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Original Research Article

Management of Open Tibial Shaft Fractures Treated with Primary Intramedullary Interlocking Nailing: A Prospective Study of the Functional and Radiological Outcome

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Abstract:

Background: As industrialization and urbanization progress year by year, with a 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 orthopedic surgeons, with the majority being compound fractures. The use of titanium nails has improved the rate of fracture union and considerably decreased the rate of infection.

Aim: This led us to study the functional results of primary interlocked intramedullary nailing in open tibial fractures.

Materials & Methods: This study was conducted at the Department of Orthopedic Surgery, in a tertiary care hospital, from April 2019 to Oct 2021.This is a prospective study. 34 open tibial shaft fracture cases were analyzed, of which 3 were lost to follow-up. Of the 31 cases, 3 were female and 28 were male. The average follow-up period was one year.

Results: Of the 31 patients, road traffic accidents were the mode of injury in 30 cases, and 1 had an Industrial Accident. In our study, there was 1 case of segmental fracture, 12 fractures were comminuted, 9 cases had an oblique pattern, and 8 cases had transverse fractures. We classified open fractures of the tibia according to the Gustilo and Anderson classification. Among 31 patients: Grade II - 15; Grade III A -12, and Grade III B- 4.

Conclusion: The primary treatment of choice for such challenging fractures would be debridement, interlocking nailing, and primary flap cover for our patients with open tibial fracture.

Keywords: Orthopedic Surgeon, Tibia, Open Fractures, Long Bone, Bulky Frames, Non-union, Mal-union.

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Introduction

As industrialization and urbanization progress year by year, with a 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 orthopedic surgeons, with the majority being compound fractures [1]. As one-third of the tibial surface is subcutaneous, open fractures are more common in the tibia than in any other long bone [2].

Furthermore, the blood supply to the tibia is more precarious than that of bones enclosed by bulky muscles [3]. The most important causes of tibial fractures are road traffic accidents, sports injuries, direct blows or assault, and falls and gunshot injuries [4]. The important factors in prognosis are (1) amount of initial displacement of fractures, (2) Degree of comminution, (3) signs of infection, and (4) severity of soft tissue injury. Because of the high prevalence of complications associated with these fractures, their management is often difficult, and the optimal treatment method remains controversial [5,6]. The primary objective of the management of open fractures is to prevent or eradicate wound sepsis [7]. Each fracture is an individual problem, and the decision to treat it by internal or external fixation should be based on a realistic assessment of the advantages and hazards of each method in the circumstances of that particular case [8].

Management of tibial fractures requires the widest experience and the best clinical acumen to choose the most appropriate treatment for a particular fracture pattern [8]. Among the various modalities of treatment, such as closed reduction and application of Plaster of Paris (POP) cast, open reduction and internal fixation with plates and screws, intramedullary fixation (interlocked intramedullary nailing, Enders nails, etc.), and external fixation techniques, surgeons must be capable of performing all these techniques, weigh the advantages and disadvantages of each technique, and adopt the best possible treatment [9,10]. The best treatment should be determined by a thorough analysis of the morphology of the fracture, the amount of energy imparted to the extremity, the mechanical characteristics of the bone, age and general condition of the patient, and most importantly, the status of the soft tissues (skin, muscle, etc.) and the associated neurological and vascular status of the leg [11].

Three goals must be met for the successful treatment of open tibial fractures: (a) prevention of infection, (b) achievement of fracture union, and (c) restoration of function. These goals are interdependent and are usually achieved in chronological order [12]. For example, failure to prevent infection promotes delayed union or nonunion and delays functional recovery of the limb.

Immobilization of the limb in a plaster cast has mostly been used in the past; however, it does not always maintain the length of the limb and leaves the wound relatively inaccessible [13]. Open reduction and internal fixation with plates and screws have yielded unacceptably high infection rates [14].

This method may be associated with more severe or local injuries and displaced intra-articular fractures of the knees and ankles [15]. External fixation, which is considered the treatment of choice by many orthopedic surgeons, has the following disadvantages: 1) bulky frames, 2) frequent pin track infections, 3) nonunion, and 4) malunion [1-10].

