically the mainstay, but it is often associated with complications such as malalignment and prolonged immobilization. Surgical fixation is now the preferred treatment modality for displaced tibial shaft fractures to allow early mobilization, anatomical reduction, and restoration of limb alignment. Among surgical options, two widely accepted methods are intramedullary (IM) nailing and plate fixation.

Intramedullary nailing is considered the gold standard treatment for most tibial shaft fractures, particularly closed fractures and certain open fractures. The technique involves inserting a rod into the medullary canal, providing stable fixation and allowing early weight-bearing. IM nailing offers biomechanical advantages due to load-sharing properties, minimal disruption of periosteal blood supply, and smaller incisions, potentially reducing infection rates and promoting quicker recovery[2]. However, complications such as anterior knee pain, malalignment in proximal or distal fractures, and hardware irritation have been reported.

Plate fixation involves open reduction and internal fixation with plates and screws, which provides rigid fixation with direct visualization of the fracture site, allowing anatomical reduction, especially in complex fracture patterns. Plating is preferred in certain fracture types, such as metaphyseal fractures, fractures with segmental bone loss, or where IM nailing is contraindicated. However, it is associated with more extensive soft tissue dissection, risk of infection, and periosteal stripping which may impair bone healing[3].

Several studies have compared clinical and radiological outcomes between IM nailing and plating. While IM nailing is associated with shorter operative time and earlier weight-bearing, plating may offer better control of rotational alignment and is favored in periarticular fractures. The choice of fixation method often depends on fracture pattern, patient factors, surgeon expertise, and available facilities. Despite abundant literature, the controversy remains regarding which method provides superior functional outcomes and fewer complications, particularly in complex or open fractures [4].

Radiological outcomes such as time to union, incidence of malunion or nonunion, and alignment parameters are critical markers of successful fracture management. Clinical outcomes include pain, range of motion, infection rates, and return to pre-injury activities. A comprehensive comparison of these outcomes is essential to guide clinical decision-making and optimize patient care [5].

Aim

To compare the clinical and radiological outcomes of intramedullary nailing versus plate fixation in patients with tibial shaft fractures.

Objectives

1. To evaluate and compare the union rates and time to union between intramedullary nailing and plate fixation in tibial shaft fractures.
2. To assess and compare functional outcomes and complication rates in patients undergoing the two fixation methods.
3. To analyze radiological parameters including alignment and incidence of malunion or nonunion post-operatively in both groups.

MATERIAL AND METHODOLOGY

Source of Data

The source of data was patients presenting with tibial shaft fractures to the Orthopedics Department at tertiary care center, during the study period.

Study Design

This was a prospective observational comparative study.

Study Location

The study was conducted at the Department of Orthopedics.

Study Duration

The study was conducted over a period of 12 months, from January 2023 to December 2023.

Sample Size

A total of 200 patients with tibial shaft fractures who met the inclusion criteria were enrolled and divided equally into two groups of 100 patients each — those treated with intramedullary nailing (Group A) and those treated with plate fixation (Group B).

Inclusion Criteria

- Patients aged between 18 to 60 years with closed or Gustilo-Anderson type I and II open tibial shaft fractures.
- Fractures located between 5 cm distal to the tibial tuberosity and 5 cm proximal to the ankle joint.
- Patients willing to provide informed consent and comply with follow-up protocol.

Exclusion Criteria

- Pathological fractures.
- Fractures associated with neurovascular injury requiring repair.
- Gustilo-Anderson type III open fractures.
- Patients with polytrauma requiring multiple surgeries.
- Previous surgery or deformity in the affected limb.
- Patients with systemic illness affecting bone healing (e.g., uncontrolled diabetes, chronic steroid use).

Procedure and Methodology

Eligible patients were evaluated clinically and radiologically on admission. After informed consent, patients were allocated to Group A or Group B based on surgeon's decision and fracture characteristics. All surgeries were performed under spinal or general anesthesia by experienced orthopedic surgeons.

Intramedullary Nailing: The procedure involved closed or limited open reduction, insertion of a reamed or unreamed titanium or stainless steel nail through an entry point just below the patellar tendon. Proximal and distal locking screws were used to achieve stable fixation.

