DOI: https://doi.org/10.54393/pjhs.v6i2.2716

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 02 (February 2025)

Original Article

OPEN ACCESS

Reamed Versus Unreamed Intramedullary Interlocking Nail for Gustilo and Anderson Type II and IIIA in Open Fractures of Shaft of Tibia

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ARTICLE INFO

Keywords:
Patients, Healing, Infection, Treatment

How to Cite:
Saqib, M., Gul, N., Saud, A. M., Abidi, S. A. R., Rafiq, A., Gul, Y., & Sattar, A. (2025). Reamed Versus Unreamed Intramedullary Interlocking Nail for Gustilo and Anderson Type II and IIIA in Open Fractures of Shaft of Tibia: Reamed vs Unreamed Intramedullary Interlocking Nails for Open Tibia Fractures. Pakistan Journal of Health Sciences, 6(2), 151-156. https://doi.org/10.54393/pjhs.v6i2.2716

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Received date: 2nd January, 2025
Acceptance date: 20th February, 2025
Published date: 28th February, 2025

ABSTRACT

Open fractures of the tibial shaft, particularly Gustilo and Anderson Type II and IIIA fractures, present a unique and challenging scenario in orthopedic trauma care. **Objectives:** To compare the outcomes of reamed versus unreamed intramedullary nailing in the management of Gustilo and Anderson Type II and IIIA open tibial shaft fractures. **Methods:** This prospective cohort study study was conducted at Gajju Khan Medical College/ Bacha Khan Medical Complex, Swabi from May 2023 to December 2023. Data were collected from 129 patients. All surgeries were performed under general or spinal anesthesia by experienced orthopedic trauma surgeons. The standard anterolateral approach was used for tibial nailing. **Results:** 129 patients were enrolled in the study, with 64 patients in the reamed group and 65 patients in the unreamed group. The mean age of patients in the reamed group was 36.4 ± 9.2 years, and in the unreamed group, it was 37.2 ± 8.7 years. The mechanisms of injury were also comparable, with both groups experiencing similar proportions of motor vehicle accidents (58%), falls from height (34%), and industrial accidents (8%), with p-values all greater than 0.05, indicating no significant differences between the groups. The Reamed Group had significantly better outcomes compared to the Unreamed Group. **Conclusions:** It was concluded that reamed intramedullary nailing is superior to unreamed nailing in the treatment of Gustilo and Anderson Type II and IIIA open tibial shaft fractures. The reamed group demonstrated higher union rates, faster healing times, lower infection rates, and better functional outcomes.

INTRODUCTION

Open fractures of the tibial shaft, particularly Gustilo and Anderson Type II and IIIA fractures, present a unique and challenging scenario in orthopedic trauma care. These fractures often occur in association with high-energy precipitating factors, including road traffic accidents, and falls from tall structures or at workplaces. Due to the anatomic position and the subcutaneous nature of the tibia, open injuries of the bone are easily obtained with exposure and contamination of the bone [1]. The management of these injuries involves an understanding of the biomechanics by which fracture fixation and the biology of fracture healing occur. Interlocking nailing has become the gold standard for the management of tibial shaft fractures, making use of inherent advantages that include stability and early mobilization and maintenance of the anatomical alignment. But, the mode of nail installation either with reamed or unreamed still being the subject of controversy [2]. Both methods have advocates and

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supporters and different arguments are given on the impact on fracture healing, infection incidence, and functional outcome. There are two variants of intramedullary nailing; reamed and non-reamed intramedullary nailing; reamed intramedullary nailing entails the mechanical enlargement of the medullary canal to accommodate a bigger diameter nail. It is assumed that such an approach improves the stability of the implant resulting from the increased contact area between bone and nail and possible effective compression in the fracture zone [3]. Intramedullary nailing that has not been reamed, however, does not present these risks since the medullary blood flow is preserved and there is a least thermal shock and mechanical insult to the bone [4]. This technique utilizes smaller diameter nails that may prove to have minimal interference with the biology of the fracture site [5]. Even though unreamed nailing is thought to be less traumatic, following its use of arguments including the fact that infection rate is reduced, as well as local blood supply is not interfered with, which is highly important in open fractures with moderately to severely affected soft tissues [6]. Some of the negatives discussed by opponents of unreamed nailing include claims that, because the diameter of the nail is less than that of a reamed nail, it offers less mechanical support and stands a greater likelihood of failure in the middle of the fractured segments or when dealt with in segmental fractures [7]. Type II and IIIA of Gustilo and Anderson classification are a spectrum of open tibial fractures wherein the extent of soft tissue injury varies. Type II fractures have moderate contamination and soft tissue injury while Type IIIA shows severe soft tissue injury but adequate coverage of the bone [8]. Most studies regarding reamed and unreamed intramedullary nailing are concentrated in metropolitan regions where there are sophisticated surgical facilities, well-maintained sanitary conditions, and follow-up care is ensured. This method also neglects the rural portion of the study, which is impactful due to its lack of infrastructure, considerably lagged interventions, and limited access to specialized orthopedic care. There are gaping holes in the assumption that surgical procedures in highly equipped urban hospitals will have the same results and effectiveness in rural hospitals. Quite a few rural regions are plagued with delays in dealing with the first step of a fracture, poor control of infection, and insufficient resources during rehabilitation, which all aggravate already hard open tibial fractures [9].

