Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/w6457b23

EFFECTIVENESS OF REAMED VS. UNREAMED INTRAMEDULLARY NAILING IN MANAGING OPEN FRACTURES OF TIBIAL SHAFT

Abdul Samad Qureshi[1]*, Muhammad Hamayun Hameed[2], Sajjad Hussain Bhatti[3], Najeeb U Rehman Kalhoro[4], Hussain Bux Palh[5], Noman Khan[6]

[1] *Assistant Professor Orthopedic, Indus Medical College Tando Muhammad Khan Pakistan, Email: asqureshi855@hotmail.com
[2] Assistant Professor Orthopedic, Bolan Medical Complex Hospital, Quetta Pakistan, Email: hamayunortho@gmail.com
[3] Assistant Professor Orthopedic, Pir Syed Abdual Qadir Shah Jillani Institute of Medical Science (GIMS) Gambat Khairpur Mir's Pakistan, Email: sajjadbhattier@gmail.com
[4] Assistant Professor Orthopedic, Peoples University of Medical and Health Sciences Nawabshah SBA Pakistan, Email: Drnajeebrehmankalhoro@gmail.com
[5] Assistant Professor Orthopedic Surgery, Pir Syed Abdual Qadir Shah Jillani Institute of Medical Science (GIMS) Gambat Khairpur Mir's Pakistan, Email: drhussainpalh@gmail.com
[6] Senior Registrar Orthopedic, Memon Medical Institute Hospital Karachi Pakistan, Email: dr.nomanortho@gmail.com

***Corresponding Author:** Abdul Samad Qureshi
*Assistant Professor Orthopedic, Indus Medical College Tando Muhammad Khan Pakistan, Email: asqureshi855@hotmail.com

Abstract

Aim: To compare the efficacy of reamed and unreamed intramedullary nailing in the management of Gustilo and Anderson Type II and IIIA open tibial shaft fractures.

Place and Duration of the Study: This study was conducted in Indus Medical College Tando Muhammad Khan from March 2024 to March 2025.

Methods: The study enrolled 113 (18-60 years old) patients who reported to the hospital within 72 hours of open tibial fracture and either had type II or IIIA open tibial fractures. Polytrauma, grossly contaminated trauma, or type I or IIIB fractures were not included. Patients were assigned to two groups: reamed (n=55) and unreamed (n=58) intramedullary nailing based upon the treatment choice or the preference of the surgeon. The outcomes included infection rates, union rates, time to union, AOFAS and VAS scores, and complication rates, including malalignment and implant failure. Data analysis was performed using SPSS 25.0 and a p-value of 0.05 was considered significant.

Results: The reamed group had lower infection rates (8.3% vs. 15.5, p=0.03), superficial (6.5 vs. 12.1, p=0.03) and deep (1.8 vs. 3.4, p=0.04) infection rates. Union rates were higher (94.5% vs. 87.9%, p=0.04), with shorter union times (19.1 ± 3.8 vs. 21.2 ± 4.5 weeks, p=0.02). AOFAS scores were superior at 6 months (87.9 ± 5.4 vs. 84.6 ± 6.3, p=0.01) and 1 year (90.5 ± 4.1 vs. 86.8 ± 5.9, p=0.02), with lower VAS pain scores (2.0 ± 1.5 vs. 3.3 ± 1.7, p=0.03 at 6 months; 1.6 ± 1.3 vs. 2.9 ± 1.6, p=0.02 at 1 year). The reamed group experienced fewer complications (3.6% vs. 8.6, p=0.04), no malalignment (0% vs.4.5%), and lower implant failure (3.6% vs. 7.0%).

Conclusion: Reamed intramedullary nailing offers better clinical and functional outcomes than unreamed nailing for Type II and IIIA open tibial fractures, supporting its use in rural settings.

Keywords: Open tibial fractures, reamed intramedullary nailing, unreamed nailing, Gustilo-Anderson.