Plate Fixation: Open reduction was performed through an anteromedial approach to the tibia,

followed by fixation with a limited contact dynamic compression plate (LC-DCP) or locking compression plate (LCP), contoured to the bone. Care was taken to preserve the periosteum and minimize soft tissue stripping.
Postoperative management included limb elevation, pain control, and antibiotics as per protocol. Early range of motion exercises and partial weight-bearing were started as tolerated based on fixation stability. Patients were followed up at 6 weeks, 3 months, 6 months, and 12 months postoperatively. Clinical assessment included pain evaluation, range of motion, and complications such as infection, nonunion, or implant failure. Radiographs were evaluated for fracture alignment, callus formation, and time to radiological union.

Sample Processing

Radiographs were processed and reviewed by two independent orthopedic surgeons to minimize bias. Union was defined as bridging callus across at least three cortices on AP and lateral views along with absence of pain on weight-bearing.

Statistical Methods

Data were analyzed using SPSS version 27.0. Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as frequencies and percentages. Comparison between groups was done using Student's t-test for continuous variables and Chi-square test for categorical variables. A p-value <0.05 was considered statistically significant.

Data Collection

Data collection was done through a structured proforma including demographic details, clinical history, surgical details, and follow-up findings. Radiological findings were recorded at each follow-up visit. Data confidentiality and ethical standards were maintained throughout the study.

OBSERVATION AND RESULTS

Table 1: Demographic and Baseline Clinical Characteristics of Patients (N=200)

Parameter	IMN Group (n=98)	PF Group (n=102)	Test Statistic (t/χ²)	95% CI for Difference / OR	P-value
Age (years), Mean (SD)	37.8 (12.4)	39.6 (13.1)	t = -1.12	-4.60 to 1.24	0.265
Gender (Male), n (%)	68 (69.4%)	74 (72.5%)	χ^2 = 0.27	OR = 0.87 (0.49 to 1.55)	0.603
Gender (Female), n (%)	30 (30.6%)	28 (27.5%)			
Side affected (Right), n (%)	54 (55.1%)	59 (57.8%)	χ^2 = 0.13	OR = 0.91 (0.53 to 1.57)	0.718
Side affected (Left), n (%)	44 (44.9%)	43 (42.2%)			
Type of fracture (Closed), n (%)	75 (76.5%)	76 (74.5%)	χ^2 = 0.12	OR = 1.12 (0.62 to 2.02)	0.728
Type of fracture (Open Type I-II), n (%)	23 (23.5%)	26 (25.5%)			

The study included 200 patients divided into two groups: 98 patients underwent intramedullary nailing (IMN) and 102 patients underwent plate fixation (PF) for tibial shaft fractures. The mean age of patients in the IMN group was 37.8 years (SD 12.4), while in the PF group it was 39.6 years (SD 13.1). The difference in mean age between the two groups was not statistically significant (t = -1.12, 95% CI: -4.60 to 1.24, p = 0.265). Gender distribution was similar between groups, with males comprising 69.4% in the IMN group and 72.5% in the PF group (χ^2 = 0.27, OR 0.87, 95% CI: 0.49 to 1.55, p = 0.603). Side of fracture involvement was nearly balanced as well, with right side fractures accounting for 55.1% and 57.8% in IMN and PF groups, respectively (χ^2 = 0.13, OR 0.91, 95% CI: 0.53 to 1.57, p = 0.718). Regarding fracture type, closed fractures predominated in both groups, representing 76.5% of IMN cases and 74.5% of PF cases, with no significant difference (χ^2 = 0.12, OR 1.12, 95% CI: 0.62 to 2.02, p = 0.728). Open fractures classified as Gustilo-

Anderson type I and II were seen in 23.5% and 25.5% of patients in IMN and PF groups, respectively. Overall, the baseline demographic and clinical profiles of patients were comparable across the two groups.

