

**BACTERIAL CULTURES AND OUTCOME OF
INTRAMEDULLARY INTERLOCKING NAIL IN
OPEN DIAPHYSEAL FRACTURES OF TIBIAL**

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ABSTRACT

Background: *The tibial shaft is one of the most common open long bone fractures; treatment improperly can lead to many serious complications and frequently cause permanent sequelae. Infection is one of the most common and disastrous complications of an open fracture. Therefore, determining the role of qualitative bacterial cultures in implementing the most effective antibiotics for opening tibial fractures and managing promptly and with precision is extremely important to avoid these complications and restore the patient's rehabilitation. Due to the paucity of articles exclusively dealing with this topic, we conducted a study to determine bacterial cultures and the functional outcome of intramedullary interlocking nailing in these patients. Objectives:* This study assessed Bacterial cultures and the outcome of intramedullary interlocking nails in open diaphyseal fractures of the tibial. **Materials and Method:** A cross-sectional descriptive study was conducted on 32 patients with open diaphyseal fractures of tibial who were initially treated with thorough wound debridement and lavage, followed by surgical treatment with intramedullary interlocking nails. The qualitative method of antibiotic disc diffusion in agar (Kirby Bauer) is often applied to determine the susceptibility of bacteria to different antibiotics. All 32 patients were followed up, which was conducted using clinical criteria, and a radiographic was assessed using the RUST score. **Results:** In our study, the injury surgery interval was 14.54 ± 6.304 hours. *Staphylococcus aureus* and *Staphylococcus epidermidis* were common bacteria in open tibial fractures. The mean union time was 15.43 ± 3.726 weeks, which was assessed by RUST score and clinical criteria. The functional outcome with Ketenjian and Shelton Criteria was excellent results in 28 (87.5%) cases and good outcomes in 4 (12.5%) cases. **Conclusion:** Using the intramedullary interlocking nail in open diaphyseal fractures of the tibial is an excellent procedure that leads to good results with reduced hospital stay, good range of motion, and low infection rate, leading to better union.

Keywords: *open tibial fractures, bacterial cultures, intramedullary interlocking nailing, RUST score, Ketenjian and Shelton Criteria.*

I. INTRODUCTION

Open diaphyseal fractures of the long bone are the most complex, challenging, and controversial orthopedic injuries. Open diaphyseal fractures of the tibia are serious and common injuries, accounting for the highest proportion of open fractures of long bones. Open fractures lead to deep infections, nonunion, etc., with relevant consequences for the patient in terms of restoration of limb function and an increase in time of hospitalization. Infection is one of the most common and disastrous complications of an open fracture, with a reported incidence of 2-25% [1], especially in grade III. The loss of skin and devitalization of bone and soft tissue are usually the main reasons for the development of infection [2]. Complications of open fractures increase with the age of the patient and the complexity of the injury. Orthopedic surgeons should be acquainted with the pathophysiology of the fractured bone as well as soft tissue, as well as the timing, risks, and benefits of the different treatment options. Proper assessment should include a complete history of injury, neurovascular examination, and a proper diagnosis of bone and soft tissue damage, thus taking into consideration the general condition of the patient [3]. The primary goal in the management of open fractures is to prevent the infection of bone and soft tissue.

The optimum treatment for open fractures of the tibia remains controversial. External fixation is often the most commonly sought option for temporary fracture fixation, but it often leads to malunion, delayed union, loss of reduction, and pin-track infection. However, thorough debridement and lavage of the wounds as soon as the patients present to the casualty and primary intramedullary interlocking nailing (i.e., in Diaphyseal Fractures) done on an emergency basis has shown good to excellent results in these patients, in terms of Fracture Union and Soft tissue healing (absence of osteomyelitis). It reduces hospital stays and morbidity. Furthermore, it negates the need for a second surgery and its complications. Besides, several studies have been done to identify the most common bacteria involved in contaminating open fractures, and this has led to an acceptance of the usage of broad-spectrum antibiotics for their eradication.