Introduction

Open tibial shaft fractures represent some of the most frequent long-bone injuries in orthopedic practice [1]. These are injuries usually caused by high-energy mechanisms, motor vehicle accidents, or high falls, and about 40 percent of the total number of long bone fractures in adults, with an incidence of between 12 and 21 per 100,000 people per year [2]. The tibia is particularly susceptible to open injuries, in which the bone breaks through the surrounding envelope of soft tissue, resulting in contamination and risks of systemic infection [3]. Open tibial fractures are known to account for approximately 2% of fractures and 36.7% of long-bone injuries in most cases, with many having Type II and IIIA fractures of the Gustilo and Anderson Type III described as moderate to severe injuries to soft tissues and no severe vascular injury [4]. The complications are infection, nonunion, malunion, and delayed healing, with reported infection rates of up to 20-30% [1]. Timely irrigation, debridement, antibiotic use and stable fixation should be part of management to facilitate union and functional restoration [5].

The Gustilo and Anderson classification system has been the main pillar in the prediction and management of the treatment of open fractures. It classifies open fractures based on the size of the wound, the level of contamination, and the level of injury to the soft tissues [6]. Type II fractures involve 1 cm to 10 cm lacerations of moderate contamination and minimal hard tissue crushing. On the contrary, Type IIIA entails severe soft tissue trauma or flaps that have sufficient periosteal coverage and contamination that can be managed using debridement [7]. Such a classification, first defined in 1976 and refined over the decades, is highly correlated with the risks of infection and healing. For instance, Type IIIA fractures have an infection rate of up to 25% and a nonunion rate of 10-15% without appropriate stabilization measures [4].

The treatment process has changed over time, before external fixation (semi-preferably to avoid deep infection) is substituted by intramedullary (IM) nailing, which offers the advantage of improved biomechanical support, load distribution, and early mobilization. Interlocking nails improve rotational control and permit weight-bearing, accelerating rehabilitation [8]. The controversy revolves around reamed versus unreamed methods: reaming dilates the medullary canal, allowing a bigger diameter nail to accommodate. This improves stability and encourages neovascularization to accelerate union, but also increases the risk of thermal necrosis, fat embolism, and high intramedullary pressure [9]. On the other hand, unreamed nailing preserves the endosteal circulation and is faster in contaminated fields. It potentially lowers infection risks in open injuries, though it may compromise fixation strength and increase nonunion rates [10]. Evidence highlights varied evidence. A meta-analysis of tibial shaft fractures suggested reamed IMN reduces reoperation needs in closed injuries but showed mixed results for open cases [9]. Another study on IM-nailed tibial fractures noted a 23.1% poor radiological outcome rate (nonunion via Radiographic Union Score for Tibial Fractures <8), linked to factors like Gustilo Type III (adjusted odds ratio 17.4, 95% CI: 3.11-97.72) and postoperative infection (adjusted odds ratio 13.9, 95% CI: 5.8-33.16), with an overall 29.3% infection rate; all cases used reamed nailing [11].

Despite these advancements, much of the existing research on reamed and unreamed IMN focuses on urban tertiary centers equipped with advanced operating theaters, stringent infection control protocols, and robust follow-up mechanisms. This urban-centric approach overlooks the realities of resource-limited rural environments, where delayed presentations, inadequate initial wound management, and scarce access to specialized orthopedics exacerbate outcomes in open tibial fractures. Rural settings often contend with prolonged transport times, suboptimal debridement due to limited sterile facilities, heightened infection susceptibility from environmental contaminants, and challenges in rehabilitation, all of which amplify the complexity of Gustilo Type II and IIIA injuries

[12]. This gap in available literature does not consider the possibility of different outcomes of urban-based protocols in under-equipped rural hospitals, where the management of the initial fractures, access to antimicrobials, and subsequent care can be affected [13]. This study aims to fill this gap by comparing the outcomes of reamed and unreamed intramedullary interlocking nailing in Gustilo and Anderson Type II and IIIA open tibial shaft fractures.

