

Results of Primary Tibial Nailing of Open Tibial Diaphyseal Fractures in Adults

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Abstract

Background: Tibial fractures are the most common long bone fractures encountered by most Orthopedic surgeons, and the majority of them are compound fractures. Since one-third of the tibial surface is subcutaneous, open fractures are more common in the tibia than in any other long bone.

Aim: To assess results of primary tibial nailing of open tibial diaphyseal fractures G I and G II in adult patients regarding union information and complication.

Patients and methods: This prospective interventional study involved 15 patients with diaphyseal tibial open fractures who were admitted to the Orthopedic Surgery Department, Faculty of Medicine Al-Azhar University, and Zagazig General Hospital. Time from 2020 to 2024, about 60 months.

Results: It found that shaft fractures were more frequent than upper and lower, and most of the fractures were grade I. It found a statistically significant good negative correlation between the time interval to surgery and time to complete union. It found a statistically significant good positive association between time to complete union and complications, while a statistically significant negative correlation was observed between time to complete union and satisfaction. It found a statistically significant positive association between fracture grade and complications and time to complete union.

Conclusion: Intramedullary nailing is the best technique for managing Gustilo type III open tibial fractures due to its reduced occurrence of infectious complications and problems with fracture healing.

Keywords: Tibia; Open fracture; Nailing; Diaphyseal fractures

1. Introduction

As industrialization and urbanization progress year by year, with the rapid increase in road traffic, the incidence of high-energy trauma is increasing exponentially at the same speed. Tibial fractures are the most common long bone fractures encountered by most Orthopedic surgeons, and the majority of them are compound fractures. Since one-third of the tibial surface is subcutaneous, open fractures are more common in the tibia than in any other long bone.¹

Furthermore, the blood supply of the tibia is more precarious than that of bones enclosed by bulky muscles. The most important causes of tibial fractures are road traffic accidents, sports

injuries, direct blows or assault, falls and gunshot injuries. The important factors in prognosis are 1) the amount of initial displacement of fractures, 2) the degree of comminution, 3) the signs of infection, and 4) the severity of soft tissue injury.²

Because of the high prevalence of complications associated with these fractures, management is often difficult, and the optimum method of treatment remains a subject of controversy.³

The purpose of this research was to assess the outcomes of primary tibial nailing of open tibial diaphyseal fractures G I and G II in adult patients regarding union and complication over one year.

2. Patients and methods

This prospective interventional study involved 15 patients with diaphyseal tibial open fractures who were admitted to the Orthopedic Surgery Department, Faculty of Medicine Al-Azhar University, and Zagazig General Hospital from 2020 to 2024 for about 60 months.

Inclusion criteria: Involved as cases presenting within twenty-four hours post-trauma, open diaphyseal fractures of the tibia, skeletally mature cases, and open fractures classified as G I to G II regarding the Gustilo-Anderson categorization.

Exclusion criteria: Open metaphyseal and epiphyseal fractures of the tibia in cases presenting more than twenty-four hours post-trauma, skeletally immature cases, open fractures classified as GIIa, G IIb and G IIc per the Gustilo-Anderson categorization, floating knee injuries, or cases requiring secondary internal fixation.

Methods:

All patients enrolled in the study were randomized and subjected to the following evaluation.

Preoperative evaluation: Preoperative evaluation included full detailed history, general examination, local examination of the limb and classification of diaphyseal open fracture.

Investigations: Investigations included radiological investigations (anterior posterior and lateral radiographs of leg show knee and ankle joints) and preoperative laboratory investigations.

Surgical technique

Each case has been treated using reamed intramedullary nails. In cases treated with nailing, the procedure was conducted with the case positioned on the fracture table, which was modified at the distal end to facilitate 90-degree knee flexion with the leg suspended. A longitudinal incision along the patellar ligament has been made for nail insertion, prolonging from the lower pole of the patella to a point just proximal to the tibial tuberosity. Access to the intramedullary canal has been achieved via a trans-patellar tendon approach. In each case, the medullary canal has been reamed with reamers to a diameter that exceeded the diameter of the chosen nail by one millimeter. The nail diameter has been determined throughout the operation based on the size of the reamer that first contacted the cortex at the isthmus of the medullary canal. All nails were statically locked with screws in both the distal and proximal segments.

