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OUTCOME EVALUATION OF UNREAMED CLOSED INTERLOCKING INTRA MEDULLARY NAILING IN THE MANAGEMENT OF OPEN TIBIAL SHAFT FRACTURES ACROSS GUSTILO ANDERSON TYPES EXCEPT TYPE IIIC

Dr. Alok C. Patil[1], Dr. Bindusar[2], Dr. Shivaraj A. C.[3], Dr. Shweta Patil[4]*

[1]Assistant Professor, Department of Orthopaedics, Mahadevappa Rampure Medical College Kalaburagi, Karnataka, India.
[2]Senior Resident, Department of Orthopaedics, Kodagu Institute of Medical Sciences, Kodagu, Karnataka, India.
[3]Assistant Professor, Department of Orthopaedics, Mahadevappa Rampure Medical College Kalaburagi, Karnataka, India.
[4]*Consultant Neurologist, ESIC Medical College Kalaburagi, Karnataka, India.

***Corresponding Author:** Dr. Shweta Patil
*Consultant Neurologist, ESIC Medical College Kalaburagi, Karnataka, India.

Abstract

Background: This study was conducted to evaluate the effectiveness of unreamed closed interlocking intramedullary nailing, with the exception of type IIIC, in the treatment of open tibial shaft fractures throughout the Gustilo-Anderson type.

Methods: This was a hospital-based study conducted among patients, both male and female who had open fractures of the tibia. The study was undertaken at the department of Orthopaedics, Basaveshwar Teaching and General Hospital, Gulbarga. 20 patients who had open fractures of the tibial shaft were treated with wound debridement and interlocking intramedullary nailing without reaming from January 2021 to December 2022 after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Results: The majority of the patients belonged to the 25–31 age range. There are just three female patients out of the total 17 (85%) male patients. (15%). Road traffic accidents were the leading cause of fractures (75%). Most individuals had fractures to their right tibia. Fifteen patients (75%) had fractures to their right tibia. The majority of the open fractures of the tibia were Gustilo type I (50%). The majority of the fracture patterns (40%) were shared by 8 patients. Transverse was in 5 (25%), oblique was also 5 (25%) and spiral was 2 (10%). Most of the patients were operated on within 1 (i.e., 8-24 hours) after trauma (50%); 1 case was operated on less than 8 hours after trauma (5%), 18 cases were operated on under spinal anaesthesia and 2 cases under general anaesthesia. The midline patellar tendon splitting technique was applied for nail implantation in each case. We operated for an average of ninety minutes. (Time interval: 60–120 minutes) Outcomes for 15 instances (75%) were great, 3 cases (15%) had acceptable outcomes, 1 case (5%) was fair, and 1 case (5%) was bad. 14 patients (70%) were pleased, 5 patients (25%) were satisfied, and 1 patient (5%) was unhappy.

Conclusion: Early weight bearing and early joint mobility are important benefits of interlocking since they enable a quicker return to work. Unreamed interlocking nailing is a viable treatment option for open tibial shaft fractures that has demonstrated favourable outcomes with few problems.

Keywords: Unreamed, Closed Interlocking, Intramedullary Nailing, Open Tibial Shaft Fractures, Gustilo-Anderson Type, Type 111C.