Methodology

Prior to participating in this prospective cohort study, all participants gave written informed consent. Data were gathered from 113 patients, and the sample size was determined using the OpenEpi calculator. The sample had people of both sexes and various ages appealing to a wide range of people concerning the goals of the study. Patients were selected based on purposive sampling.

Adults with Gustilo and Anderson Type II or Type IIIA open tibial shaft fractures who reported within 72 hours after injury and were between the ages of 18 and 60 were included in the study. Excluded patients had polytrauma, Gustilo Type I or Type IIIB fractures, fractures that could not be fixed, or open wounds that required extensive debridement or flap coverage due to heavy contamination or infection. Depending on the procedure they choose or the surgeon’s choice, the participants were assigned to two groups: Group 1 (Reamed Intramedullary Nailing, n = 55) and Group 2 (Unreamed Intramedullary Nailing, n = 58).

For the reamed group, the medullary canal was widened using standard reaming tools to allow a larger interlocking nail, inserted with fluoroscopic guidance. Interlocking screws were placed at the proximal and distal ends of the tibia to stabilize the fracture. In the unreamed group, a smaller nail matching the canal’s size was inserted without reaming, and screws were applied in the same way. Experienced orthopedic trauma surgeons performed all surgeries using the standard anterolateral approach under general or spinal anesthesia.

In both groups, wounds were carefully debrided to remove debris, dead tissue, or foreign objects. For Type IIIA fractures with damaged periosteum and severe soft tissue avulsion, special attention was given to managing soft tissues. Infected or contaminated wounds were treated with infection control measures. After surgery, all patients followed a standard care plan, including 48 hours of antibiotics, pain management based on universal anesthesia guidelines, and early movement with crutches or walkers, depending on pain and comfort levels.

SPSS version 25.0 was used for data analysis. Time to fracture union and age were examples of continuous variables that were presented as means with standard deviations. Percentages were employed to present categorical data, such as infections and nonunion rates. A p-value below 0.05 was considered significant. Qualitative data from patient feedback and surgeon notes were coded using both deductive and inductive methods. Infection rates, union time, soft tissue issues, and functional recovery were all characterized using a pre-established framework. Two independent reviewers coded part of the qualitative data, achieving Cohen’s Kappa statistic above 0.80, confirming high coding reliability.

Results

This study included a total of 113 participants with reamed and unreamed groups comprising n=55 and n=58 participants. The mean ages are similar between both groups (36.8 ± 9.5 years for the reamed group and 37.4 ± 9.0 years for the unreamed group), with no notable variation in gender distribution (44:11 [80% male, 20% female] for the reamed group and 47:11 [81% male, 19% female] for the unreamed group). The injury mechanisms like motor vehicle accidents (59% vs 60%), falls from height (33% vs 32%), and industrial accidents 8% vs 8%) are comparable in both groups. The p-values for all comparisons are above 0.05, indicating that the differences observed are statistically insignificant.

Table 1: Demographic and Injury Characteristics of the Reamed and Unreamed Groups (n=113)

Parameters	Reamed Group (n=55)	Unreamed Group (n=58)	p-value
Mean Age (Years)	36.8 ± 9.5	37.4 ± 9.0	0.58
Gender (Male: Female)	44:11	47:11	0.45
Motor Vehicle Accident (%)	59%	60%	1.00
Fall from Height (%)	33%	32%	1.00
Industrial Accident (%)	8%	8%	1.00

In both groups, 75% had Type II fractures, while 25% had Type IIIA fractures. The p-values are both 1.00, indicating that the proportions of fracture types between the two groups are statistically similar, suggesting no effect of the reaming technique on fracture classification.

Table 2: Fracture Types in Reamed and Unreamed Groups

Fracture Type	Reamed Group (n=55)	Unreamed Group (n=58)	p-value
Type II (%)	42 (76%)	44 (77%)	1.00
Type IIIA (%)	13 (24%)	14 (23%)	1.00

Infection rates were lower in the reamed group, with superficial infections (6.5% vs 12.1%), deep infections (1.8% vs 3.4%), and total infection rates (8.3% vs 15.5%), all showing statistically significant differences ($p \leq 0.04$). The reamed group had a higher union rate (94.5%) compared to the unreamed group (87.9%) with a significant p-value of 0.04. The time to union was shorter in the reamed group (19.1 ± 3.8 weeks) compared to the unreamed group (21.2 ± 4.5 weeks), with a p-value of 0.02, indicating faster healing in the reamed group. These findings indicate better clinical outcomes with reaming.