Follow-up: The patient underwent surgery and was assessed for wound healing, sutures removal, and re-examination every month for a year.

Postoperatively, patients began passive and active motion exercises and were allowed partial weight bearing at 8-12 weeks and full weight bearing when necessary. Any complications related to bone and soft tissue healing or infection were recorded. The range of motion of the knee and ankle joints was compared to the contralateral normal side.

Methods of evaluation: The outcomes were evaluated utilizing criteria derived from the categorizing of Karlstorm and Olerud. The results have been evaluated based on the following criteria: bony recovery and soft tissue, infection of bone or soft tissue, range of pain-free joint movement (knee and ankle), deformity, and shortening. The outcomes have been classified into four categories: excellent, good, fair, or poor. Various parameters were carefully recorded throughout the case's hospitalization and subsequent monitoring visits to evaluate the efficiency of the procedure.

Ethical considerations

The research includes an invasive operational technique. The college ethics committee has approved the research, and consent has been obtained from all cases prior to the procedure.

Statistical analysis

The gathered data have been organized and analyzed utilizing SPSS version 23 software (SPSS Inc, Chicago, IL). Categorical data have been expressed as numerical values and percentages. Quantitative data have been assessed for normalcy utilizing the Kolmogorov-Smirnov test, with normality assumed at a p-value more than 0.05. Quantitative data have been presented as mean \pm standard deviation. The Pearson correlation test was employed to assess the association among quantitative data, whereas the Spearman correlation test has been utilized for nominal data. The designated level of significance in this study has been established at 0.05 (P-value less than 0.05 has been deemed significant).

3. Results

The study population had a mean age of 34.8 years (± 11.8 SD), with a male predominance (66.7% males vs. 33.3% females). Hypertension (HTN) was present in 20% of the participants, while type 2 diabetes mellitus (DM) was observed in 26.7% of the cases. These demographic and clinical characteristics provide a baseline understanding of the study cohort.

Table 1. Demographic properties of studied patients

		MEAN	SD
AGE (YEARS)		34.8	11.8
		N	%
SEX	Female	5	33.3
	Male	10	66.7
HTN		3	20
DM TYPE 2		4	26.7

The majority of fractures were located in the mid-region (53.4%), followed by the lower region (33.3%) and the upper region (13.3%). According to the Gustilo-Anderson classification, most fractures were Grade I (67.3%), while the remaining were Grade II (33.3%). These findings highlight the distribution and severity of fractures in the study population.

Table 2. Fracture Properties of studied patients:

		N	%
LEVEL	Upper	2	13.3
	Mid	8	53.4
	Lower	5	33.3
GRADE (OPEN GASTILLO)	I	10	67.3
	II	5	33.3

The mean time to surgery was 14.2 hours (± 6.2 SD). The majority of cases (53.3%) underwent surgery within 6-12 hours, while 40% were operated on within 12-24 hours. Only 6.7% of cases had surgery within 6 hours. These data reflect the timing of surgical intervention in the study population.

Table 3. Perioperative data of studied patients and Interval of time to surgery

	MEAN	SD
TIME TO SURGERY (HRS)	14.2	6.2
TIME INTERVAL	N	%
6H	1	6.7
6-12H	8	53.3
12-24H	6	40

The mean time to fracture union was 15.3 weeks (± 2.3 SD). Complications, specifically infections, were observed in 26.7% of the cases. These findings provide insight into the healing timeline and the rate of postoperative complications in the study population.

