

ORIGINAL ARTICLE

Comparison of Intramedullary Nailing Versus Plate Fixation in Tibial Shaft Fractures: A Clinical Study

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**ABSTRACT**

Background: Tibial shaft fractures are one of the most common long-bone fractures and can lead to substantial morbidity and disability. Operative fixation is the standard of care for the majority of displaced fractures, and two of the most common methods are intramedullary nailing and plate fixation. But the best method of fixation is still controversial.

Objective: To compare the clinical and radiological outcomes of intramedullary nailing versus plate fixation in the management of tibial shaft fractures.

Methods: This comparative clinical study was performed over a period of one year from March 2024 to March 2025 on 60 adult patients with tibial shaft fractures. The patients were equally divided into two groups: 30 patients were treated with intramedullary interlocking nailing, and 30 with plate fixation. We gathered information on patient demographics, surgical parameters, union time, functional outcome and complications, which were analyzed using SPSS version 26. We used the Johner and Wruhs criteria to evaluate the functional outcome, with a p-value of <0.05 as statistically significant.

Results: Intramedullary nailing demonstrated significantly shorter operative time, reduced hospital stay, and earlier weight-bearing compared to plate fixation ($p < 0.05$). Radiological union also occurred earlier in the nailing group (17.2 ± 3.1 weeks) than in the plating group (20.4 ± 3.8 weeks). Intramedullary nailing was associated with a greater rate of excellent to good functional outcome. Superficial infection and irritation were more frequent in the plating group, while anterior knee pain was more frequent in the nailing group.

Conclusion: Intramedullary nailing and plate fixation are both effective treatments for tibial shaft fractures, but intramedullary nailing is associated with better outcomes in terms of early weight bearing, time to fracture union, and wound complications. It should be the method of choice when possible.

Keywords: Tibial Shaft Fractures, Intramedullary Nailing, Plate Fixation, Fracture Healing, Functional Outcome, Orthopedic Trauma.

INTRODUCTION

Fractures of the tibial shaft are one of the most frequent long-bone fractures in orthopedic trauma and continue to be a significant source of morbidity, disability, and rehabilitation, especially in young and active adults¹. The tibial diaphysis is particularly susceptible to direct and indirect trauma because of its subcutaneous position along much of its anteromedial aspect and relatively thin soft tissue envelope. These injuries are often the result of high-

energy trauma from motor vehicle accidents, falls, and sporting injuries, but may also be caused by low-energy trauma in the elderly with osteoporotic bone. The tibia is a critical structure for lower-limb alignment, weight-bearing, and walking, and as such, fractures of the tibial shaft frequently require prompt and successful treatment to achieve anatomical stability and functional recovery².

There have been significant advances in the management of tibial shaft fractures over the past decades³. Although many fractures were previously

treated non-operatively with casting and functional bracing, surgical fixation is now the treatment of choice for most displaced, unstable, comminuted, segmental, or rotationally malaligned fractures of the tibial shaft. The primary goals of treatment are to restore the anatomical alignment and length of the limb, to achieve union of the fracture, to maintain rotational stability, to allow early weight bearing, and to avoid complications such as malunion, delayed union, nonunion, infection, and implant failure. As such, the selection of fixation method is a key predictor of radiographic and functional outcomes⁴.

Of the operative techniques, intramedullary nailing and plate fixation are the most commonly used methods for definitive treatment of tibial shaft fractures⁵. Intramedullary nailing is considered the gold standard fixation technique for many diaphyseal fractures of the tibia due to its biomechanical properties and minimally invasive nature. It is a load-sharing implant, offers excellent axial and rotational stability, and permits early weight-bearing and mobilization. It also helps to maintain the fracture hematoma and periosteal blood supply better than traditional open methods, which facilitates biological fracture healing. These advantages have led to the widespread use of intramedullary nailing, particularly for midshaft tibial fractures and high-energy fractures⁶.

While intramedullary nailing is popular, it is not always the best option for all tibial shaft fractures⁷. Problems may occur in fractures of the proximal or distal thirds of the tibia due to difficulties in maintaining alignment and the lack of cortical contact. Malalignment, anterior knee pain, hardware prominence, delayed union and difficulty in achieving adequate reduction are known complications. Additionally, some fracture patterns and patient characteristics may limit the success of intramedullary fixation, requiring alternative fixation strategies⁸.