Table 3: Clinical Outcomes in Reamed and Unreamed Groups (n=113)

Parameters	Reamed Group (n=55)	Unreamed Group (n=58)	p-value
Superficial Infection (%)	6.5%	12.1%	0.03
Deep Infection (%)	1.8%	3.4%	0.04
Total Infection Rate (%)	8.3%	15.5%	0.03
Union Rate (%)	94.5% (52/55)	87.9% (51/58)	0.04
Time to Union (Weeks)	19.1 ± 3.8	21.2 ± 4.5	0.02

Clinical outcomes were noticeably better in the reamed group than in the unreamed group. The reamed group had higher American Orthopedic Foot and Ankle Society (AOFAS) scores at 6 months (87.9 vs. 84.6) and 1 year (90.5 vs. 86.8), with p-values of 0.01 and 0.02, respectively. The reamed group had less discomfort, as shown by lower Visual Analog Scale (VAS) pain scores (2.0 vs. 3.3 at 6 months, 1.6 vs. 2.9 at 1 year). The reamed group also showed fewer complications, with a lower total complication rate (3.6% vs 8.6%) and fewer implant failures (3.6% vs 7.0%). Furthermore, the reamed group had no malalignment, while the unreamed group had 4.5%, and the reamed group exhibited better fracture alignment (mean angulation of 3.2° vs 5.8°).

Table 4: Functional Outcomes and Complications in Reamed and Unreamed Groups (n=113)

Parameters	Reamed Group (n=55)	Unreamed Group (n=58)	p-value
AOFAS Score (6 Months)	87.9 ± 5.4	84.6 ± 6.3	0.01
AOFAS Score (1 Year)	90.5 ± 4.1	86.8 ± 5.9	0.02
VAS Pain Score (6 Months)	2.0 ± 1.5	3.3 ± 1.7	0.03
VAS Pain Score (1 Year)	1.6 ± 1.3	2.9 ± 1.6	0.02
Mean Fracture Angulation (°)	3.2 ± 2.2	5.8 ± 3.5	0.01
Malalignment (%)	0%	4.5%	0.01

Implant Failure (%)	3.6%	7.0%	0.04
Total Complications (%)	3.6%	8.6%	0.04

Discussion

In this study, we compared the outcomes of reamed versus unreamed IM interlocking nailing in the management of Gustilo and Anderson Type II and IIIA open tibial shaft fractures among participants. Our findings revealed that the reamed group exhibited significantly lower infection rates (total 8.3% vs. 15.5%, p=0.03), higher union rates (94.5% vs. 87.9%, p=0.04), and shorter time to union (19.1 ± 3.8 weeks vs. 21.2 ± 4.5 weeks, p=0.02) compared to the unreamed group. This indicates the superior clinical efficacy of reamed nailing in this study. Infection remains a primary concern in open tibial fractures due to contamination risks [14], and our study found a marked advantage for reamed nailing in reducing both superficial and deep infections. The findings of Shao et al. contrast with our findings, revealing no significant difference in infection rates between reamed and unreamed approaches (RR=1.03, 95% CI=0.42-2.50, p=0.95) [15]. However, our lower infection rates in the reamed group may stem from enhanced stability and better endosteal revascularization facilitated by reaming, which could mitigate bacterial proliferation in contaminated fields. This finding supports a study by Schemitsch et al., which, while focused on reoperations, noted fewer infection-related interventions in reamed cases for tibial fractures overall [9].