INTRODUCTION

With the increasing number of industrialization, urbanization and vehicles on the road in India, complex trauma cases caused by road traffic accidents have increased progressively. It was stated that tibial shaft fractures are important for two reasons (Nicoll). The first reason is that they are common, and secondly, their management is controversial. Because one-third of the tibial surface is subcutaneous throughout most of its length, open fractures are more common in the tibia than in any other major long bone. Furthermore, the blood supply of the tibia is more precarious than that of bones enclosed by heavy muscles.[1] The most frequent long bone fractures that orthopaedic surgeons treat are tibial diaphyseal fractures. About 26 tibial diaphyseal fractures occur annually per 1 lakh people in an average population. Male incidence is around 41 per 1 lakh per year, whereas female incidence is about 12 per 1 lakh per year. Males are afflicted more frequently than girls. Tibial fractures have a bimodal distribution, with young men predominating.[2] The major goal in the treatment of fractured tibias is to achieve functionally useful and stable extremities. Yet, the spectrum of injuries to the tibia is so great that no single method of treatment is applicable to all fractures. The effective treatment of open tibia fractures requires the accomplishment of three objectives: the accomplishment of bone union, the avoidance of infection, and the return of function. These objectives are interrelated and often accomplished in the specified chronological order. For instance, failing to avoid infection encourages delayed union or nonunion and postpones the limb's functional recovery.[3] Over the years, various modalities of treatment have been used. Today, the well-established principle of biological osteosynthesis is rightly applied in long bone fracture healing, hence the selection of closed intramedullary interlocking nailing without reaming in the treatment of open fractures of the tibial shaft in this study. In his book “Closed Treatment of Common Fractures”, Charley J. expressed his belief that a nonreamed intramedullary nail will ultimately be the best course of action for treating tibial fractures.[4] Since closed intramedullary nailing is now achievable thanks to image intensifiers, intramedullary nailing, whether locked or unlocked, has become a desirable choice. As a load-sharing tool, nails are rigid against both axial and torsional forces. Compared to other internal fixation methods, closed nailing includes the least amount of soft tissue disruption, fracture hematoma, and the normal healing process of the bone.[5] It has been shown that using intramedullary nails, like Lottes and Ender nails, without reaming can help treat open tibial fractures with low rates of infection after surgery. However, because the fractures around these tiny nails tend to shrink or shift, they are not recommended for common fractures.[5,6] The severity of soft tissue injuries, level of contamination, fracture pattern, and degree of comminution are the main parameters influencing the prognosis of open tibial fractures following high-energy trauma. Any surgical procedure, such as the insertion of a plate or screw, might worsen the devitalization of already damaged local tissues in the event of considerable stress. Thus, in order to prevent infection and facilitate the healing of tibial fractures, it is crucial to avoid such surgical operations. Deep infection and malunion are highly common side effects of plaster cast therapy. Due to their versatility and ability to promote early soft tissue healing, external fixators have been widely used in the past. It is linked to a high rate of pin tract infection, though, and even with sufficient antibiotic therapy, infection is likely to occur if a subsequent surgery like plating or nailing is performed after the fixator is removed. Unreamed intramedullary nailing is the current standard of care for Gustilo type I, II, and IIIA open tibia fractures that are brought to the emergency room within 6 to 8 hours. There are reportedly clear benefits to undreamed tibial nailing versus reamed nailing. It has been seen in experimental research that unreamed nailing results in a smaller loss in cortical circulation than medullary canal reaming.[7]

Using an undreamed nail, Klein et al. found a 31% drop in cortical circulation, whereas reaming resulted in a 71% reduction. It has been discovered that reaming open fractures removes tiny pieces of bone from the soft tissue connection and spreads the pollution from the open wound throughout the medullary cavity. Additionally, it has been shown that reaming delays osseous union and slows down revascularization. A hollow nail has double the surface area of a solid nail, meaning that it has more dead space and is therefore more prone to infection. A loosely fitted intramedullary nail has a lower risk of cortical necrosis than a snugly fitted reamed nail. Furthermore, a firm nail's smooth surface may lessen bacterial adhesion and thereby reduce the risk of infection. Thus, our goal in this study is to examine how unreamed interlocking nailing is used to treat open tibia fractures.

AIMS AND OBJECTIVES

1. To assess the efficacy of closed interlocking medullary nailing in the treatment of open tibial shaft fractures without reaming. (Types I, II, IIIA, and IIIB of Gustilo).
2. To investigate the challenges (complications) that arose throughout the surgical investigation.
3. To get the patient moving right away.
4. To prevent angulation and deformity, to maintain limb length equality.
5. To compare the efficacy of interlocking intramedullary nailing without reaming in treating open fractures of the tibia with other standard similar studies in terms of.

a. Time required for the union of fractures.
b. Range of motion at the ankle and knee joints.
c. Pain at the knee joint.
d. Rate of malunion and mal rotation.
e. Rate of infection.
f. Failure of the implant.