With the invention of interlocked intramedullary nails, all of the above-mentioned goals and complications have been well addressed. A nail is a load-sharing device that is stiff to both axial and torsional forces [11-15]. Closed nailing involves the least damage to soft tissues, fracture hematoma, and the natural process of bone healing compared with other forms of internal fixation [12]. The locking of intramedullary nails to the major proximal and distal fragments decreases the incidence of comminuted fracture malunions. The use of titanium nails has improved the rate of fracture union and considerably decreased the rate of infection. This led us to study the functional results of primary interlocked intramedullary nailing in open tibial fractures.

Materials & methods:

This study was conducted at the Department of Orthopedic Surgery, of a tertiary care Hospital, from April 2019 to Oct 2021.This is a prospective study. 34 open tibial shaft fracture cases were analyzed, of which 3 were lost to follow-up. Of the 31 cases, 3 were female and 28 were male. The average follow-up period was one year.

The inclusion criteria were as follows: extra-articular open tibia fractures with/without fibula fracture except grade IIIC; age above 18 years; Grade I, II, IIIA & IIIB, Open tibial fractures with associated injuries; head injury; other fractures; and other soft tissue injuries. The exclusion criteria were Open Tibial fractures treated primarily with external fixation, nonunion of the tibial fractures, intra-articular fractures, closed tibial fractures, and Grade IIIC fractures.

Results:

Table 1: Age incidence

Age in yrs	No. of Patients
11 – 20	1
21 – 30	14
31 – 40	4
41 – 50	8
51 – 60	1
61 – 70	3
TOTAL	31

The patients' ages ranged from 18 to 70 years. Average: 37

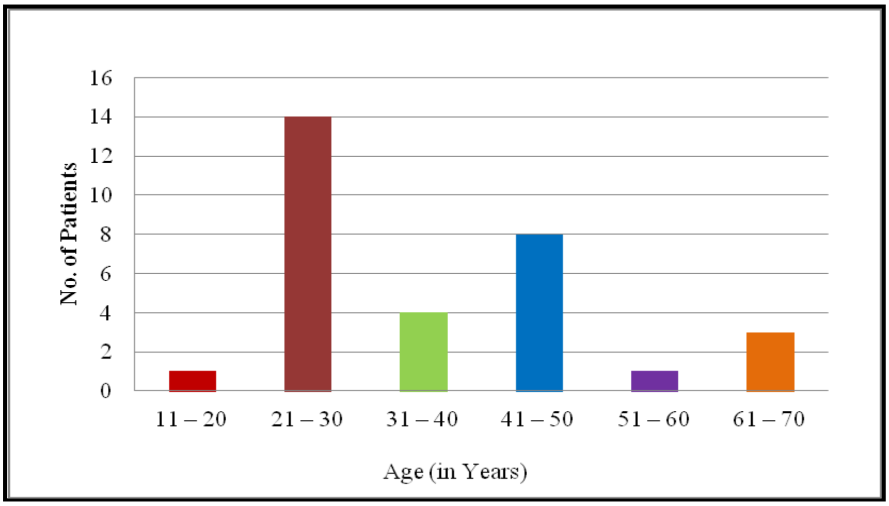

Figure 1:

Table 2: Sex incidence

Sex	No. of Patients
Male	28
Female	3

In our study, males predominated at a ratio of 9:1.

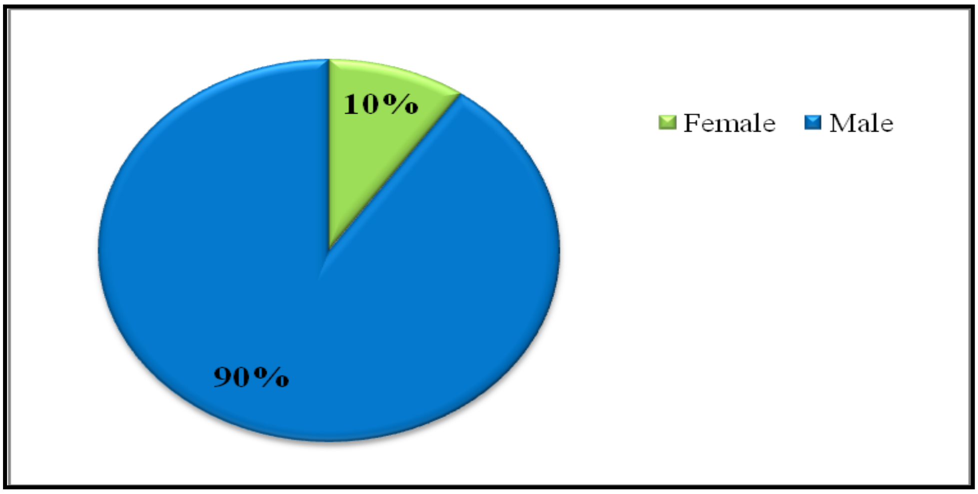

Figure 2:

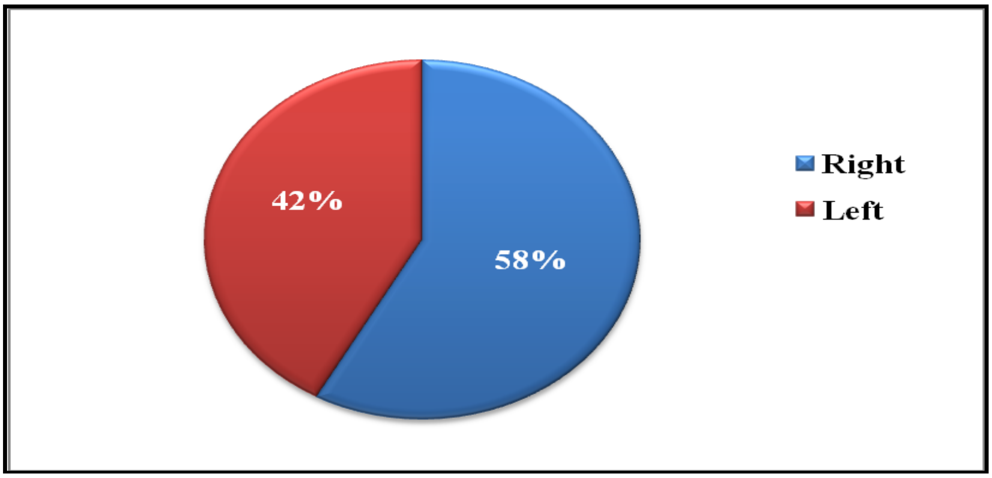

Figure 3:

Table 3: Associated Injuries

Injuries / Fractures	No. of Patients
Head Injury	2
Posterior dislocation hip	1
Tibial Plateau fracture / Galeazzi fracture	1
Metatarsal fracture	1
Distal radius fractures	1

23% of our patients had associated injuries

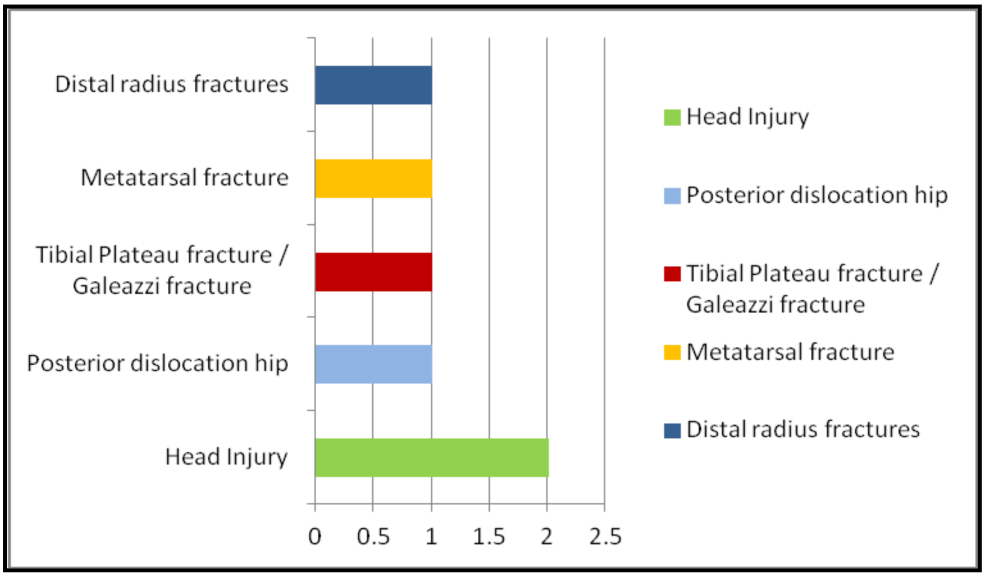

Figure 4:

Anatomy of Fractures: In our study, there was 1 case of segmental fracture, 12 fractures were comminuted, 9 cases had an oblique pattern, and 8 cases had transverse fractures.