Table 4. Time to Union of studied patients and Post-operative complications:

	MEAN	SD
TIME TO UNION (WEEKS)	15.3	2.3
	N	%
COMPLICATIONS (INFECTIONS)	4	26.7

The majority of patients (73.4%) reported excellent satisfaction with the treatment outcomes, while 13.3% rated their satisfaction as good and another 13.3% as fair. These results indicate a high level of patient satisfaction overall.

Table 5. Outcome satisfaction of studied patients:

		N	%
SATISFACTION	Fair	2	13.3
	Good	2	13.3
	Excellent	11	73.4

Table 6 showed that, it found a statistically significant good negative correlation between time interval to surgery and time to complete union, it found a statistically significant good positive correlation between time to complete union and Complications (slower healing more complications). While there was a statistically significant excellent negative correlation between time to complete union and satisfaction. It found a statistically significant good positive correlation

between fracture grade and Complications and time to complete union.

Table 6. Correlation between(time interval to surgery, time to union, fracture Grade) and fractures outcome.

TIME TO SURGERY	R	P VALUE
TIME TO UNION	-0.52	0.04*
COMPLICATIONS	-0.35	0.2
SATISFACTION	0.3	0.3
TIME TO UNION	r	P Value
COMPLICATIONS	0.83	0.001*
SATISFACTION	-0.84	0.001*
FRACTURE GRADE	r	P Value
TIME TO UNION	0.59	0.02*
COMPLICATIONS	0.53	0.04*
SATISFACTION	-0.2	0.5

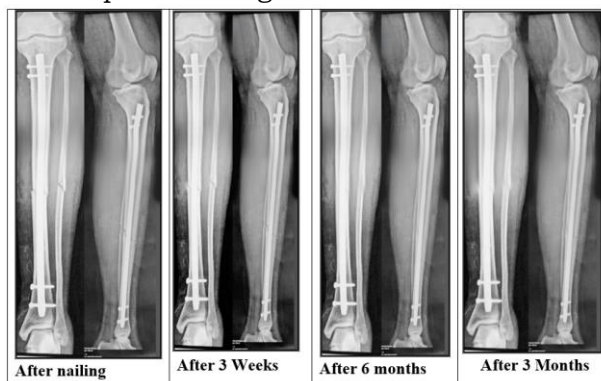
CASE PRESENTATION

Case (1)

Male patient aged 37 years presented to Emergency room with direct trauma to his Lt Leg and had Lt Open GI fracture midshaft tibia. The fracture was managed by reamed ILN. It was united in 14 weeks and the result was excellent.



Preoperative images

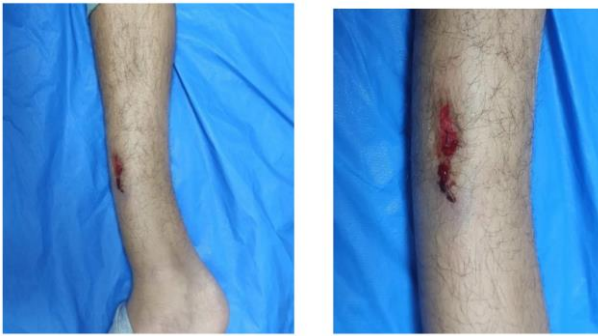


Postoperative follow up

Case (2)

Male patient aged 23 yrs presented to emergency room with Rt open g1 fracture lower third the fracture managed by reamed ILN. It was

united in 20 weeks result was excellent.



Preoperative images



Post-operative Follows up

4. Discussion

Open tibial fractures are typically unstable due to soft tissue stripping, comminution, or a combination of both factors. Rigid fixation has demonstrated efficacy in decreasing infection rates, enhancing healing, and aiding the rehabilitation of open tibial fractures. Controversy persists regarding certain phases of treatment, regardless of the prevalence of open tibial shaft fractures.⁴

The current analysis reveals a mean age and gender distribution consistent with the findings of Kakar and Tornetta⁵, indicating a majority of the young male demographic. This can be due to the increased activity and ability to be injured within this category.

In separate research, unreamed interlocking nails have been utilized, as stated by Kakar and Tornetta⁶.