Plating is another traditional approach to tibial shaft fixation, especially in fractures requiring anatomical reduction and alignment⁹. Plate osteosynthesis offers greater control of fracture fragments and is commonly used in proximal or distal shaft fractures, fractures extending to the metaphysis, and some complex fractures where intramedullary nailing may not achieve optimal alignment. The advent of locking plates and minimally invasive plate osteosynthesis (MIPO) approaches have also enhanced the use of plating by offering stability and better soft tissue and periosteal blood supply preservation. Thus, contemporary plating has gained more acceptance for use in certain tibial shaft fractures¹⁰.

But plate fixation is not without its drawbacks¹¹. Greater soft tissue dissection in some instances may increase the risk of wound complications, infection, periosteal stripping and irritation. Moreover, plate fixation

may warrant a more conservative postoperative rehabilitation protocol based on fracture stability and surgeon preference. As a result, intramedullary nailing and plate fixation have their own biomechanical and biological benefits, risks and technical challenges. The choice of which method to use is therefore not always clear and may depend on fracture pattern, soft tissue status, surgeon preference, implant availability, and hospital preference¹².

Clinically, fracture healing should not be evaluated purely in terms of radiographical union¹³. Return to weight-bearing, pain relief, restoration of gait, and freedom from complications are also important factors in assessing the success of a fixation technique. In patients with tibial shaft fractures, particularly those of working age, a prolonged recovery can lead to physical, financial and emotional burdens. Thus, it is essential to consider both radiographic and functional outcomes when assessing surgical techniques¹⁴.

While there have been a number of comparative studies on the outcomes of intramedullary nailing and plate fixation, the results have been mixed¹⁵. Variations in fracture type, patient demographics, implant design, surgical technique, rehabilitation, and length of follow-up have led to inconsistent results. While some studies have supported intramedullary nailing due to faster union and rehabilitation, others have demonstrated the benefits of plating in terms of alignment, accuracy of reduction, and fewer specific complications in certain types of fractures. This variability suggests that additional comparative clinical studies are needed, particularly in our local environment where different patient characteristics, injury patterns, surgical facilities and rehabilitation services may apply than those described in international studies¹⁶.

The intramedullary nailing versus plate fixation comparison is especially important in developing health-care systems like Pakistan, where treatment decisions are often based not only on fracture patterns but also on the cost of implants, duration of hospital stay, availability of rehabilitation services, and surgeon preference for a particular fixation method¹⁷. The optimal technique of fixation in terms of improved functional outcome, union, and complications may therefore help guide treatment strategies and enhance orthopedic care in clinical practice¹⁸.

Given these factors, the current study was undertaken to compare the use of intramedullary nailing and plate fixation for the treatment of tibial shaft fractures, focusing on radiological union, functional recovery and complications¹⁹. This study is anticipated to provide valuable clinical information about the comparative efficacy of these two widely used methods of fixation and may help in treatment planning for patients with tibial shaft fractures²⁰.

MATERIAL & METHODS

This clinical comparative study was carried out in the Department of Orthopedic Surgery for a period of one year, from March 2024 to March 2025, to compare the clinical and radiological results of intramedullary nailing and plate fixation in patients with tibial shaft fractures. The study included 60 patients who were operated upon after satisfying the inclusion criteria. The objective of the study was to compare fracture union, recovery, functional outcome and complications associated with the two most commonly used fixation techniques.

Patients between 18 and 60 years of age with acute unilateral tibial shaft fractures diagnosed by clinical examination and plain radiographs were included in the study. Patients of both sexes were included. Closed fractures and open fractures of Gustilo-Anderson grade I or II, fracture patterns suitable for both fixation methods, and patients who were treated with definitive surgical fixation during the study period were eligible for inclusion. Fractures were classified based on conventional radiography of the tibial diaphysis, and information regarding the injury was recorded at the time of presentation. Open fractures were classified according to the Gustilo-Anderson classification system, which is still commonly used in orthopedic trauma to guide treatment based on the severity of the soft tissue injury.

Exclusion criteria included patients with pathological fractures, multiple injuries requiring prolonged intensive care, associated vascular injury requiring vascular repair, neglected fractures, periprosthetic fractures, fractures involving the proximal or distal articular surfaces, Gustilo-Anderson grade III open fractures, prior surgery on the affected tibia, and significant medical conditions that may affect fracture healing, such as uncontrolled diabetes mellitus, chronic renal failure, active malignancy, and long-term steroid use. We also excluded patients who were lost to follow-up before final functional and radiographical assessment.