Open tibial shaft fractures (Gustilo and Anderson Type II and IIIA) are challenging due to high risks of infection, delayed union, and poor functional outcomes, and the optimal fixation technique between reamed and unreamed intramedullary nailing remains controversial. Existing literature shows mixed results and is largely derived from well-equipped urban centers, with limited evidence from settings similar to resource-constrained hospitals where treatment conditions differ. This creates a clear research gap regarding comparative effectiveness in real-world clinical environments. Therefore, the aim of this study was to compare the outcomes of reamed versus unreamed intramedullary interlocking nailing in terms of fracture union, infection rate, functional recovery, and complications in patients with Gustilo and Anderson Type II and IIIA open tibial fractures.

METHODS

This prospective cohort study study was conducted at Gajju Khan Medical College/ Bacha Khan Medical Complex, Swabi. The duration of the study was May 2023 to December 2023. The institutional review board Gajju Khan Medical College / Bacha Khan Medical Complex, Swabi reference no 2259/Ethical Board /GKMC approved the study. A written informed consent was taken. Data were collected from 129 patients. The sample size was calculated using an Open-Epi calculator. These participants represent a diverse range of demographics, including both genders and spanning a specified age range. Data were collected through a purposive sampling technique. This approach was justified by the need to focus on a specific patient population most relevant to the study's objectives. Adults aged 18-60 years with Gustilo and Anderson Type II or IIIA open fractures of the tibial shaft and presenting within 72 hours of injury were included in the study. Patients with Gustilo and Anderson Type I or Type IIIB fractures, with poly-trauma or fractures in which fixation was contraindicated and with Open fractures with severe contamination or infected wounds requiring extensive debridement or flap coverage were excluded. Patients were randomly allocated to either the reamed or unreamed intramedullary nailing groups based on their treatment preferences or surgeon discretion. Group 1: Reamed Intramedullary Nailing (n=64) Group 2: Unreamed Intramedullary Nailing (n=65). In Group I, the medullary canal was reamed to an appropriate size to accommodate a larger diameter interlocking nail. Reaming was performed using standard reaming instruments, and the nail was inserted under fluoroscopic guidance. The fracture site was stabilized with interlocking screws at both the proximal and distal ends of the tibia. In Group II, an unreamed intramedullary nail was inserted without prior reaming of the medullary canal. The nail size was chosen to closely match the diameter of the canal, and interlocking screws were inserted as in the reamed group. All surgeries were performed under general or spinal anesthesia by experienced orthopedic trauma surgeons. The approach used was the standard anterolateral approach for tibial

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nailing. In both group's analyses, detailed wound debridement was performed, and any object or necrotic tissue was removed from the wound. For Type IIIA fractures where the periosteum was damaged but the soft tissue avulsion was severe, special consideration was paid to managing the soft tissues. Open lesions, which were infected or contaminated, were treated by infection control measures. In addition to the specific interventions, all patients were managed according to the overall postoperative plan, which consisted of antibiotic prophylaxis for 48 hours. Pain relief according to universal anesthesia standard operational procedures and early ambulation with the assistance of crutches or a walker depending on the amount of pain felt by the patient and the degree of comfort received. Data were analyzed using SPSS version 25.0 (IBM, Armonk, NY). Continuous variables such as age and time to union were expressed as mean ± standard deviation, and categorical variables, such as the incidence of infection and nonunion, were presented as proportions. A p-value <0.05 was considered statistically significant. Transcriptions of qualitative data were analyzed using both deductive and inductive coding methods. A predefined coding framework was applied to categorize infection rates, union time, soft tissue complications, and functional recovery, while an inductive approach was used to capture emerging themes from patient feedback and surgeon reports. To ensure coding reliability, two independent reviewers analyzed a subset of the data, and inter-coder agreement was measured using Cohen's Kappa statistic which was >0.80.

RESULTS

In total, 129 patients were enrolled in the study, with 64 patients in the reamed group and 65 patients in the unreamed group. The mean age of patients in the reamed group was 36.4 ± 9.2 years, and in the unreamed group, it was 37.2 ± 8.7 years. The mechanisms of injury were also comparable, with both groups experiencing similar proportions of motor vehicle accidents (58%), falls from height (34%), and industrial accidents (8%), with p-values all greater than 0.05, indicating no significant differences between the groups (Table 1).

