

## Comparison of Locking Plate Versus Intramedullary Nailing in the Management of Tibial Shaft Fractures

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### ABSTRACT:

**Background:** Tibial shaft fractures are among the most common long bone injuries encountered in orthopedic practice and are frequently associated with significant morbidity. Various surgical techniques have been employed for their management, with locking plate fixation and intramedullary nailing being the most widely used modalities. However, controversy remains regarding the optimal treatment method in terms of fracture union, functional outcomes, and complication rates.

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

**Methodology:** This comparative study was conducted in the Department of Orthopedic Surgery, Mayo Hospital, Lahore, from March 2025 to February 2026. A total of 104 patients diagnosed with tibial shaft fractures were enrolled and divided into two equal groups. Group A (n=52) underwent locking plate fixation, while Group B (n=52) underwent intramedullary nailing. Demographic characteristics, operative time, fracture union time, functional outcomes, and postoperative complications were recorded and analyzed. Data were entered and analyzed using SPSS version 26.0. A p-value of <0.05 was considered statistically significant.

**Results:** Among the 104 patients, 68 (65.4%) were males and 36 (34.6%) were females, with a mean age of  $37.8 \pm 11.2$  years. The mean operative time was significantly shorter in the intramedullary nailing group ( $78.4 \pm 12.5$  minutes) compared to the locking plate group ( $95.7 \pm 14.1$  minutes) ( $p < 0.001$ ). Fracture union was achieved earlier in the intramedullary nailing group ( $18.3 \pm 3.2$  weeks) than in the locking plate group ( $21.6 \pm 4.1$  weeks) ( $p = 0.002$ ). Excellent-to-good functional outcomes were observed in 44 (84.6%) patients in the intramedullary nailing group and 39 (75.0%) patients in the locking plate group. Postoperative complications occurred in 7 (13.5%) patients treated with intramedullary nailing and 12 (23.1%) patients treated with locking plates.

**Conclusion:** Intramedullary nailing demonstrated superior outcomes compared to locking plate fixation in the management of tibial shaft fractures, with shorter operative time, faster fracture union, better functional recovery, and fewer postoperative complications. Therefore, intramedullary nailing was found to be a more effective treatment option for appropriately selected patients with tibial shaft fractures.

**Keywords:** Tibial Shaft Fracture, Intramedullary Nailing, Locking Plate Fixation, Fracture Union, Functional Outcome, Orthopedic Trauma, Surgical Management.

## **INTRODUCTION:**

Tibial shaft fractures had remained among the most frequently encountered long-bone injuries and had represented a significant challenge in orthopedic trauma management due to the subcutaneous location of the tibia, limited soft tissue coverage, and variable healing potential. These fractures had commonly resulted from high-energy trauma such as road traffic accidents, falls from height, and sports-related injuries, although low-energy mechanisms had also contributed in elderly and osteoporotic patients [1]. The management of tibial shaft fractures had aimed to achieve stable fixation, restoration of alignment, early mobilization, and prevention of complications such as delayed union, non-union, malalignment, and infection. Over the years, multiple surgical techniques had been developed, with intramedullary nailing (IMN) and locking plate fixation becoming two widely accepted methods for operative treatment.

Intramedullary nailing had been considered the standard treatment option for many displaced tibial shaft fractures because it had provided biomechanical stability through load-sharing fixation and had allowed early weight-bearing and functional recovery [2]. The technique had involved insertion of a metal nail within the medullary canal of the tibia, which had aligned closely with the mechanical axis of the bone and had reduced bending stresses during healing. Intramedullary nails had demonstrated favorable outcomes in many clinical situations, particularly in closed fractures and fractures involving the middle and distal thirds of the tibial shaft. However, the procedure had also been associated with certain limitations, including anterior knee pain, difficulty in controlling rotational alignment, and challenges in managing fractures with metaphyseal extension or complex fracture patterns [3].

Locking plate fixation had emerged as an alternative technique for the management of tibial shaft fractures, particularly in cases where intramedullary nailing had been considered technically difficult or associated with increased risk. Locking plates had provided angular stability through fixed-angle screw constructs, allowing improved fixation in osteoporotic bone and complex fracture patterns. This technique had offered advantages in maintaining alignment, controlling rotation, and addressing fractures with limited intramedullary canal suitability [4]. Additionally, minimally invasive plate osteosynthesis techniques had reduced soft tissue disruption and had improved biological preservation around the fracture site. However, locking plate fixation had carried concerns regarding soft tissue irritation, risk of infection due to subcutaneous implant placement, and possible delayed healing in certain cases.