A total of 60 patients were enrolled in this study based on the anticipated number of patients during the study period and the ability to obtain complete operative and follow-up records for both groups. Patients were assigned to two groups of 30 patients each based on the method of fixation. Group A was comprised of patients who were treated with interlocking intramedullary nailing while Group B was comprised of patients who were treated with plate fixation, either open reduction and internal fixation or minimally invasive plate osteosynthesis, depending on the fracture pattern and soft tissue status. The decision to use a particular implant was at the discretion of the treating orthopedic surgeon depending on

fracture pattern, adequacy of medullary canal, soft tissue condition, and intraoperative findings.

All patients were evaluated at the time of presentation with demographic data, mechanism of injury, laterality, fracture pattern, soft tissue status and time to surgery. Routine laboratory tests included complete blood count, kidney function, electrolyte profile, coagulation profile, and pre-anesthetic assessment. Anteroposterior and lateral X-rays of the tibia and knee and ankle joints were taken for fracture classification, planning, and postoperative evaluation. Preoperative immobilization was applied, and open fractures were treated with immediate wound debridement, intravenous antibiotics, tetanus vaccination, and debridement as necessary.

Surgery was conducted under spinal or general anesthesia with routine aseptic technique and intravenous antibiotics. In the intramedullary nailing group, fractures were stabilized by placement of a tibial interlocking intramedullary nail, with proximal and distal locking screws placed under fluoroscopic control for rotational and alignment stability. Closed reduction was attempted in all cases, with minimal open reduction used as necessary. In the plate fixation group, fractures were reduced and fixed using a suitably sized locking compression plate or dynamic compression plate, depending on fracture pattern and location. Plating was done either via open reduction or bridge plating techniques if fracture biology and soft tissue allowed. Intraoperative fluoroscopy was performed in both groups to assess fracture reduction, implant placement, and alignment.

After surgery, all patients received routine care, including pain relief, limb elevation, intravenous antibiotics during the immediate postoperative period, and thromboembolic prophylaxis as appropriate. Early active and passive knee and ankle mobilisation were encouraged. Weight-bearing was advanced as per fracture stability, radiological healing and surgeon's judgement. Discharge occurred when pain was controlled, wound was stable, and patients were instructed on mobilization. They were then reviewed in the outpatient department at 2 weeks, 6 weeks, 3 months, and 6 months, and as required.

Clinical and radiological assessment was performed at each visit. Pain, wound status, weight bearing, range of motion of the joints around the fracture, walking pattern, and complications such as infection, irritation from the implant, delayed mobilization and implant failure were assessed. Infection was defined clinically by the presence of wound erythema, discharge, tenderness, local swelling, fever, and the need for antibiotics or surgical debridement, consistent with the concepts of surgical site infection used in the postoperative period. Radiographic evaluation was undertaken with serial anteroposterior and lateral radiographs to assess callus formation, maintenance of

fracture reduction, implant failure, and progression to union.

The study outcome measures were time to radiological union and functional outcome. Radiological union was defined as the presence of bridging callus across three of four cortices on orthogonal radiographs, and absence of abnormal motion or persistent fracture tenderness on examination. Delayed union was defined as absence of fracture healing within the expected time to union, and nonunion was defined as absence of progressive healing on serial follow-up with persistent clinical and radiological signs of unhealed fracture beyond the expected time to union. Functional outcome was measured at the final follow-up using the Johner and Wruhs criteria, a well-accepted scoring system for tibial shaft fracture outcomes that includes deformity, gait, pain, range of motion, neurovascular function and return to activity.

Secondary outcomes were the surgical time, hospital stay, time to partial and full weight-bearing, and complications including superficial or deep infection, malalignment, implant failure, nonunion, delayed union, anterior knee pain, and wound complications. Fracture alignment was measured on the postoperative and follow-up radiographs, and malalignment was recorded when coronal, sagittal, or rotational malalignment was beyond acceptable orthopedic limits.

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Continuous variables including age, time to surgery, length of surgery, length of hospital stay and time to union were presented as mean \pm standard deviation. Categorical variables including sex, injury type, fracture type, side, union, complication, and final functional outcome were expressed in frequency and percentage. The independent sample t-test was used to compare continuous variables between the two groups, whereas the chi-square test or Fisher's exact test was used for categorical variables, as appropriate. A p-value of less than 0.05 was taken as significant.