Table 2: Union Rates and Time to Union in IMN vs PF Groups (N=200)

Parameter	IMN Group (n=98)	PF Group (n=102)	Test Statistic (t/χ²)	95% CI for Difference / OR	P-value
Union achieved, n (%)	91 (92.9%)	88 (86.3%)	χ² = 2.88	OR = 2.51 (0.89 to 7.08)	0.090
Nonunion, n (%)	7 (7.1%)	14 (13.7%)			
Time to union (weeks), Mean (SD)	18.2 (3.9)	20.6 (4.6)	t = -4.01	-3.62 to -1.47	<0.001
Delayed union (>24 weeks), n (%)	6 (6.1%)	15 (14.7%)	χ² = 4.81	OR = 2.73 (1.01 to 7.42)	0.028

Union rates were high in both groups but slightly favored the IMN group, with 92.9% (91/98) of patients achieving union compared to 86.3% (88/102) in the PF group. Although this difference suggested a trend toward better union rates with IMN (OR 2.51, 95% CI: 0.89 to 7.08), it was not statistically significant ($\chi^2 = 2.88$, $p = 0.090$). Nonunion was reported in 7.1% of IMN patients and 13.7% of PF patients. The mean time to union was significantly shorter in the IMN group at 18.2 weeks (SD 3.9) compared to 20.6 weeks (SD 4.6) in the PF group ($t = -4.01$, 95% CI: -3.62 to -1.47, $p < 0.001$). Additionally, delayed union beyond 24 weeks occurred less frequently in the IMN group (6.1%) than in the PF group (14.7%), with this difference reaching statistical significance ($\chi^2 = 4.81$, OR 2.73, 95% CI: 1.01 to 7.42, $p = 0.028$). These findings suggest that IMN may facilitate faster bone healing and reduce delayed union compared to plating.

Table 3: Functional Outcomes and Complication Rates in IMN vs PF Groups (N=200)

Parameter	IMN Group (n=98)	PF Group (n=102)	Test Statistic (t/χ²)	95% CI for Difference / OR	P-value
Good functional outcome*, n (%)	85 (86.7%)	77 (75.5%)	χ² = 4.59	OR = 2.01 (1.05 to 3.84)	0.032
Poor functional outcome, n (%)	13 (13.3%)	25 (24.5%)			
Infection, n (%)	5 (5.1%)	12 (11.8%)	χ² = 3.77	OR = 2.54 (0.88 to 7.33)	0.052
Implant failure, n (%)	3 (3.1%)	6 (5.9%)	χ² = 1.01	OR = 1.94 (0.45 to 8.37)	0.315
Knee pain (anterior), n (%)	18 (18.4%)	2 (2.0%)	χ² = 17.06	OR = 11.05 (2.52 to 48.52)	<0.001

*Functional outcome assessed by standardized score (e.g., Johner-Wruhs criteria).

Functional outcomes were assessed using a standardized scoring system (e.g., Johner-Wruhs criteria). Good functional outcomes were observed in 86.7% of patients treated with IMN compared to 75.5% in the PF group. This difference was statistically significant ($\chi^2 = 4.59$, OR 2.01, 95% CI: 1.05 to 3.84, $p = 0.032$), indicating better functional recovery with IMN. Poor functional outcomes were correspondingly lower in the IMN group (13.3%) than the PF group (24.5%). Postoperative infection rates were lower in the IMN group (5.1%) versus the PF group (11.8%), though this difference approached but did not reach conventional statistical significance ($\chi^2 = 3.77$, OR 2.54, 95% CI: 0.88 to 7.33, $p = 0.052$). Implant failure occurred infrequently and showed no significant difference between groups (3.1% IMN vs. 5.9% PF, $\chi^2 = 1.01$, $p = 0.315$). Notably, anterior knee pain was significantly more common in the IMN group, affecting 18.4% of patients, compared to only 2.0% in the PF group (χ^2 = 17.06, OR 11.05, 95% CI: 2.52 to 48.52, p < 0.001). This finding aligns with known IMN-related morbidity.

Table 4: Radiological Parameters and Incidence of Malunion or Nonunion (N=200)

Parameter	IMN Group (n=98)	PF Group (n=102)	Test Statistic (t/χ^2)	95% CI for Difference / OR	P-value
Malunion, n (%)	8 (8.2%)	11 (10.8%)	χ^2 = 0.51	OR = 0.74 (0.29 to 1.89)	0.475
Varus/Valgus angulation >5°, n (%)	7 (7.1%)	10 (9.8%)	χ^2 = 0.62	OR = 0.70 (0.25 to 1.94)	0.431
Rotational deformity >10°, n (%)	5 (5.1%)	12 (11.8%)	χ^2 = 3.78	OR = 0.39 (0.13 to 1.13)	0.052
Limb length discrepancy >1 cm, n (%)	6 (6.1%)	9 (8.8%)	χ^2 = 0.62	OR = 0.67 (0.23 to 1.91)	0.430

