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Outcomes of Early Intramedullary Nail Fixation for Open Tibial Shaft Fracture

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Abstract **Original Research Article**

Background: Open tibial shaft fractures necessitate immediate treatment. Because of the potential of infection, treatment of open tibial shaft fractures is debatable. It is suggested that intravenous antibiotics and fracture debridement be administered within 6 to 24 hours. Few studies have looked at outcomes when surgical therapy is given more than 24 hours after the fracture occurs. ***Aim of the study:*** The purpose of this study is to identify the risk factors for nonunion and infection after early intramedullary nailing in an open tibial shaft fracture. ***Methods:*** This study was conducted in TMSS Medical College, Bogura, Bangladesh. A retrospective study looked at open tibial shaft fractures treated with primary intramedullary nailing, from January 2021 to January 2022. The study included 42 patients who were admitted to the study institution. All collected data was entered into a Microsoft Excel Work Sheet and analyzed in SPSS 11.5 using descriptive statistics. ***Results:*** Forty-two patients (42 fractures) were included: 7 Gustilo type I, 18 type II, 12 type III-A, and 5 type III-B. Infection occurred in eight patients (19%). At the latest follow-up, one patient showed signs of non-union. Infection risk did not linked with Gustilo ($p = 0.53$) or AO type ($p = 0.66$). The time between trauma and wound debridement was substantially greater in infected patients ($p = 0.049$). Forty fractures (95.2%) healed in a mean of 6.9 6.1 months (range, 2-40). Non-union was associated with AO type ($p = 0.05$) but not with Gustilo type ($p = 0.07$). ***Conclusion:*** The only factor impacting infection risk was the length of time between treatments. Non-union status was tied to AO comminution grade. Primary intramedullary nailing appeared to be reliable if treated early and with thorough debridement. The benefits are early restoration of weight-bearing and a reduced patient load.
Keywords: Open tibial fractures, Intramedullary nails, Infection, Union.

INTRODUCTION

The most common long-bone fracture is a tibial fracture. Extensive study on the clinical management and outcome of these fractures has been conducted [1]. Because of the danger of infection, primary intramedullary nailing in open tibial shaft fractures is controversial [2-4]. Complication rates increase dramatically with high intensity trauma, soft tissue damage, wound contamination, altered vascularity, and unstable fractures [5]. Several techniques have been established to reduce these problems, including the use of prophylactic antibiotics, tetanus toxoid, rapid soft tissue debridement and rebuilding, skeletal stabilisation, prophylactic bone grafting, and adjuvant treatment such as rhBMP-2 [6]. The ultimate goal is to establish bone union without infection and a completely functional pain-free limb [7]. Open fracture management is considered an orthopaedic emergency [8]. Traditionally, open tibial fractures were treated with an external fixator, preferably within six hours of injury [9]. Monolateral external fixation has been used successfully to treat open tibial fractures, but not without severe problems [10]. Plate fixation has resulted in an excessively high infection rate, necessitating the search for an alternative fracture stabilisation method [11]. The recent growth in the use of circular external fixators for open tibial fractures is encouraging, particularly in high energy injuries, although this treatment must be tailored to each patient [12]. The effectiveness of intramedullary nails in the immediate treatment of open tibial fractures is debatable [13]. The concern of osteomyelitis traditionally prohibited any type of internal fixation, particularly in the immune-compromised host, as well as delays in surgical treatment of more than six hours [14]. Reamed nails provide a biological and mechanical advantage, but they are harmful to the endosteal vasculature, perhaps increasing infection and non-union [15]. The use of intramedullary nails has advanced from low energy open Gustilo grade 1 and grade 2 fractures to more severe Gustilo grade 3 injuries, with excellent long-term results [16]. Many institutions now use both reamed and unreamed nails to ensure axial alignment, early weight bearing, bone union, and early return to pre-injury function with minimal problems [17]. The purpose of this study is to identify the risk factors for nonunion and infection after early intramedullary nailing in an open tibial shaft fracture.

Methodology

This study was conducted in TMSS Medical College, Bogura, Bangladesh. A retrospective study looked at open tibial shaft fractures treated with primary intramedullary nailing, from January 2021 to January 2022. The study included 42 patients who were admitted to the study institution. Gustilo and the AO were used to classify fractures. The location on the shaft, any bone defect, and the time between trauma and debridement were all recorded, as were skin coverage techniques and the time after therapy began. Clinical and radiographic evaluation with full-leg AP and lateral views was performed at 6 weeks, 3 months, 6 months, and thereafter monthly until healing (defined as bone callus unifying at least 3 cortices) was achieved (if not by 6 months). Delayed consolidation (non-union at 6 months but callus progression on the following X-ray) or definitive non-union at 6 months, as well as any methods to encourage consolidation (dynamization, nail change, and reaming of nail) were noted. Malunion greater than 5 frontally and/or sagittally was screened for on full-leg AP and lateral views during consolidation. CRP increase with hyperleukocytosis and purulent effusion and/or local inflammatory symptoms and/or positive bacteriology after revision surgery identified the onset of sepsis. All collected data was entered into a Microsoft Excel Work Sheet and analyzed in SPSS 11.5 using descriptive statistics.