MATERIALS & METHODS

This was a hospital-based study conducted among patients, both male and female who had open fractures of the tibia. The study was undertaken at the department of Orthopaedics, Basaveshwar Teaching and General Hospital, Gulbarga. 20 patients who had open fractures of tibial shaft were treated with wound debridement and interlocking intramedullary nailing without reaming from January 2021 to December 2022 after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Inclusion Criteria

- More than eighteen years old.
- Shaft fractures in the tibia occurred between 4 cm proximal to the ankle joint and 4 cm distal to the tibial tuberosity, with a medullary canal big enough to take a minimum 8 mm nail.
- Open fractures are classified as type I, II, IIIA, and IIIB by Gustilo Anderson.

Exclusion Criteria

- Age less than 18 years.
- Associated intraarticular fractures of the proximal or distal tibia.
- Closed fractures and Gustilo-type IIIC fractures.
- Fractures with intraarticular extension.
- Burns or wounds over the entry portal.

Statistical Methods

Data was entered in MS Excel and analysed using SPSS software. The results were presented as tables.

RESULTS

Age (in years)	Number of Patients	Percentage
18-24	5	*25*
25-31	7	*35*
32-38	4	*20*
39-45	4	*20*
Total	**20**	**100**
Age Distribution		
Sex	**Number of Patients**	***Percentage***
Male	17	*85*
Female	3	*15*
Total	**20**	**100**
Sex Distribution		
***Table: 1** Demographic Distribution*		

The majority of the patients were in the age range of 25–31 years (35%); the youngest patient was 21 years old, and the oldest patient was 45 years old.
The majority of the patients were male 17 (85%), and only 3 were female (15%).

MOI	Number of Patients	Percentage
RTA	15	75
Fall	2	10
Assault	1	5
Direct Blow (Fall of object)	2	10
Total	**20**	**100**
Mode of Injury		
Side Affected	**Number of Patients**	**Percentage**
Right	15	75
Left	5	25
Total	**20**	**100**
Side of Fracture		
Type of Fractures	**Number of Patients**	**Percentage**
Type I	10	50
Type II	6	30
Type IIIA	3	15
Type IIIB	1	5
Total	**20**	**100**
Fracture Classification		
Table 2		

75% of the fractures in our study were caused by car accidents. Most individuals had fractures to their right tibia. Fifteen patients (75%) had fractures to their right tibia.
In our analysis, Gustilo type I fractures accounted for 50% of the majority of open tibia fractures. The central portion of the tibia sustained the majority of the fractures (45%). Communited fracture patterns accounted for 40% of all tibial fractures.

Pattern of Fracture	Number of Patients	Percentage
Transverse	5	25
Oblique	5	25
Spiral	2	10
Communited	8	40
Total	**20**	**100**
Pattern of Fracture		

Duration between Trauma and Operation	Number of Patients	Percentage
< 8 hours	1	5
8-24 hours	10	50
2 to 4 days	5	25
>4 days	4	20
Total	**20**	**100**

Statistics of Surgery

Table 3

Majority of the fracture patterns were comminuted (40%) 8 patients. Transverse was 5 (25%), oblique was also 5 (25%) and spiral was 2 (10%).

In our study, the majority of patients underwent surgery within one (i.e., 8–24 hours) following trauma (50%), one instance underwent surgery fewer than eight hours after trauma (5%), 18 cases underwent spinal anaesthesia, and 2 cases underwent general anaesthesia. The midline patellar tendon splitting technique was applied for nail implantation in each case. We operated for an average of ninety minutes. (Time interval: 60–120 minutes)

Functional Outcome	Number of Patients	Percentage
Excellent	15	75
Good	3	15
Fair	1	5
Poor	1	5
Total	**20**	**100**

Functional Results

Sl. No.	Criteria	Excellent (left=right)	Good	Fair	Poor
1.	Non-unions, osteitis, amputations	None	None	None	Yes
2.	Neurovascular disturbance	None	Minimal	Moderate	Severe
3.	Deformity				
	Varus / valgus	None	2^0-5^0	6^0-10^0	>10^0
	Anteroversion /recurvation	0^0-5^0	6^0-10^0	11^0-20^0	>20^0
	Rotation	0^0-5^0	6^0-l0^0	11°-20°	>20^0
4	Shortening	0-5mm	6-10mm	11-20mm	>20mm
5	Mobility				
	Knee	Normal	>80%	>75%	<75%
	Ankle	Normal	>75%	>50%	<50%
	Subtabular	>75%	>50%	>50%	-
6	Pain	None	Occasional	Moderate	Severe
7	Gait	Normal	Normal	Insignificant limp	Significant limp
8	Strenuous activities	Possible	Limited	Severely limited	Impossible
9	Radiological union	Consolidated	Consolidated	Union	Not Consolidated