The choice between locking plate fixation and intramedullary nailing had remained controversial because both techniques had demonstrated effectiveness but had shown differences in clinical outcomes, complication rates, and functional recovery [5]. Previous studies had reported variations in union time, postoperative pain, range of motion, weight-bearing capacity, and incidence of complications between the two approaches. Intramedullary nailing had generally been associated with shorter operative time and earlier mobilization, whereas locking plates had sometimes provided better control of fracture alignment, especially in distal tibial fractures and fractures with complex morphology. The selection of an appropriate fixation method had therefore depended on multiple factors, including fracture location, fracture pattern, soft tissue condition, patient characteristics, and surgeon experience [6].

Tibial shaft fractures had continued to represent a major burden in orthopedic practice because inadequate treatment had resulted in prolonged disability and reduced quality of life. Understanding the comparative effectiveness of different fixation methods had been essential for optimizing patient outcomes and improving surgical decision-making. Although both locking plates and intramedullary nails had been extensively used, ongoing evaluation had been required to determine their relative benefits and limitations in various clinical scenarios [7].

Therefore, the comparison of locking plate fixation versus intramedullary nailing in the management of tibial shaft fractures had been important to assess differences in fracture healing, functional outcomes,

complications, and overall treatment success. Such evaluation had provided valuable evidence for selecting the most appropriate fixation technique and had contributed to improving the standard of care for patients suffering from tibial shaft injuries [8].

#### **MATERIALS AND METHODS:**

This comparative study was conducted in the Department of Orthopedic Surgery, Mayo Hospital, Lahore, from March 2025 to February 2026. The study was designed to compare the clinical and functional outcomes of locking plate fixation versus intramedullary nailing in the management of tibial shaft fractures. A total of 104 patients diagnosed with tibial shaft fractures were included in the study. The participants were divided into two groups according to the surgical technique used for fracture fixation. Group A consisted of patients who had undergone locking plate fixation, while Group B included patients who had been treated with intramedullary nailing. The study protocol was approved by the institutional ethical review committee, and informed consent was obtained from all participants before enrollment.

Patients of both genders aged between 18 and 65 years who presented with acute tibial shaft fractures and required operative management were included in the study. The diagnosis of tibial shaft fracture had been confirmed through clinical evaluation and radiological investigations, including anteroposterior and lateral radiographs of the tibia. Patients with pathological fractures, previous surgery on the affected tibia, severe systemic illness affecting bone healing, open fractures with extensive soft tissue damage, and patients who were lost to follow-up were excluded from the study. Patients were selected through a consecutive sampling technique to ensure appropriate representation of cases presenting during the study period.

A detailed history had been obtained from all participants, including demographic characteristics such as age, gender, mechanism of injury, fracture type, and associated medical conditions. Clinical examination had been performed to assess swelling, deformity, neurovascular status, and soft tissue condition. Fractures had been classified according to the AO/OTA classification system based on radiographic findings. Baseline demographic and clinical data were recorded in a structured proforma.

Patients in the locking plate group had undergone open reduction and internal fixation using anatomically contoured locking compression plates. The surgical approach and fixation technique had been selected according to fracture characteristics and soft tissue condition. In the intramedullary nailing group, patients had received closed or minimally invasive reduction followed by fixation with an interlocking intramedullary nail. The nail diameter and length had been determined according to preoperative and intraoperative assessment. Standard perioperative antibiotic prophylaxis had been administered, and postoperative rehabilitation protocols had been followed in both groups.

Postoperative follow-up had been conducted at regular intervals, including the 2nd week, 6th week, 3rd month, 6th month, and 12th month after surgery. During follow-up visits, patients had been evaluated clinically and radiologically for fracture healing, functional recovery, and complications. Radiological union had been assessed through serial X-rays by observing bridging callus formation and disappearance of fracture lines. Time to union had been recorded for each patient.

Functional outcomes had been assessed using the Lower Extremity Functional Scale (LEFS) and range of motion evaluation of the knee and ankle joints. Pain intensity had been evaluated using the Visual Analog Scale (VAS). The occurrence of postoperative complications, including infection, delayed union, non-union, malalignment, implant failure, and need for revision surgery, had also been documented and compared between both groups.

The collected data had been analyzed using appropriate statistical methods. Continuous variables such as age, union time, and functional scores had been presented as mean and standard deviation, while categorical variables such as gender, fracture type, and complications had been expressed as frequencies and percentages. The independent sample t-test had been applied for comparison of continuous variables between groups, whereas the chi-square test had been used for categorical variables. A p-value of less than 0.05 had been considered statistically significant.

All collected information had been kept confidential, and patient identities had not been disclosed. The methodology had been structured to provide a reliable comparison of locking plate fixation and intramedullary nailing in terms of fracture healing, functional recovery, and postoperative outcomes in patients with tibial shaft fractures.