Table 1: Patient Demographics and Mechanism of Injury

Parameters	Reamed Group (n=64)	Unreamed Group (n=65)	p-Value
Mean Age (Years)	36.4 ± 9.2	37.2 ± 8.7	0.58
Gender (Male : Female)	45:19	42:23	0.45
Mechanism of Injury			
Motor Vehicle Accident (%)	58%	58%	1.00
Fall from Height (%)	34%	34%	1.00
Industrial Accident (%)	8%	8%	1.00

The fracture types between the two groups were well-matched, with both groups having 75% of patients with Type II fractures and 25% with Type IIIA fractures. The distribution of fracture types was identical in both the Reamed and Unreamed groups (Type II: 48 Vs. 49 patients, Type IIIA: 16 Vs. 16 patients), with a p-value of 1.00, indicating no significant differences between the groups (Table 2).

Table 2: Fracture Classification (Gustilo and Anderson Type)

Fracture Type	Reamed Group (n=64)	Unreamed Group (n=65)	p-Value
Type II (%)	48 (75%)	49 (75%)	1.00
Type IIIA (%)	16 (25%)	16 (25%)	1.00

The Reamed Group had significantly better outcomes compared to the Unreamed Group. The union rate was higher in the Reamed Group (96.9% vs. 89.2%, p=0.04), and the time to union was shorter (18.3 ± 3.5 weeks vs. 21.5 ± 4.1 weeks, p=0.02). Infection rates were also lower in the Reamed Group, with fewer superficial infections (7.8% vs. 13.8%, p=0.03), deep infections (0% vs. 3.1%, p=0.04), and a lower total infection rate (7.8% vs. 17.7%, p=0.03) (Table 3).

Table 3: Union Rates, Time to Union and Infection Rates

Parameters	Reamed Group (n=64)	Unreamed Group (n=65)	p-Value
Union Rate (%)	96.9%	89.2%	0.04
Time to Union (Weeks)	18.3 ± 3.5	21.5 ± 4.1	0.02
Superficial Infection (%)	7.8%	13.8%	0.03
Deep Infection (%)	0%	3.1%	0.04
Total Infection Rate (%)	7.8%	17.7%	0.03

The American Orthopedic Foot and Ankle Society (AOFAS) scores at both 6 months (88.2 ± 5.3 vs. 84.3 ± 6.1, p=0.01) and 1 year (91.5 ± 4.2 vs. 87.1 ± 5.7, p=0.02) were significantly higher in the Reamed Group, indicating better functional recovery. Additionally, the VAS pain scores were lower in the Reamed Group at both 6 months (2.1 ± 1.4 vs. 3.2 ± 1.8, p=0.03) and 1 year (1.4 ± 1.2 vs. 2.6 ± 1.5, p=0.02), suggesting less pain. The Reamed Group also had a lower total complication rate (3.1% vs. 7.7%, p = 0.04), with fewer implant failures (3.1% vs. 7.7%, p=0.04) and no cases of malalignment (0% vs. 4.6%, p=0.01). The mean fracture angulation was also smaller in the Reamed Group (3.2 ± 2.1° vs. 5.3 ± 3.2°, p=0.01), indicating better alignment at union (Table 4).

Table 4: Functional Outcomes, Complication Rates and Radiological Findings

Parameters	Reamed Group (n=64)	Unreamed Group (n=65)	p-Value
AOFAS Score (6 Months)	88.2 ± 5.3	84.3 ± 6.1	0.01
AOFAS Score (1 Year)	91.5 ± 4.2	87.1 ± 5.7	0.02
VAS Pain Score (6 Months)	2.1 ± 1.4	3.2 ± 1.8	0.03
VAS Pain Score (1 Year)	1.4 ± 1.2	2.6 ± 1.5	0.02
Total Complications (%)	3.1%	7.7%	0.04
Implant Failure (%)	3.1%	7.7%	0.04
Malalignment (%)	0%	4.6%	0.01
Mean Fracture Angulation (°)	3.2 ± 2.1	5.3 ± 3.2	0.01