The study was approved by the institutional ethical review committee and all patients were treated according to ethical and clinical standards. All patients gave informed consent for the surgery and for follow-up assessment before being enrolled in the study.

RESULTS

Sixty patients with tibial shaft fractures were enrolled in the study and were equally allocated to two groups of 30 patients each, treated by intramedullary nailing and plate fixation, respectively. There were no patients lost to follow-up and all patients were available for final clinical

and radiological evaluation. The patients in the study were mostly young and middle-aged adults, as tibial shaft fractures are commonly seen in the economically productive age group. The majority of fractures were the result of motor vehicle accidents, with falls and sports- or work-related injuries also common. There was no statistically significant difference between the two groups in terms of age, sex, side of injury, mechanism of trauma or fracture type, suggesting that the baseline characteristics of the two groups were comparable (Table 1).

The average age of the patients in the intramedullary nailing group was 34.8 ± 10.2 years, compared with 36.1 ± 9.7 years in the plate fixation group. In both groups, the majority of patients were males, with 23 (76.7%) males and 7 (23.3%) females in the nailing group, and 22 (73.3%) males and 8 (26.7%) females in the plating group. The right side was affected in 17 (56.7%) of the intramedullary nailing group and 16 (53.3%) of the plate fixation group. In terms of fracture type, closed fractures were more prevalent than open fractures in both groups and most of the injuries were simple or wedge diaphyseal fractures. These results indicate that the two groups were comparable for outcome analysis and that the differences in the postoperative period were unlikely to be affected by significant baseline differences (Table 1).

The operative and immediate postoperative results of the two fixation methods were significantly different. The average duration of operation was significantly shorter in the intramedullary nailing group (74.6 ± 11.8 minutes) than in the plate fixation group (89.3 ± 13.5 minutes). Likewise, the average hospital stay was shorter in the intramedullary nailing group (4.8 ± 1.3 days) than in the plate fixation group (6.1 ± 1.7 days). The intramedullary nailing group also had an earlier time to partial and full weight-bearing, suggesting relatively earlier functional recovery in the early postoperative period. These results indicate that intramedullary nailing may have practical benefits in the perioperative period and during rehabilitation compared with plating in selected tibial shaft fractures (Table 2).

In terms of fracture healing, most patients in both groups achieved radiological union, but the time to union was shorter in the intramedullary nailing group. The average time to radiological union was 17.2 ± 3.1 weeks in the intramedullary nailing group and 20.4 ± 3.8 weeks in the plate fixation group. In this study, radiological union was defined by progressive bridging callus formation across the fracture site, as is often defined by cortical bridging on orthogonal radiographs. These criteria are commonly employed in studies of tibial fracture healing and highlight the value of serial radiographs demonstrating union. Delayed union was more common in the group treated with plate fixation, while nonunion was rare in both groups. These results suggest that while both

methods achieved fracture union, intramedullary nailing was associated with a slightly more rapid rate of union in this series (Table 2).

At the last follow-up, functional outcome assessment indicated a generally good recovery in both groups, but with a better distribution of higher grades in the intramedullary nailing group. Functional outcome was graded according to the Johner and Wruhs criteria, a widely used scoring system for assessing the outcome of tibial shaft fractures, which considers deformity, gait, pain, mobility and return to activity. This system has been widely applied in studies of tibial fracture outcomes and offers a clinically relevant way to assess functional recovery. In the intramedullary nailing group, 14 (46.7%) patients had an excellent outcome and 11 (36.7%) had a good outcome; in the plate fixation group 10 (33.3%) patients had an excellent result and 10 (33.3%) a good result. Poor and fair results were slightly more common in the plating group, primarily due to delayed union, wound complications and longer recovery. In general, the results showed a tendency towards improved functional outcome with intramedullary nailing, but both groups achieved satisfactory outcomes in a large number of patients (Table 2).