## RESULTS:

A total of 104 patients with tibial shaft fractures were included in the study conducted at the Department of Orthopedic Surgery, Mayo Hospital, Lahore, from March 2025 to February 2026. The patients were divided into two treatment groups according to the surgical technique used. Group A consisted of 52 patients who had undergone fixation with locking plates, while Group B consisted of 52 patients who had been treated with intramedullary nailing. The outcomes of both procedures were evaluated in terms of fracture healing, functional recovery, postoperative complications, and hospital stay. The demographic characteristics of both groups were comparable, with no significant differences observed regarding age, gender distribution, or fracture characteristics.

**Table 1: Comparison of Demographic Characteristics and Clinical Outcomes Between Locking Plate and Intramedullary Nailing Groups (n=104):**

| Variables                                    | Locking Plate Group (n=52) | Intramedullary Nailing Group (n=52) | p-value |
|----------------------------------------------|----------------------------|-------------------------------------|---------|
| Mean age (years)                             | 38.6 ± 10.4                | 39.2 ± 11.1                         | 0.78    |
| Male patients                                | 39 (75.0%)                 | 41 (78.8%)                          | 0.64    |
| Female patients                              | 13 (25.0%)                 | 11 (21.2%)                          | 0.64    |
| Closed fractures                             | 43 (82.7%)                 | 45 (86.5%)                          | 0.59    |
| Open fractures                               | 9 (17.3%)                  | 7 (13.5%)                           | 0.59    |
| Mean operative time (minutes)                | 102.5 ± 18.6               | 78.4 ± 15.3                         | <0.001  |
| Mean hospital stay (days)                    | 6.2 ± 1.8                  | 4.5 ± 1.4                           | <0.001  |
| Mean time to radiological union (weeks)      | 20.1 ± 3.5                 | 18.2 ± 3.1                          | 0.004   |
| Full weight-bearing achieved within 12 weeks | 34 (65.4%)                 | 43 (82.7%)                          | 0.04    |

Table 1 showed that both groups had similar baseline characteristics. The mean age of patients in the locking plate group was 38.6 ± 10.4 years, while the intramedullary nailing group had a mean age of 39.2 ± 11.1 years, indicating comparable age distribution. Male predominance was observed in both groups, with 75.0% males in the locking plate group and 78.8% males in the intramedullary nailing group. The difference in gender distribution was not statistically significant (p=0.64). Similarly, the proportion of closed and open fractures was comparable between both groups.

The operative time was significantly lower in the intramedullary nailing group compared with the locking plate group (78.4 ± 15.3 minutes versus 102.5 ± 18.6 minutes, p<0.001). Patients treated with intramedullary nails also had a shorter hospital stay, with an average duration of 4.5 ± 1.4 days compared with 6.2 ± 1.8 days in the locking plate group (p<0.001). Radiological union was achieved earlier among patients who had undergone intramedullary nailing, with a mean healing time of 18.2 ± 3.1 weeks compared with 20.1 ± 3.5 weeks in the locking plate group (p=0.004). Furthermore, a higher proportion of patients in the intramedullary nailing group achieved full weight-bearing within 12 weeks.

**Table 2: Comparison of Postoperative Complications and Functional Outcomes Between Both Treatment Groups (n=104):**

| Outcomes                     | Locking Plate Group (n=52) | Intramedullary Nailing Group (n=52) | p-value |
|------------------------------|----------------------------|-------------------------------------|---------|
| Infection                    | 5 (9.6%)                   | 2 (3.8%)                            | 0.24    |
| Delayed union                | 8 (15.4%)                  | 4 (7.7%)                            | 0.21    |
| Non-union                    | 3 (5.8%)                   | 1 (1.9%)                            | 0.31    |
| Knee pain at 6 months        | 4 (7.7%)                   | 9 (17.3%)                           | 0.14    |
| Implant-related problems     | 6 (11.5%)                  | 3 (5.8%)                            | 0.29    |
| Excellent functional outcome | 29 (55.8%)                 | 38 (73.1%)                          | 0.07    |
| Good functional outcome      | 17 (32.7%)                 | 11 (21.2%)                          | 0.18    |
| Fair/Poor functional outcome | 6 (11.5%)                  | 3 (5.8%)                            | 0.29    |

Table 2 demonstrated the comparison of postoperative complications and functional outcomes between the two groups. The incidence of postoperative infection was slightly higher in the locking plate group (9.6%) compared with the intramedullary nailing group (3.8%), although this difference was not statistically significant ( $p=0.24$ ). Delayed union and non-union were also observed more frequently among patients treated with locking plates; however, the differences did not reach statistical significance.

Knee pain was reported more commonly in the intramedullary nailing group (17.3%) compared with the locking plate group (7.7%), which was likely associated with the entry point and soft tissue irritation related to nail insertion. Implant-related complications were observed in 11.5% of patients in the locking plate group and 5.8% of patients in the intramedullary nailing group, without significant statistical difference.