In the past few decades, using intramedullary interlocking nailing in opening tibial fractures and the selection of antibiotics to treat these infections have been advocated and practiced by many surgeons. However, it still remains a matter of debate. Therefore, this study aims to observe the density of common bacterial in open fractures and the antibiotic sensitivity pattern of various bacterial isolates to implement the most effective antibiotics for open tibial fractures, and intramedullary nailing has been proven to be the method of choice for fixation of these fractures and as it fulfills the objective of stable fixation with minimal tissue damage resulting in better and quicker fracture union, early rehabilitation and at the same time decreasing hospital stay of patient.

II. MATERIALS AND METHODS:

2.1. Patient selection

Inclusion criteria:

Patients \geq 16 years old

Gustilo and Anderson Grade I, II, and IIIA compound tibia shaft fractures.

Patients with bacterial cultures and antibiograms are treated with an intramedullary interlocking nail.

Exclusion Criteria :

Pathological fractures

Patients with systemic infections, infected (osteitis) bone

Patients not giving informed consent

2.2. Method

Research design: cross-sectional descriptive study

Simple sign: N = 32 patients

Research content:

Patient's fracture characteristics: Grade of open fracture (Gustilo and Anderson classification), level of fractures, pattern.

Injury-Surgery interval and wound management: Early wound debridement was carried out, wounds were irrigated, and any foreign body was looked at; if any were found, it was removed.

Bacterial Cultures: a sterile cotton-tipped applicator was applied deep into the wounds and was rotated over a 1 cm² area in the deep tissue of the open fracture wound, and then it was kept in the culture tube. The culture and sensitivity reports were collected usually three days afterward. The qualitative method of antibiotic disc diffusion in agar (Kirby Bauer) is often applied to determine the susceptibility of bacteria to different antibiotics.

All the selected patients were treated with debridement and intramedullary interlocking nail. Partial weight-bearing was individualized based on fracture type and nail diameter. Immediate postoperative and then regular x-rays were taken during follow-up (4, 8, 12, 24 and 36 weeks). Functional outcome was assessed by Ketenjian and Shelton. Criteria modified by Yokoyama et al. were pain, range of motions of knee and ankle joints, swelling, and gait. An average follow-up of 6 months.

2.3. Data analysis:

The results are presented in mean±SD and percentages. Data was evaluated based on the descriptive statistics. Data was then put to statistical analysis using SPSS 26.0.

III. RESULTS

3.1. Characteristics of fracture

Table 1. Characteristics of fracture

Characteristics		No. of Patients	Percentage
Grade	I	14	43.8%
	II	11	34.4%
	IIIA	7	21.9%
Level of fractures	Proximal third	5	15.6%
	Middle third	15	46.9%
	Distal third	12	37.5%
Pattern	Transverse	12	37.5%
	Oblique	14	43.8%
	Segmental	6	18.8%

Out of the 32 fractures, 14 (43.8%) were type I, 11 (34.4%) were type II and 7 (21.9%) were type IIIA. Most of the fractures were either in the middle third of the shaft (46.9%), or the distal third of the shaft (37.5%), whereas the proximal third of the shaft included only (15.6%). The different diaphyseal fracture patterns noted in our series, transverse were 12 (37.5%), Oblique was 14 (43.8%), and Segmental was 6 (18.8%).

Table 2. Injury - Surgery interval

Injury - Surgery Interval	No. of Patients	Percent
<6 hours	4	6.3%
6-12 hours	11	34.4%
12-24 hours	15	46.9%
>24 hours	2	12.5%