Result

Deep infection occurred in eight individuals (19.05%), with no correlation to Gustilo or AO type (Table-1). The mean duration from trauma to debridement was 406±283 minutes (range, 85-1520 minutes), and it exceeded 6 hours in 19 cases. Septic consequences were strongly related to traumato-debridement time ($p = 0.043$): mean 594±398 minutes (range, 250-1520 minutes) with infection versus 387±264 minutes (85-1200 minutes) without infection. Six of the eight patients (75%) required more than six hours from trauma to debridement. At the most recent follow-up, 42 patients (95.24%) had bone healing after a mean of 6.9±6.1 months (range, 2-40 months). Non-union had a non-significant tendency in terms of soft-tissue involvement ($p = 0.07$). AO type was associated to healing duration ($p = 0.008$) and nonunion ($p = 0.05$) (Table-2). At 6 months, 28 patients (66.67%) did not have complete bone healing. Twelve patients had delayed consolidation, including four after dynamization before 6 months and one following nail change and reaming at 4 months for infection. Sixteen (38.1%) had non-union: 12 aseptic and 4 septic (Table-3). One septic distal tibial fracture was treated with transplantar nailing, whereas the other two required repeat debridement and bone resection, reaming and nail change, and segmental bone transport on a nail with monoplanar external fixation (Figure-1).

Table-1: Rates of deep infection and p-values

Factors	Deep infection	p-value* (* Fisher exact test)
Gustilo type		
I	14.29 (1/7)	p = 0.53
II	16.67 (3/18)	
III-A	16.67 (2/12)	
III-B	40 (2/5)	
AO type		
A	20 (4/20)	p = 0.66
B	10 (1/10)	
C	25 (3/12)	

Table -2: Non-union and bone healing time, with the p-values

Factors	**Non-union**	**p-values p*** (* Fisher exact test)	**Bone healing time (months)**	**p-values p**** (** Kruskal-Wallis test)
Gustilo type				
I	14.29 (1/7)	p = 0.07	5.5 ± 2.3 (3–12)	p = 0.29
II	27.78 (5/18)		6 ± 4.8 (2–29)	
III-A	58.33 (7/12)		8.9 ± 9.4 (3–40)	
III-B	60 (3/5)		9.2 ± 6.9 (3–23)	
AO type				
A	25 (5/20)	p = 0.05	5.5 ± 3.7 (2–23)	p = 0.008
B	30 (3/10)		8.8 ± 9.6 (3–40)	
C	66.67 (8/12)		9.2 ± 5.6 (3–21)	

Table-3: Surgical revision (for sepsis and assisted bone healing)

Procedure	**Gustilo I**	**Gustilo II**	**Gustilo III-A**	**Gustilo III-B**
Dynamization				
< 6 months	1(3 months	2 (5 months)	5 (1–2 months, 2–3 months, 2–4 months)	
> 6 months (aseptic non-union)		5 (2–7 months, 3–10 months)	1 (9 months)	1 (7 months)
Reaming ± nail change				
Sepsis < 6 months	1 (4 months)	3 (2–1 months, 1–3 months)		
Septic non-union (> 6 months)				1 (8 months)
Aseptic non-union (> 6 months/negative samples)	1 (9 months)	5 (1–7 months, 1–10 months, 2–11 months, 1–30 months + cancellous graft)		
Other/septic context				
Segmental bone transport (ascension)			1–6 months (defect + infection) Consolidation-18 months	1–6 months (defect + infection) Consolidation-15 months
Transplantar nailing (HANTM nail [Synthes*])			1 (16 months) septic non-union + on-consolidated ankle osteoarthritis at last follow-up –36 months	
Other				
Aponeurotomy/Compartment syndrome	1		1	
Supramalleolar derotation osteotomy				1