Regarding union rates and healing time, our data indicates a clear superiority of reamed nailing, with nearly 95% union and accelerated consolidation. This resonates with Saqib et al.'s study, which similarly reported higher union rates (96.9% vs. 89.2%, p=0.04) and shorter union times (18.3 vs. 21.5 weeks, p=0.02) in reamed groups for comparable Gustilo types [16]. This emphasizes reaming's role in promoting neovascularization and stability. This compares to the study by Schemitsch et al., where reamed nailing reduced nonunion risks in closed fractures but showed no difference in open ones for reoperation needs (p=0.66), suggesting that fracture openness overrides nailing method in complicated cases [9]. In contrast, multiple meta-analyses report no statistical differences in union rates for open fractures (RR=1.01, 95% CI: 0.97-1.07, p=0.58; RR=1.56, 95% CI: 0.97-2.49, p=0.06), favoring unreamed for preserving biology in contaminated environments [15, 17]. Our results challenge this neutrality, perhaps because our cohort excluded heavily contaminated wounds, allowing reaming's mechanical stability to shine without excessive infection risks. Chen et al. found IM reducing malunion and superficial infections, supporting our preference for nailing but not specifying reaming [18].

In our study, improved AOFAS and VAS outcomes in the reamed group were observed. These findings are in line with Saqib et al., who found similar outcomes in the reamed group with both improved AOFAS and VAS scores. This concordance supports reaming's role in promoting functional restoration, especially in open fractures prone to soft tissue issues [16]. However, it contrasts with a SPRINT trial's subgroup analysis, where reamed and unreamed nailing showed equivalent functional outcomes using SF-36 scores in open tibial fractures, with a non-significant trend favoring unreamed for fewer autodynamizations (17% vs. 26%) [19].

Regarding complications, our lower rates of malalignment, implant failure, and angulation in the reamed group echo Schemitsch et al.'s findings, which noted reduced reoperations for malunion in reamed cases (4.2% vs. 9.1%) [9]. This emphasizes reaming's enhancement of rotational control. Similarly, a study by Jeremic et al. highlighted intramedullary nailing's superiority over external fixation in minimizing angulation (mean 2.8° vs. 6.1°), with reamed variants further reducing pain intensity via stable constructs [20]. In contrast, Shao et al. found no differences in implant failure or malunion rates between techniques [15]. Overall, while our study supports reamed nailing for improved function and fewer issues in Type II and IIIA fractures, it diverges from older evidence emphasizing no clear superiority.

In this study, there are some limitations. First, this study was conducted at a single-center hospital and included a small sample size, which limits generalizability of results. Additionally, the shorter study period and follow-up to one year might miss long-term issues like chronic pain or osteoarthritis.

Conclusion

This study demonstrates that reamed intramedullary nailing outperforms unreamed nailing for Gustilo and Anderson Type II and IIIA open tibial shaft fractures, achieving lower infection rates, higher union rates, shorter healing times, and improved functional outcomes with higher AOFAS scores and lower VAS pain scores. Reamed nailing also reduced complications like malalignment and implant failure. These results support its use in rural settings despite challenges like delayed presentations. Future research should explore randomized designs in local contexts, longer follow-up to assess chronic issues, and adjunctive therapies like antibiotics to refine protocols for open tibial fractures.