In our study, the mean time injury surgery interval was 14.54 ± 6.304 hours

3.2. Frequency distribution of pathogenic bacteria involved in open fracture of tibia

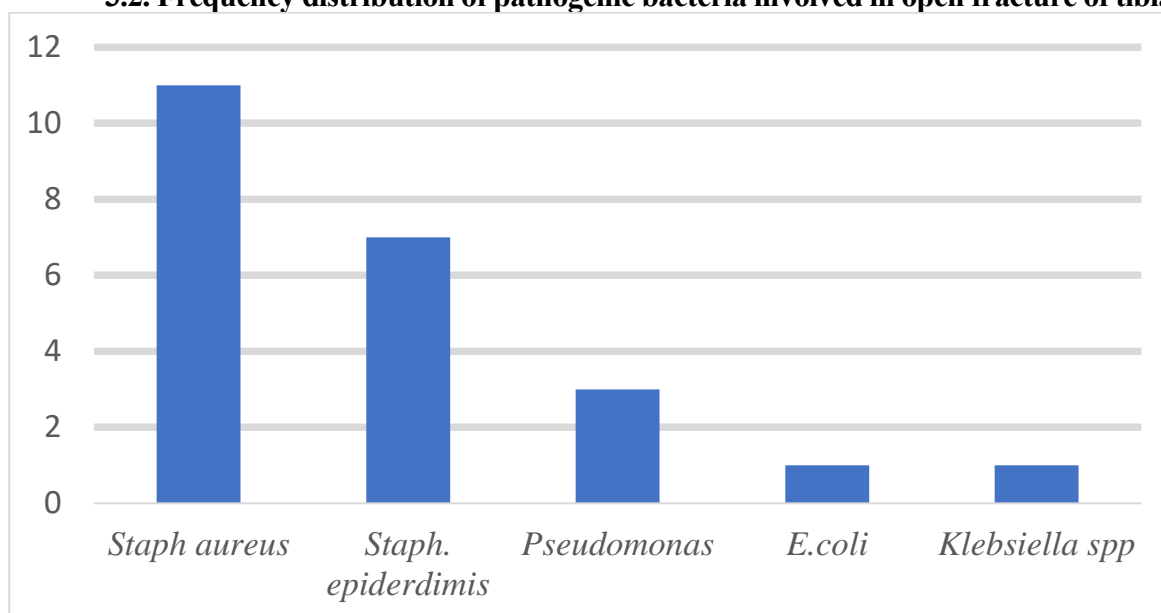


Figure 1: Frequency distribution of patients according to a type of pathogenic bacteria involved in open fracture (n=32)

Staphylococcus aureus (11) and *Staphylococcus epiderdimis* (7) were common bacteria that were found to be present in 25 isolated bacteria.

3.3. Union time

Table 3. Union time

Union time	Grade I	Grade II	Grade IIIA
10-16 weeks	10	8	2
16-24 weeks	4	3	4
>24 weeks	0	0	1

The union of the fracture was assessed using the radiographic union scale in tibial (RUST) fractures and clinical criteria. Mean union time was found to be 15.43 ± 3.726 weeks.

3.4. Functional Outcome

Table 4. Functional Outcome

Results	No.of patient	Percentage
Excellent	28	87.5%
Good	4	12.5%
Fair	0	0.0%
Poor	0	0.0%
Total	32	100.0%

The Functional outcome was assessed by Ketenjian and Shelton Criteria modified by Yokoyama et al criteria in our study, which showed excellent results in 87.5% of cases and good outcomes in 12.5% of cases.

IV. DISCUSSION

4.1. Injury - Surgery interval and wound management in open tibial fractures:

Infection is one of the most common and disastrous complications of an open fracture, which can lead to osteomyelitis, sepsis, tissue loss, or even amputation. Most infections in open fractures are suspected at the time of initial trauma and are associated with soft tissue injury. Early and repeated wound debridement, in combination with antibiotic therapy based on bacterial cultures, was the preferred treatment modality for opening tibia fractures. Surgical interval plays a critical role, as delayed surgical debridement can lead to complications. Time to treatment was the important factor influencing the risk of infection [4]; in our study, most of the patients were operated on within less than 24 hours, and almost all of these were devoid of complications, so our study supports the immediate surgical intervention to early wound debridement. In our study, the mean time injury surgery interval was 14.54 ± 6.304 hours; this delay is because our institute is a central general hospital where patients come after primary management outside. The most important thing is that surgery should be initiated as soon as possible, with optimally rigorous debridement. Debridement has to be performed no matter how many times to obtain good outcomes and prevent infection in open fractures. So, our study supports the concept of immediate surgical intervention.

