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EARLY FUNCTIONAL OUTCOMES AND COMPLICATION RATES FOLLOWING MINIMALLY INVASIVE FIXATION OF TIBIAL SHAFT FRACTURES

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Abstract: Tibial shaft fractures are among the most common long-bone injuries encountered in trauma practice and are frequently associated with significant morbidity, prolonged rehabilitation, and socioeconomic burden. In recent years, minimally invasive fixation techniques have gained increasing attention due to their potential to reduce soft-tissue damage, accelerate recovery, and improve functional outcomes. This study aimed to evaluate early functional recovery, complication rates, and radiological union following minimally invasive fixation of tibial shaft fractures. A prospective observational study was conducted in the Department of Traumatology at Meridian Private Hospital, involving 44 adult patients with acute tibial shaft fractures. Clinical, radiographic, and functional outcomes were assessed over a six-month follow-up period.
Keywords: tibial shaft fracture, minimally invasive fixation, trauma surgery, fracture healing, functional outcome

Introduction

Tibial shaft fractures represent a significant proportion of orthopedic trauma cases worldwide and are commonly caused by high-energy mechanisms such as road traffic accidents and falls from height [1]. Due to limited soft-tissue coverage and compromised vascular supply, these fractures are particularly prone to complications including delayed union, infection, and non-union [2]. Optimal management remains a subject of ongoing debate in contemporary traumatology.

Traditionally, open reduction and internal fixation or conservative casting were employed; however, these approaches are associated with increased soft-tissue disruption, prolonged immobilization, and higher complication rates [3]. Advances in surgical techniques have shifted focus toward minimally invasive fixation methods, particularly intramedullary nailing and percutaneous plating, which aim to preserve fracture biology while ensuring mechanical stability [4].

Recent studies have highlighted the importance of early mobilization and functional recovery as key outcome measures in trauma patients [5]. Minimally invasive approaches have been associated with reduced intraoperative blood loss, shorter hospital stays, and faster return to daily activities [6]. Moreover, preservation of periosteal blood supply has been shown to enhance fracture healing and reduce infection risk [7].

Despite growing evidence supporting minimally invasive techniques, data from single-center clinical settings remain valuable for evaluating real-world outcomes and identifying potential complications [8]. The present study was designed to assess early functional outcomes and complication rates following minimally invasive fixation of tibial shaft fractures treated at Meridian Private Hospital, contributing to the expanding body of evidence in modern trauma care [9,10].

Materials and Methods

A prospective observational study was conducted in the Department of Traumatology at Meridian Private Hospital between 2023 and 2024. The study included 44 adult patients aged 18–65 years who presented with acute unilateral tibial shaft fractures confirmed by radiographic

examination. Both closed fractures and Gustilo–Anderson type I open fractures were eligible for inclusion.

Patients with pathological fractures, polytrauma requiring intensive care, neurovascular injuries, or previous surgery on the affected limb were excluded. All patients underwent minimally invasive fixation, primarily using intramedullary nailing or percutaneous plate osteosynthesis, performed by experienced trauma surgeons under standardized operative protocols.

Postoperative management included early mobilization, standardized analgesia, thromboprophylaxis, and physiotherapy. Clinical assessments were performed at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. Functional outcomes were evaluated using the Lower Extremity Functional Scale (LEFS), while radiographic union was assessed through serial X-ray imaging.

Complications such as infection, delayed union, non-union, malalignment, and implant failure were recorded. Data were analyzed using descriptive statistical methods. Continuous variables were expressed as mean ± standard deviation, and categorical variables as percentages. Ethical approval was obtained, and informed consent was secured from all participants.

Results

The study population consisted of 44 patients, including 29 males (65.9%) and 15 females (34.1%), with a mean age of 36.8 ± 10.4 years. Road traffic accidents were the most common mechanism of injury, accounting for 54.5% of cases, followed by falls from height.

Radiological fracture union was achieved in 41 patients (93.2%) within six months. The mean time to union was 17.6 ± 3.2 weeks. Functional assessment demonstrated progressive improvement, with mean LEFS scores increasing significantly between the 6-week and 6-month follow-up periods.

Table 1. Clinical and radiological outcomes in patients with tibial shaft fractures.