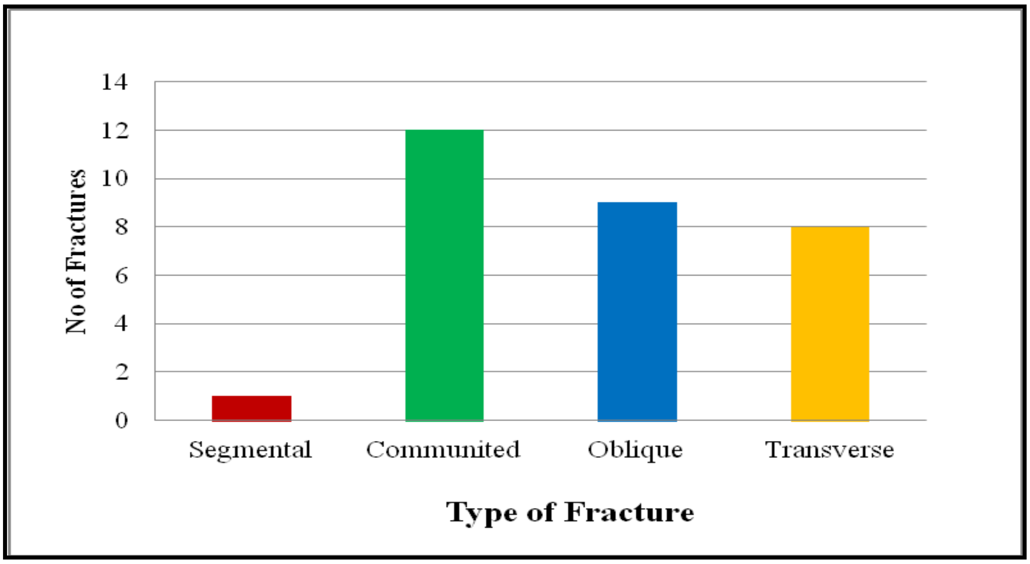

Figure 5:

Of the 31 patients, road traffic accidents were the mode of injury in 30 cases, and 1 had an Industrial Accident.

Table 4: Mode of Injury

No. of Cases	Mode of injury
30	Road Traffic Accident
1	Industrial Accident

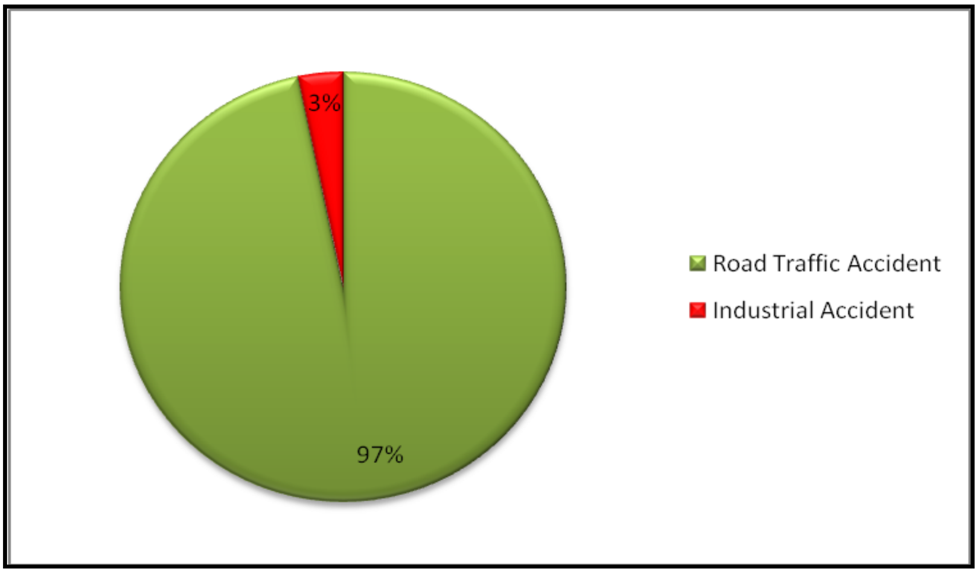

Figure 6:

Classification of Soft Tissue Injury: We classified open fractures of the tibia according to the Gustilo and Anderson classification. Among 31 patients: Grade II - 15, Grade III A - 12, Grade III B - 4.