Johner and Wruh's Criteria for Evaluation of Final Results

Table 4

Outcomes for 15 instances (75%) were great, 3 cases (15%) had acceptable outcomes, 1 case (5%) was fair, and 1 case (5%), was poor.

Patient's Satisfaction

14 patients (70%) were pleased, 5 patients (25%) were satisfied, and 1 patient (5%) was unhappy.

DISCUSSION

There are still a number of unsolved problems about the best way to treat open tibial shaft fractures. These fractures, which are typically brought on by high-energy trauma, present a number of issues because of the tibia's inadequate soft tissue covering and restricted vascular supply. They can lead to infection, malunions, and occasionally even amputation. Although the frequency of these problems has declined due to recent advancements in wound covering techniques and fixation devices, the best way to treat open tibial shaft fractures is still being developed.[8]

The eventual result of tibial shaft fractures is affected by two main lesion-related variables. The first is the fracture's severity, which is determined by the degree of initial displacement, comminution, and soft tissue damage, as stated by the author.[9] Therefore, regardless of the fixing technique employed, the more serious the fracture, the higher the risk of problems and the longer the healing times.

he impairment of the tibial blood supply is the second reason. In open fractures, there is periosteal circulation disruption following extensive soft tissue destruction and periosteal stripping from the bone, in addition to disruption of the endosteal circulation. This highlights the need to use stabilisation techniques to prevent further interruption of the blood flow in order to maintain the vascularity of the endosteal arteries as much as feasible.

The most popular therapy for open tibia fractures has been the use of a plaster cast, yet this has a number of drawbacks. After treating 140 open tibial fractures with a cast, the study observed a 15% infection rate. According to the current study of the 63 open tibial shaft fractures, 27% had healed with a shortening of more than ten millimetres and 6.3% with a shortening of more than thirty millimetres. More subsequently, the study observed that out of 24 open tibial fractures treated with a cast, 12.5 percent of them resulted in malunions. Thus, stable fractures with no soft tissue damage should be saved for immobilisation in a plaster cast.

Plaster casts in corporating titanium screws can be used to repair unstable and open fractures.[10] This technique has proven useful for distal tibial fractures, particularly the rotation-type Pilon fractures and those with joint extension. The benefits of this approach include preserving length, preventing rotation, and enabling knee mobility. The drawbacks of this include pivoting of the bone, angulation at the fracture site, and severe pin tract infection.

By providing firm stabilisation for an unstable fracture, plate osteosynthesis lessens the likelihood of non-union. Nonetheless, patients with open tibial factures are experiencing an intolerable rate of infection as a result of the soft tissue having to be stripped in order to apply a plate.
According to the authors,[11] treating open fractures with plating increased the risk of infection five times and non-union by twice, making the use of plates an unsightly therapeutic choice.
When treating severely communicated open tibial shaft fractures (grades TuB and C), external fixation techniques continue to offer a number of benefits. These benefits include early stabilisation for patients suffering from polytrauma, an increase in the survival rate of injured tissues, and the ability to turn and move around to help patients avoid more serious complications. External fixation is being used less frequently for grade I, II, and IIIA open fractures. With this method, delayed unions and malunions are frequent.[12] Some studies suggest that these problems can be avoided by using secondary intramedullary nailing after external fixation. However, this method has a higher risk of deep infections after delayed conversion or prior pin tract infections.

Out of all the known intramedullary devices, open tibial fractures have responded well to unreamed, unlocked nails; however, compound or segmental fractures were not sufficiently stabilised by the implant. Holbrook et al. assessed twenty-eight open tibial fractures treated with external fixation in a randomised, prospective trial comparing external fixation with Ender nails. They found that the rate

of deep infection was 14%, the rate of pin tract infection was 21%, and the rate of malunions was 36%. They found a 7 percent infection incidence and a 21 percent malunion rate for twenty-nine similar open fractures repaired with Ender nails. Lack of axial control is the main drawback of Ender's nail fixation.