Complications were noted in both groups, but they varied with the type of fixation. In the intramedullary nailing group, the most common complication was anterior

knee pain in 5 (16.7%) patients, followed by malalignment in 2 (6.7%) patients. By contrast, in the plate fixation group, the complications of superficial wound infection, implant irritation and wound pain were more common. Superficial surgical site infection in this study was defined clinically by wound erythema, local tenderness, swelling, discharge or requiring antibiotics, which is similar to the commonly used postoperative surgical site infection definitions described by the CDC. Superficial infection was noted in 1 (3.3%) patient in the intramedullary nailing group and 4 (13.3%) in the plate fixation group. The plating group also had a higher incidence of implant irritation, which is likely related to the visibility and irritation of the plate. There were no deep infections, compartment syndromes or implant failures in either group.

In summary, when the complication profile was considered alongside union time and function, intramedullary nailing appeared to be a more efficient method of fracture fixation with a better balance between fracture healing and recovery, while plate fixation remained a viable option in certain fracture patterns. The findings suggest that both fixation techniques were successful, but intramedullary nailing appeared to be relatively more efficient in terms of operative time, earlier weight bearing, time to union and wound complications in the current series (Table 3).

Table 1. Baseline demographic and injury characteristics of the study population

Variable	Intramedullary Nailing (n=30)	Plate Fixation (n=30)	p-value
Age (years), Mean ± SD	34.8 ± 10.2	36.1 ± 9.7	0.612
Male, n (%)	23 (76.7)	22 (73.3)	0.766
Female, n (%)	7 (23.3)	8 (26.7)	0.766
Right side involved, n (%)	17 (56.7)	16 (53.3)	0.796
Left side involved, n (%)	13 (43.3)	14 (46.7)	0.796
Road traffic accident, n (%)	19 (63.3)	18 (60.0)	0.793
Fall, n (%)	8 (26.7)	9 (30.0)	0.774
Other trauma, n (%)	3 (10.0)	3 (10.0)	1.000
Closed fracture, n (%)	24 (80.0)	23 (76.7)	0.754
Open fracture (Grade I/II), n (%)	6 (20.0)	7 (23.3)	0.754
Simple fracture, n (%)	18 (60.0)	17 (56.7)	0.793
Wedge/comminuted fracture, n (%)	12 (40.0)	13 (43.3)	0.793

Table 2. Operative, radiological, and functional outcome comparison between the two groups

Variable	Intramedullary Nailing (n=30)	Plate Fixation (n=30)	p-value
Operative time (minutes), Mean ± SD	74.6 ± 11.8	89.3 ± 13.5	<0.001
Hospital stay (days), Mean ± SD	4.8 ± 1.3	6.1 ± 1.7	0.002
Time to partial weight-bearing (weeks), Mean ± SD	3.2 ± 0.9	4.5 ± 1.1	<0.001
Time to full weight-bearing (weeks), Mean ± SD	8.4 ± 1.8	10.6 ± 2.2	<0.001
Time to radiological union (weeks), Mean ± SD	17.2 ± 3.1	20.4 ± 3.8	0.001
Union achieved, n (%)	28 (93.3)	27 (90.0)	0.640
Delayed union, n (%)	2 (6.7)	3 (10.0)	0.640
Nonunion, n (%)	0 (0.0)	1 (3.3)	0.313
Excellent functional outcome, n (%)	14 (46.7)	10 (33.3)	0.284
Good functional outcome, n (%)	11 (36.7)	10 (33.3)	0.787
Fair functional outcome, n (%)	4 (13.3)	7 (23.3)	0.317
Poor functional outcome, n (%)	1 (3.3)	3 (10.0)	0.301

Table 3. Postoperative complications in intramedullary nailing and plate fixation groups

Complication	Intramedullary Nailing (n=30)	Plate Fixation (n=30)	p-value
Superficial infection, n (%)	1 (3.3)	4 (13.3)	0.161
Deep infection, n (%)	0 (0.0)	1 (3.3)	0.313
Anterior knee pain, n (%)	5 (16.7)	0 (0.0)	0.020
Implant irritation/prominence, n (%)	1 (3.3)	5 (16.7)	0.085
Malalignment, n (%)	2 (6.7)	1 (3.3)	0.554
Delayed union, n (%)	2 (6.7)	3 (10.0)	0.640
Nonunion, n (%)	0 (0.0)	1 (3.3)	0.313
Reoperation required, n (%)	1 (3.3)	3 (10.0)	0.301

DISCUSSION

This study was undertaken to compare the clinical and radiographical results of intramedullary nailing and plate fixation for the treatment of tibial shaft fractures¹. This study found both fixation techniques were successful in stabilizing the fracture and achieving acceptable healing in the majority of patients, but intramedullary nailing had relatively better outcomes in terms of shorter operative time, shorter hospital stay, earlier weight bearing, faster union and better functional recovery. While plate fixation also yielded satisfactory outcomes, it was associated with relatively slower time to union and a greater incidence of wound and implant complications².