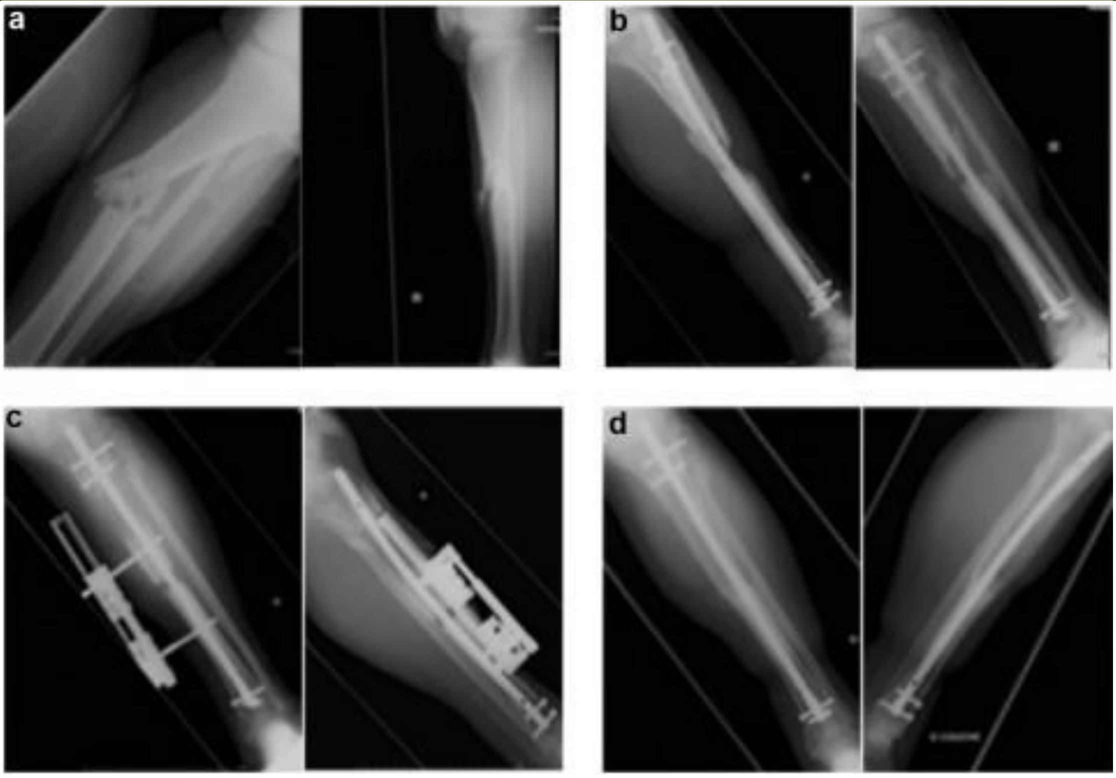

Figure-1: Gustilo type III-B open tibial shaft fracture: bone transport with intramedullary nailing at 6 months. Preoperative radiograph (a). Two months postoperative radiograph (b). At 4 months, segmental bone translocation was performed using intramedullary nailing and a monoplanar external fixator (c). Complete bone healing after 15 months (d)

DISCUSSION

The current findings were comparable to previous studies on deep infection rates after primary intramedullary nailing in open tibial shaft fractures (19.05%, compared to 6.5-12.9%, depending on the series [18], taking all Gustilo types together), and particularly for Gustilo III-B fractures (40%, compared to 20-33% [19]). These rates are lower than those reported for external fixation: 21.4-66.7% [20]. The current study had certain drawbacks. It was in retrospect. The inter-observer assessment of soft-tissue lesions varied, resulting in measurement bias [21]. The severity of soft-tissue lesions may have been initially overestimated (3 subsequent necroses), resulting in an underestimation of fracture severity. There was no difference in infection rates based on Gustilo type or degree of comminution on the AO classification. Only the time between trauma and debridement was linked to the establishment of profound infection. Some authors questioned the importance of operating within 6 hours of trauma [22], but in the current series, 75% of patients with deep infection had intervals longer than 6 hours, and it appears to us to be critical that surgery be started as soon as possible, with optimally rigorous debridement. Other factors that may have influenced infection initiation but were not investigated in this investigation include: high or low energy trauma mechanism, degree of initial wound contamination, particularly from dirt, and obesity or smoking [23]. The antibiotic prophylaxis protocol did not adhere to the French Society of Anesthesia and Intensive Care (SFAR) guidelines for open fracture, particularly Gustilo type I [24]. However, the addition of a beta-lactamase to gentamicin is suggested for badly contaminated wounds and/or treatment delays of more than 4 hours, and only two patients with Gustilo I fracture had a time interval of less than 4 hours between trauma and therapy (220 and 210 minutes, respectively). Antibiotic therapy, as well as skin covering, should be started as soon as possible [25]. Flap coverage was typically contingent on the availability of the plastic surgery team, which may have influenced the outcome of infectious complications. Consolidation was 95.24% at the most recent follow-up.

However, there was a high risk of non-union in Gustilo III fractures, which was comparable to external fixation rates [26]. There were 25 aided healing operations performed. Only four patients (9.5%), three of whom had Gustilo III-A fractures, suffered aseptic nonunion that necessitated reaming and nail modification for consolidation. We considered instances with substantial initial bone defects, which had to have a negative impact on healing and non-union outcomes. However, we believe that in such circumstances, intramedullary nailing increases subsequent segmental bone transfer [27].

Limitation of the study:

This study had a single focal point and small sample sizes. Therefore, it's possible that the study's findings don't accurately capture the overall situation.

CONCLUSION & RECOMMENDATION

Whatever the severity of the skin lesion and comminution, primary intramedullary nailing in open tibial shaft fracture appears reliable and viable. It efficiently stabilizes the fracture site, allows for skin coverage operations and early weight-bearing resumption, and is less stressful for the patient than external fixation. This internal fixation approach in Gustilo type III fractures requires emergency therapy that includes early antibiotic prophylaxis, rigorous debridement, and quick skin coverage.

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