Finkemeier et al.⁷ examined undreamed and reamed nailing in open tibial shaft fractures and found insignificant variations in infection rates or time to union.

This has generated significant disagreement regarding the optimal procedure for inserting intramedullary nails for the repair of open tibial shaft fractures.

Keating et al.⁸ indicated that they could not establish a correlation between medullary canal reaming and a higher probability of pseudarthrosis or deep infection. Even though

reaming the medullary canal damages endosteal circulation, their investigation didn't demonstrate any prejudicial effects.

Tielinen et al.⁹ stated that reaming the medullary canal may stimulate fracture consolidation.

The biological advantage is enhanced by the increased stability obtained with the insertion of a larger caliber intramedullary nail.

Court-Brown et al.¹⁰ indicated that restricted reaming of the medullary canal isn't detrimental to bone consolidation and may be advantageous.

The selection of the internal fixing method in the present investigation has been determined by the fracture pattern, location, and extent of soft tissue injury. Following debridement, all patients have been stabilized using reamed interlocking intramedullary nails.

In their comparative analysis, Keating et al.⁹ found that the average time to union for cases with open tibial fractures was thirty weeks (13-70 weeks) for the reamed tibial nail (RTN) group and twenty-nine weeks (13-50 weeks) for the unreamed tibial nail (URTN) group. Nine percent of fractures managed by reaming failed to unite, while twelve percent of fractures managed without reaming also didn't unite.

Our findings demonstrated a high success rate of the union at five months with great outcomes in this trial, which involved fifteen cases treated with IMN for open diaphyseal tibial fractures.

It is well established that restricted axial interfragmentary mobility promotes the formation of periosteal callus and promotes the healing process.

The average duration of fracture union for patients in our investigation was 15.3 weeks, with a 73.4 percent excellent.

The results of this study were shorter than other studies. Liu et al.¹⁰ reported that IMN associated with shorter healing time.

This difference in healing time could be explained by the difference in the level and grade of the fractures (24).

This study didn't reveal any cases of malunion, delayed union or nonunion.

This was comparable with the research of Küçükdurmaz et al.¹¹. The rate of infection in our series was low and occurred late. Four patients had developed an infection and were drained and treated with IV antibiotics,

while the study by Shah et al.¹² reported two cases of infection responded to debridement and antibiotics.

Giovannini et al.¹³ demonstrated that IMN correlated with reduced incidences of infection and complications in fracture healing.

A recent meta-analysis by Jeremić et al.¹⁴ indicated that the IMN method is associated with

a reduced rate of following surgery superficial infections and malunion.

A statistically significant negative association was identified between the time delay to surgery and the duration required for the full union.

It identified a statistically significant association among the duration required for union completion and the incidence of problems (longer healing times correlate with greater issues). There was a statistically significant strong negative association among the time required for union completion and satisfaction.

This was corroborated by the findings of Salem.¹⁵

It found a statistically significant positive association between fracture grade and complications and time to complete union.

In agreement with our findings, Metsemakers et al.¹⁶ reported that type, level and grade of fractures had a significant effect on healing time, results and post-operative complications.

Unlike our findings, Jeremic et al.¹⁴ reported no relation between fracture level or grade and healing time or post operative complication.

LIMITATION

The study's limitations include a small sample size of 15 patients, a single-center study, a limited follow-up period, a homogeneous patient population, lack of randomization, and incomplete control of confounding variables. The results may not be representative of practices in other institutions, and the follow-up period may have been insufficient to detect long-term complications. The study's homogeneous patient population, lack of randomized controlled trial design, and incomplete control of confounding variables could have influenced outcomes.

4. Conclusion

Intramedullary nailing is the superior method for managing Gustilo type III open tibial fractures due to its reduced occurrence of infectious complications and problems with fracture healing. Fractures of the proximal tibial shaft typically result in significantly larger fracture gaps compared to distal fractures. It has been related to prolonged time to union and radiographic union satisfaction, along with a slightly greater possibility of complications.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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