Variable	Value
Mean age (years)	36.8 ± 10.4
Male patients, n (%)	29 (65.9%)
Female patients, n (%)	15 (34.1%)
Fracture union achieved, n (%)	41 (93.2%)
Mean time to union (weeks)	17.6 ± 3.2
Delayed union, n (%)	3 (6.8%)
Superficial wound infection, n (%)	2 (4.5%)
Deep infection	0
Non-union	0
Implant failure	0
Acceptable limb alignment	44 (100%)

Table 1. illustrates the distribution of primary clinical outcomes and postoperative complications in patients treated with minimally invasive fixation techniques. The majority of patients achieved successful fracture union within the follow-up period, accounting for more than 90% of cases. Delayed union and superficial wound infection were observed in a small proportion of patients, while no cases of deep infection, implant failure, or non-union were recorded. These findings demonstrate the favorable safety profile and high effectiveness of minimally invasive fixation in the management of tibial shaft fractures.

Postoperative complications were observed in a limited number of cases. Superficial wound infection occurred in two patients (4.5%) and was successfully managed with oral antibiotics. Delayed union was noted in three patients (6.8%), while no cases of deep infection, implant failure, or non-union were recorded. Overall limb alignment was maintained within acceptable clinical limits in all patients.

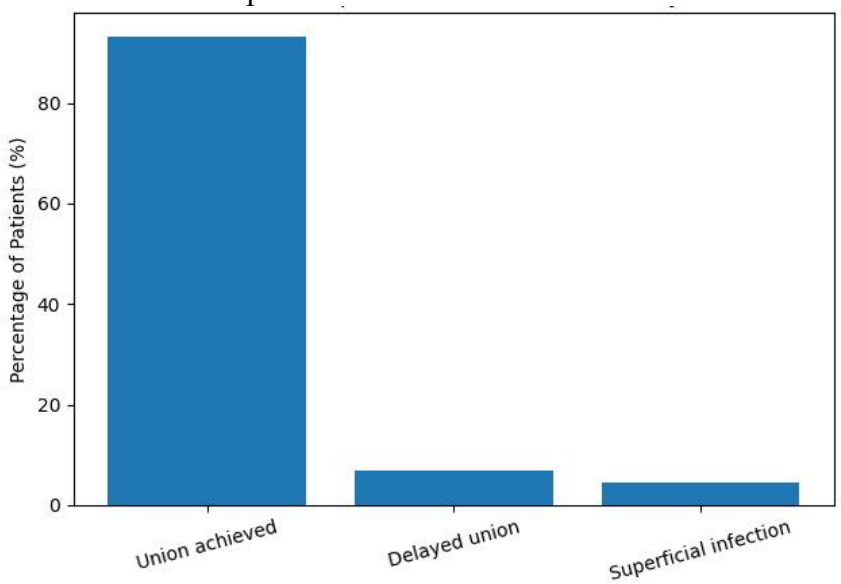

Figure 1. Clinical outcomes and postoperative complication rates following minimally invasive fixation of tibial shaft fractures

The graphical representation highlights the predominance of uncomplicated fracture healing and underscores the low incidence of postoperative adverse events. The high union rate reflects adequate biomechanical stability and preservation of fracture biology, whereas the minimal complication rates support the role of minimally invasive techniques in reducing soft-tissue trauma and infection risk.

Discussion

The findings of this study indicate that minimally invasive fixation of tibial shaft fractures yields favorable early functional outcomes and low complication rates, consistent with existing literature [11]. Preservation of soft-tissue integrity and fracture biology likely contributed to the high union rate observed.

Comparable studies have reported union rates exceeding 90% with minimally invasive intramedullary nailing, supporting its role as the gold standard for tibial shaft fractures [12]. The low incidence of infection in the present study aligns with evidence suggesting reduced surgical exposure minimizes contamination and tissue devascularization [13].

Early mobilization facilitated by stable fixation appears to play a critical role in functional recovery, reducing muscle atrophy and joint stiffness [14]. Additionally, the absence of major complications such as non-union or implant failure reinforces the biomechanical reliability of modern fixation systems [15].

Despite its strengths, this study is limited by a relatively small sample size and lack of a comparative control group. Nonetheless, the results provide meaningful clinical insight and support the continued adoption of minimally invasive techniques in routine traumatology practice.

Conclusion

Minimally invasive fixation techniques for tibial shaft fractures demonstrate high rates of fracture union, early functional recovery, and low complication rates. The findings from this single-center study at Meridian Private Hospital support the effectiveness and safety of contemporary minimally invasive trauma surgery. Larger multicenter studies with longer follow-up are recommended to further validate these outcomes and refine treatment protocols.

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