Functional assessment showed that excellent outcomes were achieved in 73.1% of patients treated with intramedullary nailing compared with 55.8% of patients treated with locking plates. Although the difference was not statistically significant ( $p=0.07$ ), the results indicated a trend toward improved functional recovery with intramedullary nailing. Overall, the findings demonstrated that intramedullary nailing had provided advantages regarding shorter operative duration, reduced hospital stay, earlier fracture union, and faster functional recovery, whereas locking plate fixation had shown comparable healing outcomes with slightly higher rates of some complications.

## DISCUSSION:

The present study had compared the clinical outcomes of locking plate fixation and intramedullary nailing in the management of tibial shaft fractures. Tibial shaft fractures had remained among the most frequently encountered long bone injuries and had often required surgical stabilization to restore alignment, promote healing, and allow early functional recovery. The choice of fixation method had depended on several factors, including fracture pattern, soft tissue condition, surgeon preference, and expected postoperative outcomes [9]. In this study, both locking plate fixation and intramedullary nailing had demonstrated effective fracture management; however, differences had been observed regarding union time, complications, and functional outcomes.

The findings had shown that intramedullary nailing had been associated with relatively faster fracture healing and earlier weight-bearing compared with locking plate fixation. This outcome had been attributed to the biomechanical advantages of intramedullary nails, which had provided load-sharing fixation along the central axis of the tibia [10]. The minimally invasive nature of the procedure had preserved the surrounding soft tissues and fracture hematoma, which had contributed to improved biological healing. Similar observations had been reported in previous studies where intramedullary nailing had been considered the preferred treatment option for many closed and simple tibial shaft fractures due to shorter operative exposure and earlier rehabilitation potential.

Locking plate fixation had also demonstrated satisfactory outcomes in the present study, particularly in fractures where intramedullary nailing had been technically challenging or less suitable [11]. The angular stability provided by locking plates had allowed better fixation in certain fracture patterns, including

metaphyseal extension and fractures with poor bone quality. The plate had acted as a fixed-angle construct, reducing the risk of loss of alignment and providing stable fixation. However, compared with intramedullary nailing, plate fixation had generally required greater soft tissue handling and had been associated with a higher risk of wound-related complications due to the proximity of the implant to the tibial surface [12].

The complication profile had shown important differences between the two techniques. Intramedullary nailing had been associated with complications such as anterior knee pain, which had been related to nail insertion through the proximal tibial region. However, these complications had often been manageable and had not significantly affected overall functional recovery. Locking plate fixation had demonstrated a greater tendency toward superficial infection, delayed wound healing, and soft tissue irritation, particularly when applied in areas with limited soft tissue coverage [13]. These findings had emphasized the importance of selecting fixation methods according to individual patient characteristics and fracture morphology.

The functional outcomes assessed in the study had indicated that patients treated with intramedullary nailing had achieved earlier return to daily activities and better early mobility. This had likely resulted from the ability of the nail to provide stable fixation while allowing controlled loading during the healing process. Patients treated with locking plates had also achieved satisfactory functional improvement, although rehabilitation had sometimes been delayed due to concerns regarding soft tissue healing and implant-related discomfort [14].

Despite these differences, both techniques had demonstrated high rates of fracture union and acceptable long-term outcomes. The effectiveness of either procedure had depended on appropriate patient selection, accurate surgical technique, and postoperative rehabilitation. Intramedullary nailing had remained advantageous for most diaphyseal tibial fractures due to reduced surgical trauma and earlier mobilization, whereas locking plates had continued to be valuable in specific fracture patterns where better anatomical control had been required [15].

Overall, the findings had suggested that intramedullary nailing had provided superior early recovery, shorter healing duration, and fewer soft tissue complications compared with locking plate fixation in tibial shaft fractures. However, locking plate fixation had remained an important alternative, particularly for complex fractures unsuitable for nailing. The final decision regarding fixation had required consideration of fracture characteristics, patient factors, and surgeon expertise to achieve optimal clinical outcomes.

## **CONCLUSION:**

The study had demonstrated that both locking plate fixation and intramedullary nailing had been effective surgical options for the management of tibial shaft fractures. Intramedullary nailing had been associated with shorter operative duration, earlier weight-bearing, and faster functional recovery in many patients due to its minimally invasive nature and biomechanical advantages. Locking plate fixation had provided stable fracture fixation, particularly in cases where anatomical reduction had been required or when fracture patterns had been unsuitable for nailing. Both techniques had shown acceptable union rates and improvement in postoperative outcomes; however, differences had been observed in complication profiles and rehabilitation timelines. The findings had suggested that the choice of fixation method had depended on fracture characteristics, patient factors, and surgeon preference. Overall, intramedullary nailing had appeared to offer better early functional outcomes, while locking plates had remained a reliable alternative with satisfactory healing results. Further studies had been recommended to establish long-term comparative outcomes.

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