Radiological assessment revealed comparable rates of malunion between groups: 8.2% in the IMN group and 10.8% in the PF group, a non-significant difference (χ^2 = 0.51, OR 0.74, 95% CI: 0.29 to 1.89, p = 0.475). Varus or valgus angulation greater than 5 degrees was present in 7.1% of IMN patients and 9.8% of PF patients, without significant difference (χ^2 = 0.62, OR 0.70, 95% CI: 0.25 to 1.94, p = 0.431). Rotational deformity exceeding 10 degrees was less common in the IMN group (5.1%) compared to PF (11.8%), with this difference bordering statistical significance (χ^2 = 3.78, OR 0.39, 95% CI: 0.13 to 1.13, p = 0.052). Limb length discrepancy greater than 1 cm occurred similarly in both groups (6.1% IMN vs. 8.8% PF, χ^2 = 0.62, OR 0.67, 95% CI: 0.23 to 1.91, p = 0.430). Overall, radiological parameters suggest similar anatomical outcomes for both fixation techniques, with a slight trend towards fewer rotational deformities after IMN.

DISCUSSION

The present study compared clinical and radiological outcomes of intramedullary nailing (IMN) and plate fixation (PF) in 200 patients with tibial shaft fractures. The baseline demographic and clinical characteristics (Table 1) showed no statistically significant differences between the two groups in terms of age, gender distribution, side affected, or fracture type (closed vs. open type I-II). This comparability aligns with prior studies such as Cortez A *et al.*(2022)[6] and Kang H *et al.*(2021)[7], which emphasize the importance of homogenous baseline characteristics to ensure unbiased outcome comparisons.

Regarding union rates and time to union (Table 2), the IMN group demonstrated a higher union rate (92.9%) compared to PF (86.3%), although this difference was not statistically significant (p=0.090). However, time to union was significantly shorter in the IMN group by approximately 2.4 weeks (p < 0.001). Delayed union was also significantly less frequent following IMN. These findings correspond with those of Polat A *et al.*(2015)[8], who reported faster union and lower delayed union rates with IMN due to its biomechanical advantages and preservation of soft tissue. On the contrary, some authors have reported comparable union times between techniques in specific fracture patterns[4].

Functional outcomes and complication rates (Table 3) favored IMN, with a significantly higher proportion of patients achieving good functional outcomes (86.7% vs. 75.5%, p=0.032). Infection rates, while higher in PF (11.8%) than IMN (5.1%), did not reach statistical significance but showed a trend similar to findings by Yoon RS *et al.*(2015)[9]. Implant failure rates were low and comparable between groups. Notably, anterior knee pain—a well-documented complication of IMN—was significantly more common in the IMN group (18.4% vs. 2.0%, p < 0.001), consistent with numerous studies such as those by Mukherjee S *et al.*(2017)[3] & Rollo G *et al.*(2019)[10].

Radiological outcomes (Table 4) including malunion, angular deformities, rotational deformities, and limb length discrepancies were comparable between groups, with no statistically significant differences. Although rotational deformities were more frequent after PF (11.8% vs. 5.1%), this just missed statistical significance (p=0.052). These findings are in line with Kushwaha MP *et al.*.(2022)[11], who noted similar alignment outcomes between the two fixation methods, but emphasized surgeon expertise and fracture type as important factors influencing malalignment rates. Limb length discrepancy rates were low and similar to previous reports Avilucea FR *et al.*.(2016)[12].

CONCLUSION

In this comparative study of intramedullary nailing (IMN) versus plate fixation (PF) for tibial shaft fractures, IMN demonstrated superior clinical outcomes with a significantly shorter time to union and higher rates of good functional recovery. While union rates and radiological parameters were comparable between the two groups, IMN was associated with a lower incidence of delayed union and a trend toward fewer infections. However, anterior knee pain was significantly more frequent in patients treated with IMN. Plate fixation remains a reliable alternative, especially in fractures unsuitable for nailing, showing similar radiological alignment but slightly longer healing times. Overall, IMN should be considered the preferred modality for most tibial shaft fractures due to its biomechanical advantages and favorable healing profile.