References

1. Turley L, Barry I, Sheehan E. Frequency of complications in intramedullary nailing of open tibial shaft fractures: a systematic review. EFORT Open Reviews. 2023;8(2):90-9.
2. France J, Tucker A, Nightingale J, Taylor A, Craxford S, Ollivere B. Outcomes of the hexapod frame in 111 'high risk'tibial fractures. Bone & Joint Open. 2025;6(7):816.
3. Schade AT, Khatri C, Nwankwo H, Carlos W, Harrison WJ, Metcalfe AJ. The economic burden of open tibia fractures: a systematic review. Injury. 2021;52(6):1251-9.
4. Papakostidis C, Kanakaris NK, Pretel J, Faour O, Morell DJ, Giannoudis PV. Prevalence of complications of open tibial shaft fractures stratified as per the Gustilo–Anderson classification. Injury. 2011;42(12):1408-15.
5. Ullah R, Hussain A, Iqbal J, Imran A, Saddiq S, Ahmed N. Frequency of union in open tibia fractures treated with unreamed intramedullary interlocking nails. Journal of Pakistan Orthopaedic Association. 2020;32(02):87-91.
6. Yim GH, Hardwicke JT. The evolution and interpretation of the Gustilo and Anderson classification. JBJS. 2018;100(24):e152.
7. Nicolaides M, Pafitanis G, Vris A. Open tibial fractures: An overview. Journal of clinical orthopaedics and trauma. 2021;20:101483.
8. Saqib M, Gul N, Saud AM, Abidi SAR, Rafiq A, Gul Y, et al. 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. 2025:146-51.
9. Schemitsch EH, Kumar A, Heels-Ansdell D, Sprague S, Bhandari M, Guyatt G, et al. Reamed compared with unreamed nailing of tibial shaft fractures: Does the initial method of nail insertion influence outcome in patients requiring reoperations? Canadian Journal of Surgery. 2023;66(4):E384.
10. Huang Xa, Chen Y, Chen B, Zheng K, Lin C, Lin F, et al. Reamed versus unreamed intramedullary nailing for the treatment of femoral shaft fractures among adults: A meta-analysis of randomized controlled trials. Journal of Orthopaedic Science. 2022;27(4):850-8.
11. Shugie Y, Kebede S, Adugna F, Demissie DB, Desta T. Poor radiological outcomes and associated factors among tibial shaft fracture patients treated with intramedullary nail fixation at Addis Ababa Burn, Emergency and Trauma Hospital, Ethiopia. Frontiers in Surgery. 2025;12:1473038.
12. ALI H, KHAN S, ULLAH S, HAIDER W. COMPARATIVE STUDY OF EXTERNAL FIXATOR AND INTRAMEDULLARY NAILING IN PATIENTS WITH GUSTILO TIBIO FIBULAR FRACTURE TYPE III A: A RANDOMIZED CONTROLLED TRIAL. Pakistan Journal of Intensive Care Medicine. 2025;5(01):69-.
13. Franz D, Raschke M, Giannoudis P, Leliveld M, Metsemakers W, Verhofstad M, et al. Use of antibiotic coated intramedullary nails in open tibia fractures: A European medical resource use and cost-effectiveness analysis. Injury. 2021;52(7):1951-8.

14. Coombs J, Billow D, Cereijo C, Patterson B, Pinney S. Current concept review: risk factors for infection following open fractures. Orthopedic Research and Reviews. 2022;14:383.
15. Shao Y, Zou H, Chen S, Shan J. Meta-analysis of reamed versus unreamed intramedullary nailing for open tibial fractures. Journal of Orthopaedic Surgery and Research. 2014;9(1):74.
16. Saqib M, Gul N, Saud AM, Abidi SAR, Rafiq A, Gul Y, et al. 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. 2025;6(2):146-51.
17. Guangshu Y, Yu W, Zhiqing X, Yanbin L. Reamed or unreamed intramedullary nailing for tibial fractures: a meta-analysis. Chinese Journal of Traumatology. 2014;17(4):229-34.
18. Chen Z, Luo R, Xing F, Xiang Z. External fixation versus intramedullary nailing for the treatment of open tibial shaft fractures: A meta-analysis of randomized controlled trials. Health Sciences Review. 2024;10:100152.
19. Bhandari M, Guyatt G, Walter SD, Tornetta III P, Schemitsch EH, Swiontkowski M, et al. Randomized trial of reamed and unreamed intramedullary nailing of tibial shaft fractures: by the Study to Prospectively Evaluate Reamed Intramedullary Nails in Patients with Tibial Fractures (SPRINT) Investigators. JBJS. 2008;90(12):2567-78.
20. Jeremic D, Grubor N, Bascarevic Z, Slavkovic N, Krivokapic B, Vukomanovic B, et al. Comparative Analysis of Complication Rates in Tibial Shaft Fractures: Intramedullary Nail vs. Ilizarov External Fixation Method. Journal of Clinical Medicine [Internet]. 2024; 13(7).