Malunions can be resolved by combining intramedullary nailing with reaming, which allows for control over length, angulation, and rotation but carries a significant infection risk when applied to open tibial fractures. Nevertheless, reaming causes the medullary canal's whole artery network to be destroyed. It also raises medullary pressure, which allows medullary fat, blood clots, and bone fragments to enter the vascular channels. The increased likelihood of infection and non-union in open tibial fractures is explained by the elimination of endosteal blood vessels, which further compromises the vascular supply already damaged by periosteal stripping and soft tissue injury. This results in significant bone necrosis.[13]

For fractures with less severe wounds, some truamatologists think that intramedullary nailing combined with reaming may be safely utilised (53). In a large series of ninety-three grade-I open tibial fractures, the study observed that six infections (6.5%) occurred following the application of interlocking intramedullary nailing with reaming. Intramedullary nailing without reaming has generally led to reduced infection rates and is less harmful to the endosteal blood supply than nailing with reaming. The study evaluated the cortical blood flow of canine tibiae both with and without reaming following nailing and discovered that although nail insertion without reaming only affects the blood supply in the inner third of the brain, reaming causes an average disruption of 70% of the cortical blood supply.

This is particularly crucial when treating open fractures, since periosteal stripping may harm the outer cortical blood supply. Because tiny-diameter interlocking tibial nails were not readily accessible, stabilisation of communal fractures or more proximal or distal fractures of the tibial shaft could not be obtained when using nails without reaming until recently.

Following the application of his nail without reaming to repair 256 open tibial fractures, the author[14] observed a 7.2% infection rate. The current study shows that malunions can occur even in fractures that have been determined to be axially stable by citing the series' 27 percent malunion rate.

Consequently, the best aspects of non-locking nailing without reaming and external skeletal fixation are combined in closed, unreamed interlocking intramedullary nailing. Controllable length, alignment, and rotation, easy accessibility to the soft tissues, and preservation of some endosteal blood supply are all present. In addition to increasing the application of intramedullary nails to fractures close to the metaphysis as well as those with more severe communition and soft tissue damage, these variables should reduce the incidence of infection and malunions.

Over the course of two years, 20 instances of open tibial shaft fractures in the current study were treated with closed, unreamed interlocking intramedullary nailing. For six to ten months on average, they were monitored. The goal of this study was to assess these individuals' treatment outcomes. These instances included people of various ages, both sexes, and fractures of various kinds and intensities.

Age Distribution

In this series, the average age of all the patients was 31. The age range of 25 to 31 is where fractures are most prevalent. In an investigation of 50 open tibia fractures, author [26] found that the average age was 34 years old. The authors[61] found that the average age of 43 patients with open tibia fractures was 36 years old. The average age of the 72 open tibia fractures in another investigation by the authors [62] was 30.3 years.

Sex Distribution

Three female patients and seventeen male patients indicated a masculine preponderance.

Nature of Violence

Seventy-five percent of the patients had fractures from auto accidents. One patient suffered from assault and the other two suffered from direct fractures following a fall. A sequence that the writer reported.[15] car crashes were the cause of 16% of fractures. They also revealed that in 23 cases (46%), pedestrian-automobile accidents were the most prevalent mode of injury.

CONCLUSION

For open diaphyseal fractures of the tibia, closed, unreamed interlocking intramedullary nailing with the use of an image intensifier appears to be possible. Advantages include patient's early mobilisation which promotes joint flexibility and aids in the healing of the fracture, little loss of blood, very little chance of infection, early union as it doesn't alter the vascularity's structure and physiology at the fracture site, easier follow-up, avoiding return visits, plaster replacements, wedging, and radiological inspections, earlier soft tissue coverage, and fracture dynamization at 8–10 weeks if union does not progress to prevent the unwanted complications of nonunion or delayed union. We are also of the opinion that locking all the proximal and distal holes should be done to avoid malunions and the fatigue of locking bolts.

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