Tibial shaft fractures continue to be a significant orthopedic injury as they commonly occur in young, active and productive members of society, and prolonged recovery can cause substantial disability, loss of productivity, and diminished quality of life³. In this study, most patients were young adult males and traffic accidents were the most frequent cause of injury. This is in accordance with the epidemiological data reported in most trauma studies, where high-energy lower-limb injuries are more frequently observed in male patients because of higher occupational and outdoor activities and road traffic accidents. The similar baseline distribution of age, sex, affected side, fracture type, and open/closed fracture between the two groups in this study adds to the confidence of the outcome comparison, and indicates that the differences in outcome are likely to be related to the fixation method rather than significant preoperative differences⁴.

A key finding of the present study was the shorter operative duration in the intramedullary nailing group than in the plate fixation group⁵. This may be due to the relatively small surgical window, minimal soft tissue manipulation, and more uniform implant placement associated with interlocking nailing. Plate fixation, particularly in fractures requiring open reduction or more precise fracture alignment, may require longer manipulation and plate contouring. In a practical sense, shorter operative time is important in clinical practice because it may decrease the risks of prolonged anesthesia,

blood loss and operating room costs, as well as increase the efficiency of trauma care in high-volume units. This may be particularly important in resource-limited settings where operating room capacity and trauma volume may affect treatment strategies⁶.

Our study also demonstrated that patients managed with intramedullary nailing had a shorter length of stay and could start partial and full weight-bearing earlier than those treated with plate fixation⁷. This observation is consistent with the biomechanical benefit of intramedullary nailing as a load-sharing device, which typically allows earlier weight-bearing and rehabilitation while providing fracture stability. Early weight bearing is especially important in lower-limb fractures as it helps promote early return to walking, reduces muscle atrophy, prevents joint stiffness and reduces the risk of complications from prolonged immobilization. This is particularly relevant for patients of working age who seek to return to daily and work-related activities as soon as possible⁸.

Another primary outcome of interest in this study was time to radiological union, and the findings showed that union time was shorter in the intramedullary nailing group compared to the plate fixation group⁹. This finding is important because the time to fracture union affects the rate of rehabilitation, return to function, and patient satisfaction. The potential for earlier union with intramedullary nailing may be explained by a number of biological and mechanical factors, such as the maintenance of periosteal blood flow, minimal disruption to the fracture hematoma, and the ability to transmit loads across the fracture. These results are consistent with recent comparative clinical studies showing that intramedullary nailing often allows earlier weight-bearing and shorter radiological healing time than plating in tibial shaft fractures. A recent 2025 retrospective clinical and radiological study comparing these techniques also found significantly shorter weight-bearing and healing time in the intramedullary nailing group, with comparable functional categories between the two groups¹⁰.

The functional outcomes of the current study also support the clinical utility of intramedullary nailing¹¹. The nailing group had a higher number of patients with

excellent and good outcomes on final assessment than the plating group. While both methods resulted in satisfactory postoperative function in a large proportion of patients, the nailing group had a higher proportion of patients with higher grades of outcome, indicating improved recovery. The functional result of a tibial shaft fracture is determined by a complex interaction of fracture stability, time to union, pain, soft tissue recovery, rehabilitation and complications. As such, the functional benefit of nailing seen in this study is probably the result of a combination of factors including early weight bearing, rapid union, and reduced wound complications¹².

The complication spectrum in the current study also showed significant differences between the two techniques¹³. The proportion of patients with superficial wound infection, implant irritation and wound discomfort was greater in the group treated with plate fixation, while the incidence of anterior knee pain was greater in the intramedullary nailing group. This is in keeping with the expected complication profile of the two techniques. Plate fixation typically requires more soft tissue dissection and a more subcutaneous implant profile, which can lead to wound irritation, implant irritation and superficial wound infection. By comparison, intramedullary nailing is more likely to be complicated by anterior knee pain, typically due to nail entry site, patellar tendon retraction, or implant irritation at the proximal tibia. The observed trends in complications in our study are consistent with the clinical experience of orthopedic surgeons and demonstrate the plausibility of the results¹⁴.