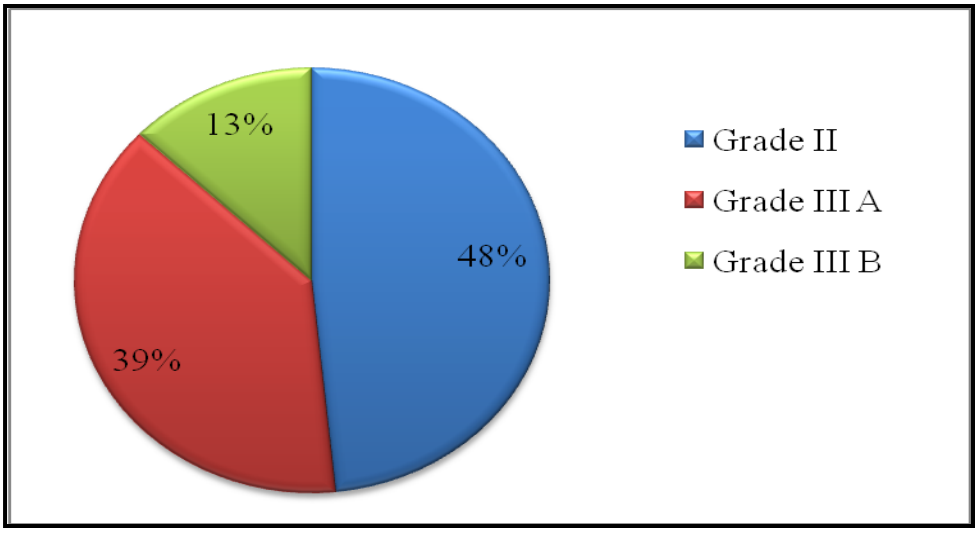

Figure 7:

Discussion:

Thorough wound debridement and external skeletal fixation, along with or without soft tissue cover, was the established treatment for open tibial fractures despite the problems of malunion and pin-track sepsis associated with its use. In the early years, intramedullary nailing using un-reamed unlocked nails produced good results in type III open tibial fractures; however, this method did not adequately stabilize the comminuted or segmental fractures. With improved metallurgy and advances in nail design, extensive studies have been conducted on the use of primary nailing and primary soft tissue cover. As a result, the use of reamed interlocking nailing [6-8] in open tibial fractures has simplified treatment without increasing the rate of infection. This eventually results in an early return to society and reduced morbidity and length of hospital stay.

Recently, treatment for open tibial fractures has evolved into a stage in which primary nailing and immediate/early soft tissue cover [9] has become the method of treatment. In our hospital, immediate wound debridement and POP immobilization followed by elective interlocking nailing are routine procedures for grade I and grade II open tibial fractures. However, it is associated with multiple surgical procedures and a long hospital stay. Wound debridement and external fixation followed by repeat wound debridement and elective delayed primary cover followed by internal fixation are methods of treatment for grade III fractures. To assess the functional outcomes of patients with open tibial fractures treated with primary nailing +/- soft tissue cover, we conducted this prospective study in our hospital. We performed 34 cases, out of which we lost the follow-up of three patients. We analyzed the union, infection, and functional outcomes in the remaining 31 patients. There were 28 males and 3 females in the study. The mean age of the patients was 37 years. We assessed the time to union, infection rate, rate of malunion, nonunion, and need for secondary procedures. In our study, the average time to union was 24.4 weeks (grade II – 19.4 weeks, grade IIIA, 23.3 weeks, grade IIIB – 30.5 weeks).

Author	Treatment	Union time (weeks)	
		III A	III B
Blachut et al (1990) [10]	External fixation	38.6	47
Christie et al (1990) [11]	External fixation	26.5	47.4
McQueen et al (1991) [12]	Intramedullary nailing	27.2	50.1
Our study	Intramedullary nailing	24.3	27.5

The grade II fracture results were comparable with those of previous studies (Averaging 23.5 weeks in a study [11]. Two required dynamization, and another required dynamization and bone grafting. In grade III fractures union time is marginally better than with the previous studies (24.3 weeks vs 27.2 weeks) in a study [12].