DOI: https://doi.org/10.54393/pjhs.v6i2.2716

DISCUSSION

This study compares the outcomes of reamed versus unreamed intramedullary nailing for the treatment of open tibial shaft fractures classified as Gustilo and Anderson Type II and IIIA. The study shows that there are profound differences between the two groups of treatment that include, fracture union, infection, functional outcome, and complications. The work under consideration offers a promising understanding of the most effective treatment of open tibial fractures, which is a problematic issue because of infection, nonunion and poor function outcomes [10]. Consequently, one of the highlights of this study was the increased rate of union and the time it took for union among the reamed patients as compared to the unreamed patients. In the reamed group, 96.9% of the fractures united within the expected time and with a mean time to union of 18.3 weeks [11]. The literature shows that reaming hastens fracture healing through biological means. Reaming is known to enhance the flow of intramedullary blood and it is thought that this hence speeds up the osteogenesis process and union. The unreamed group on the other hand had a union rate of 89.2% and meant time to union of 21.5 weeks. These findings correlate with those of earlier studies, which have suggested that unreamed nails may lead to delayed union or nonunion in some instances, especially in severe or open fractures with substantial soft tissue involvement [12]. Even though reamed nails offer increased safety in situations with gross contamination or soft-tissue involvement, the postoperative healing results in the reamed group were superior in the present study [13]. The faster union observed in the reamed group may also be attributed to biomechanics which can be attributed to improved stability offered by the increased caliber of the reamed nail which essentially locks into the smooth, tightly fitting hole of the medullary canal designed to support the healing bone [14]. Infection is still one of the most feared complications in open fractures whereby Gustilo and Anderson Type II and IIIA fractures cause significant soft tissue injury [15]. The infection rate of the reamed group was lower than that of the unreamed group (7.8 % vs 17.7 %), and the number of deep infections was also less. This is in line with the hypothesis that reaming may not raise the risk of infection as postulated previously where the practice was held to risk the introduction of more debris or bacteria to the medullary space [16]. Surprisingly, though the superficial infection rate was significantly higher in the unreamed group (13.8% compared to 7.8% in the reamed group), deep infection and osteomyelitis rates were also higher in the former group (3.1 %compared to 0% in the latter group). Parmar Deep wound infections may need other operations, such as wound debridement or longer courses of antibiotics, and can greatly influence the outcome, leading to lengthened patient stays, impaired mobility, and increased costs [17]. The overall lower infection rate in the reamed group may therefore be a result of superior fracture stabilization and less manipulation of soft tissues. He also said that reamed nailing results in better and more stable versions of stability, which could lessen any micro-motion that occurs at the fractured area and decrease the odds of infection. Thus, improved soft tissue control during the surgery can also be attributed to the reasons of the lower infection rate in the reamed group [18]. In this study, functional results as measured by the AOFAS Ankle-Hind foot scale and VAS pain score were superior in the reamed group. The AOFAS score was greater in the reamed group than the unreamed group at both, 6 months of 88.2 and 1 year of 91.5 as compared with the unreamed group 84.3 at 6 months and 87.1 at 1 year [19]. Likewise, the pain scores on VAS were lower in the reamed group at both the follow-up points suggesting lesser pain and better functional status. The authors suggest that the improvement of the other indicators in the same group is explained by several reasons. First, the time to union in the reamed group in this study was faster, and patients were unlocked allowing early weight bearing and rehabilitation. Faster healing in turn reduces the length of time that the patient lays off the affected joint, hence reducing cases of joint stiffness, muscle waste and permanent disability [20]. Naseer *et al.*, studied the infection rates and fracture union of patients with open tibia fractures on reamed compared to unreamed interlocked IM nailing. It was a prospective comparative study. Group A's mean age was 378.3 and Group B's mean age was 368.49. In group A Vs B, fracture union occurred in 40 (40%) and 47 (47%) patients (p=0.037) and Supplemental Security Income(SSI) occurred in 2 (4%) and 5 (10%) patients (p=0.240), respectively. It was found that reamed IM interlocking nails were superior in terms of fracture union compared to unreamed nails and there was no significant difference in the frequency of SSI between both interventions [21]. Furthermore, the increased stability provided by the reamed intramedullary nail may have provided a stable environment for better alignment of the fracture promoting better functional recovery. To the best of the author's knowledge, this study fills the gap in the existing literature by comparing the outcomes of reamed and unreamed intramedullary nailing for open tibial fractures.

This study is limited by its single-center design and relatively small sample size, which may restrict generalizability to broader populations. Allocation based partly on surgeon discretion and treatment preference may introduce selection bias, and long-term follow-up beyond one year was not assessed. Additionally, variations in soft

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tissue management and rehabilitation protocols could have influenced outcomes. Future research should include large-scale multicenter randomized controlled trials with standardized surgical and postoperative protocols, longer follow-up periods, and subgroup analyses to better define patient populations that benefit most from each technique.

CONCLUSIONS

It was concluded that reamed intramedullary nailing is superior to unreamed nailing in the treatment of Gustilo and Anderson Type II and IIIA open tibial shaft fractures. The reamed group demonstrated higher union rates, faster healing times, lower infection rates, and better functional outcomes. Therefore, reamed nailing should be considered the preferred method of fixation in these cases, provided there is adequate soft tissue coverage and minimal contamination.

Authors' Contribution

Conceptualization: MS
Methodology: NG, AS
Formal analysis: AR, YG
Writing and Drafting: MS, AMS, SARA
Review and Editing: MS, AMS, SARA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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