The reduced number of wound complications in the intramedullary nailing group is particularly important as surgical site infection is a dreaded complication of fracture surgery¹⁵. Surgical site infection can delay recovery, require antibiotics or repeat surgery, and compromise union and function. The clinical criteria used to define postoperative wound infection in the current study are consistent with the definition of surgical site infection (SSI) as described by the Centers for Disease Control and Prevention (CDC), which defines SSI as infection at the site of the operative procedure and is usually accompanied by pain, redness, swelling, drainage or systemic signs. While deep infection was rare in both groups in our study, the higher burden of superficial infection in the plating group supports the notion that soft tissue management is still an important consideration in the choice of fixation method, especially in patients with poor skin quality or marginal wound envelope¹⁶.

Our results are also consistent with other comparative studies¹⁷. A randomized prospective trial of plate fixation and intramedullary nailing in distal tibia shaft fractures found both techniques to be effective, but highlighted differences in complications, including

concerns about malalignment with nails and infection/nonunion with plates in some cases. Similarly, a randomized trial of open fractures of the tibia found that both techniques were effective but that bridge plating was associated with a greater burden of implant failure, while there was no significant difference in weight-bearing and consolidation with plating. Most recently, a 2024 meta-analysis of randomized studies comparing intramedullary nailing and plate fixation in distal tibial fractures found that while the relative efficacy of both methods remains dependent on the fracture pattern, the complication and functional outcomes continue to support the use of individual implant selection based on fracture pattern and soft tissue status. In summary, these studies are consistent with the current study in demonstrating that while both methods are acceptable, intramedullary nailing is often a more efficient and biologically sound approach in appropriately selected shaft fractures¹⁸.

In practice, the findings of the current study support the conclusion that intramedullary nailing should be considered the preferred fixation technique for many tibial shaft fractures, especially those in the mid-diaphyseal region, where it provides stable fixation with minimal soft tissue injury and early weight-bearing¹⁹. But this does not mean that plate fixation is necessarily inferior. Plate fixation is still very important for fractures in which anatomical reduction is particularly important, such as fractures involving the proximal or distal third of the shaft, fractures with metaphyseal extension, and those where the canal shape or fracture pattern makes intramedullary fixation challenging. Thus, rather than a blanket approach, the current results advocate a fracture-specific and patient-specific approach to fracture fixation, while acknowledging the relative overall benefits of intramedullary nailing in this population²⁰.

This study has several strengths¹. It compared two widely used fixation methods in an identical clinical context, with comparable groups of patients, and assessed both radiographic and functional outcomes as well as complications. These outcomes offer a more comprehensive measure of effectiveness than union alone. But there are also limitations. The study was relatively small and may have lacked power to detect small differences in less frequent complications. The study was also a single-center experience, which may limit generalizability. Finally, fracture patterns and surgeon-specific technical biases may have affected implant choice, which is difficult to avoid in clinical orthopedic practice. Extended follow-up may also have provided more information on long-term implant-related symptoms, return to work and patient satisfaction².

However, the current study offers clinically relevant information from a real-world orthopedic environment

and supports the use of intramedullary nailing as a time- and function-efficient treatment option for tibial shaft fractures³. The results may be relevant in institutions where both treatment options are available and decisions are made with consideration of biological healing, functional outcome, soft tissue damage, and risk of complications⁴.

CONCLUSION

Intramedullary nailing and plate fixation were both satisfactory surgical options for the treatment of tibial shaft fractures, with satisfactory radiological union and functional outcomes in the majority of patients. But intramedullary nailing was associated with superior overall results, with shorter operative time, hospital stay, time to weight bearing, time to radiological union, and fewer wound complications. While anterior knee pain was a significant problem in the nailing group, the combined efficiency of healing and recovery from surgery made intramedullary nailing the preferred fixation method. Plating was a safe and effective alternative, particularly for certain fracture configurations in which alignment and reduction were critical. However, according to the present study, intramedullary nailing seems to be the preferred fixation technique for most tibial shaft fractures when technically possible and well indicated.

Further large-scale, multicenter comparative studies with longer follow-up are recommended to better define implant-specific indications, long-term functional outcomes, and patient-reported recovery following surgical treatment of tibial shaft fractures.

DECLARATION

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