4.2. Bacterial cultures and antibiotic therapy

Our study addresses bacterial cultures and antibiotic sensitivity in open tibial fractures; in 25 out of 32 patients whose cultures reported were positive for the presence of bacteria, *Staphylococcus aureus* was the most common bacteria, with 11 bacteria isolated, followed by *Staphylococcus epidermidis*(7), *Pseudomonas*(3), *E.Coli*(1), *Klebsiella*(1). Md. Samiul Islam and his colleagues concluded that the most common bacteria in initial open fracture is *Staphylococcus aureus* [5]. Some authors whose study expressed anxiety that there is an increasing trend towards gram-negative organisms in wounds of open fractures in the future, especially for *Pseudomonas*. Pre- or post-debridement cultures to detect infection remain controversial. Some authors consider the predictability of infection from post-debridement samples, which have better prognostic value [1], and post-debridement quantitative bacterial counts are more predictive of infection. Pre- and post-debridement cultures have a role in detecting infection in open fractures. Pre-debridement cultures have better sensitivity, while post-debridement cultures have better specificity for identifying infection.

Antibiotic therapy should be used as soon as possible, and an antibiotic should be recommended early because it has a protective role in preventing infection in open fractures. However, antibiotics are used excessively to lead to the development of more resistant microorganisms. Sattar and his colleagues showed antimicrobial susceptibility to *Staphylococcus aureus* and that it had resistance against most Penicillins [6]. Ceftriaxone and Ciprofloxacin were the most effective antibiotics, and they showed maximal sensitivity against all the bacteria in open fractures [7]. Early, systemic, and wide-spectrum antibiotics should be used to provide both Gram-positive and -negative cover, which is essential in treating open fractures [1]. In our study, early antibiotics were instituted in all patients.

4.3. Functional Outcome

Patients were treated for open tibial shaft fractures by intramedullary interlocking nailing, depending on fracture pattern; when patients had early partial weight bearing, which was started early, mechanical loading is conducive to its healing. In our study, we promoted early weight bearing to healing and early union. The union of the fracture was assessed using the radiographic union scale in tibial (RUST) fractures and clinical criteria. The mean union time was found to be 15.43 ± 3.726 weeks, comparable with the mean union time in studies by K. Kamal [8], and Laigle M [4]. Having 1 case grade IIIA did not achieve sufficient union; in cases, dynamization was done where no signs of the union were present at 6 weeks to 12 weeks, so a secondary procedure was done in the form of fibulectomy and bone graft after fractures united in 26 weeks. The superficial infection of the wound in 2 patients was cleared by wound care and the usual antibiotics. Some factors influenced delayed union and infection. These were delay in debridement, injury-surgery interval, grade of open fracture, etc [9].

In our study, the functional outcome was assessed using the functional scale of Ketenjian and Shelton Criteria modified by Yokoyama et al [10]. As per the criteria, the 32 patients had excellent to good results; a range of motions of knee and ankle joints in 28 cases (87.5%) regained full range due to the early rehabilitation and the proper control of infection prevention in 4 cases (12.5%) had joint motion 75% of normal. Early rehabilitation in the form of quadriceps drill exercises and knee and ankle range of motion exercises are key in the postoperative management of tibial intramedullary interlocking nails as they help in achieving a nearly normal range of motion if started as early as possible [9,10].

V. CONCLUSION

Early antibiotic therapy and wound debridement were key factors in successfully managing open tibial fractures. Suppose primary wound closure cannot be achieved during the initial surgery. In that case, necessary early debridement must be undertaken as soon as possible, if not concomitantly with fracture fixation, to achieve good results. Therefore, our study proves that using an intramedullary interlocking nail in open diaphyseal fractures of the tibial is an excellent procedure leading to good results with reduced hospital stay, good range of motion, and low infection rate leading to better union.

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