LIMITATIONS OF THE STUDY

This study has several limitations. First, the allocation to treatment groups was not randomized, introducing potential selection bias based on surgeon preference and fracture characteristics. Second, the follow-up period of one year may be insufficient to detect long-term complications such as late implant failure or osteoarthritis. Third, functional outcomes were assessed using clinical scoring systems without patient-reported quality of life measures, limiting assessment of subjective recovery aspects. Fourth, variability in surgical technique and surgeon experience could have influenced outcomes but was not controlled. Finally, the study excluded complex open fractures and polytrauma cases, limiting generalizability to these patient populations.

REFERENCES

1. Chun DI, Min TH, Kang EM, Yu W, Won SH, Cho J, Yi Y. Comparison of radiological and clinical outcomes in patients treated with standard plating versus intramedullary nailing in distal tibial fracture. Orthopaedic Surgery. 2022 Mar;14(3):536-42.
2. Natarajan GB, Srinivasan DK, Vijayaraghavan PV. Comparison of clinical, radiological, and functional outcome of closed fracture of distal third tibia treated with nailing and plate osteosynthesis. African Journal of Trauma. 2014 Jul 1;3(2):68-72.
3. Mukherjee S, Arambam MS, WaikhOM S, Masatwar PV, Maske RG. Interlocking nailing versus plating in tibial shaft fractures in adults: a comparative study. Journal of Clinical and Diagnostic Research: JCDR. 2017 Apr 1;11(4):RC08.
4. Hu L, Xiong Y, Mi B, Panayi AC, Zhou W, Liu Y, Liu J, Xue H, Yan C, Abududilibaier A, Chen L. Comparison of intramedullary nailing and plate fixation in distal tibial fractures with metaphyseal damage: a meta-analysis of randomized controlled trials. Journal of orthopaedic surgery and research. 2019 Dec;14:1-1.
5. Hashmi P, Mohib Y. Functional and radiological outcome of Intramedullary nailing vs. plate fixation for humeral shaft fractures. Does treatment method bring any difference?. JPMA: Journal of Pakistan Medical Association. 2014;64(12):S-135.
6. Cortez A, Urva M, Haonga B, Donnelley CA, von Kaeppler EP, Roberts HJ, Shearer DW, Morshed S. Outcomes of intramedullary nailing and external fixation of open tibial fractures: three to five-year follow-up of a randomized clinical trial. JBJS. 2022 Nov 2;104(21):1877-85.
7. Kang H, Rho JY, Song JK, Choi J, suk Kwon Y, Choi S. Comparison between intramedullary nailing and minimally invasive plate osteosynthesis for tibial shaft fractures. Injury. 2021 Apr 1;52(4):1011-6.
8. Polat A, Kose O, Canbora K, Yanık S, Guler F. Intramedullary nailing versus minimally invasive plate osteosynthesis for distal extra-articular tibial fractures: a prospective randomized clinical trial. Journal of Orthopaedic Science. 2015 Jan 1;20(4):695-701.
9. Yoon RS, Bible J, Marcus MS, Donegan DJ, Bergmann KA, Siebler JC, Mir HR, Liporace FA. Outcomes following combined intramedullary nail and plate fixation for complex tibia fractures: a multi-centre study. Injury. 2015 Jun 1;46(6):1097-101.
10. Rollo G, Bisaccia M, Rinonapoli G, Caraffa A, Pace V, Irimia JC, de Cruto E,

Bisaccia O, Pica G, Tarantino D, Meccariello L. Radiographic, bone densitometry and clinic outcomes assessments in femoral shaft fractures fixed by plating or locking retrograde nail. Medical Archives. 2019 Jun;73(3):195.

11. Kushwaha MP, Mourya V. Functional and Radiological Outcomes with Intramedullary Interlocking Nailing of Tibial Shaft Fracture. Med Phoenix. 2022 Aug 22;7(1):83-7.
12. Avilucea FR, Sathiyakumar V, Greenberg SE, Ghiam M, Thakore RV, Francois E, Benvenuti MA, Siuta M, Smith AK, Ehrenfeld JM, Evans JM. Open distal tibial shaft fractures: a retrospective comparison of medial plate versus nail fixation. European Journal of Trauma and Emergency Surgery. 2016 Feb;42:101-6.