Compared to other studies, our union rate was higher. Infection was noted in four patients (11.8%), of which two were superficial (Gr. II-1 and Gr IIIA-1) and deep infection in two patients with Grade IIIB, of which repeated wound debridement, implant removal, and LRS fixation were performed, and another patient underwent the same procedure.

The infection rate in our study was comparable to those reported in other studies. Three of them (GrII-1, GrIIIA-1, and GrIIIB-1) were taken up for surgery 24 h after injury, with no primary wound care given in the earlier treated medical center. This delayed primary wound care could have been the reason for infection.

Study	Treatment	Union time(weeks)	Infection (%)
Our study	Interlocking nailing	24.1	11.6
Blachut et al (1990)	External fixation	45.2	9.5
Christie (1990)	External fixation	36.7	17.6
McQueen (1991)	Interlocking nailing	38.2	11.1

There were four cases of Gr IIIB for which additional procedures such as flap cover (fascio-cutaneous or myo-cutaneous) were performed in all patients, and secondary bone grafting was performed in two of them.

Two patients had a varus fracture malignancy. They went on for delayed union, and union was achieved at 28 and 30 weeks, respectively, with secondary bone grafting. Two patients with Gr-IIIB injuries required additional bone grafting as they progressed to delayed union. The union was eventually achieved at 31 and 33 weeks. There was limb length discrepancy in two patients, which was managed by compensatory heel and sole raise footwear.

Our patients were followed-up regularly and assessed using the Johner and Wruh criteria [21]. Results were categorized as excellent, good, fair, or poor. Eighteen patients had excellent outcomes (58.06%), 7 had good outcomes (22.05%), 4 had fair outcomes (12.9 %) and two had poor outcomes (6%).

Study	Infection	Nonunion
McGraw et al 1988 [13]	44%	54%
Maurer et al 1989 [14]	25%	35%
Our study	11.8	11.8%

Study	Treatment	Nonunion
Our study	Interlocking nailing	11.8%
J. F keatings et al [7,8]	Primary Interlocking nailing and delayed cover	12%
Sanders et al 1994 [15]	Primary Interlocking nailing and delayed cover	17%

A study [16] in 2004 reviewed cases of open tibial fractures treated with unreamed interlocking ailing and found similar results of infection and nonunion with unreamed nailing. They encountered 3.6% of nail breakage in 14.3% and screw breakage in the study. We did not encounter any such problem. Our infection rate was 11.6%

and the nonunion rate was 11.8%. In this study, the infection rate was 11.6%, and the nonunion rate was 11.8%, as shown below.

Complication	Joshi et al [16]	Our study
Infection	10.7%	11.6%
Non-union	10.7%	11.8%
Nail Breakage	3.6%	Nil
Screw Breakage	14.3%	Nil

Hamza et al reported three infections after the treatment of twenty-two open fractures [17] and Smith subsequently reported six infections in eighteen patients [18]. Klemm and Borner reported six infections after the treatment of Ninety- three grade-I open tibial fractures with the insertion of a locking nail after reaming [19]. Bone and Johnson reported two infections after the treatment of eight Grade II and Grade III fractures with nailing after reaming [20]. In our study of 31 patients with reamed interlocking nailing, four patients were infected.

Infection	Total number of patients	Infection
Hamza et al 1971 [17]	22	3
Smith et al 1974 [18]	18	6
Klemm and Borner 1986 [19]	93	6
Bone and Johnson 1986 [20]	8	2
Our study 2011	31	4

With improvements in surgical debridement, effective antibiotic coverage, early flap cover, and better metallurgy, the infection rate of compound fractures has reduced considerably.

Conclusion

The treatment of open tibial shaft fractures has evolved over the last two decades. Improved wound care, newer generation antibiotics, and better metallurgy of implants have contributed to this change.

Currently, the current trend in the management of such fractures is primary wound debridement, skeletal stabilization, and primary soft tissue cover.

We followed a similar protocol in this study involving 31 patients with open tibial fractures.

The primary treatment of choice for such challenging fractures would be debridement, interlocking nailing, and primary flap cover for our patients with open tibial fracture.

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