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## Comparative study of external fixation and flexible intramedullary nailing (Enders nailing) in open tibial fractures

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### Abstract

**Background:** Open tibia fracture, due to high energy or low energy trauma classified according to Gustilo-Anderson classification system. The mode of fixation, been a subject of controversy and some authors have proposed a need to address the issue of breach of soft tissue in these injuries.

**Methods:** The study included a total 50 patients of open tibia fractures managed in AHRC from June 2010 to June 2015. There were 10 patients of type II, 4 patients of type IIIA and 36 patients of type IIIB according to Gustilo-Anderson classification. 29 patients were admitted to ORTHO A unit managed with enders nail where 21 patients admitted to ORTHO B unit managed with external fixator. The outcome was assessed by duration of fracture union, number of surgeries required, incidence of infection and malalignment.

**Results:** Open tibia fractures were mostly in males (90%) where 70% were young patients with a mean age of 36.2. Among these patients 80% sustained high velocity injury. Mean period of fracture union in enders group were 25+7 weeks while in external fixator group was 39.4+14 weeks. Our study also reveals fractures associated with head injury united earlier. 24 out of 29 cases managed by enders nail required <3 surgeries while 15/21 cases managed by external fixator required >4 further surgeries. Among these 50 cases infection detected in 12 cases (all were treated by external fixator; 11 cases belong to Gustilo-Anderson IIIB group). 35% malalignment in external fixator group in comparison to 4% in patients treated with enders nail.

**Conclusion:** Open tibia fracture treated with ender nail united earlier than external fixator and total number of surgeries to achieve union in ender nail was significantly lesser than external fixator group. Infection and malalignment rate was also high in external fixation cases.

**Keywords:** External fixation, flexible intramedullary nailing, enders nailing, open tibial fractures

### Introduction

There has been an increase in the number of road traffic accidents in the last decade. There are 60 fatal accidents/10,000 vehicles per year in India as compared to 2-3 fatal accidents/10,000 vehicles per year in developed countries. The incidence of open tibial diaphyseal fracture is high in polytrauma cases. They are frequently associated with infection, loss of limb and high levels of morbidity. The general consensus as to the five keys to the successful treatment of these fractures include: antibiotic therapy, radical debridement and pulsed lavage irrigation, stabilization of fracture with minimal further devascularization, early soft tissue coverage and early bone-grafting.

Delayed union or nonunion may be caused as a result of the treatment itself such as inadequate fixation or immobilization, distraction of fracture fragments, or excessive periosteal stripping, but in most cases the exact cause may not be very obvious. The optimum treatment for open fractures of the tibial shaft remains controversial. Despite improvements in surgical techniques in the last century, major problems with infection, malunion, and non-union have persisted. While it is widely accepted that emergency irrigation and soft-tissue debridement are the cornerstones of initial care, there is no consensus on the best method of obtaining and maintaining alignment and stability of the tibia. External fixation of these open fractures has been the treatment of choice in many medical centers, especially since the development of unilateral half-pin frames.

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Because of the major complications that are associated with external fixation, flexible nails that are inserted without reaming of the intra-medullary canal have been advocated for use in patients who have an open fracture. The purpose of this study was to compare the results of Ender nailing with those of external fixation in the management of open fractures of the tibial shaft.

### Aims and objectives

To evaluate and compare the outcome of open tibial fractures treated by external fixation and flexible intramedullary nailing (enders nailing).

### Case selection criteria

#### Inclusion criteria

Patients with open tibial fractures either as a solitary injury or with polytrauma.

#### Exclusion criteria

- Open intra-articular fractures of either end of the tibia.
- Open metaphyseal tibial fractures (those within 4 cm of the ankle or proximal to the tibial tubercle).
- Fractures associated with a known neurovascular injury.

### Methods and material

This study, conducted in the department of Orthopaedics, Adichunchanagiri Institute of Medical Sciences, B.G.Nagara. 50 Patients with open tibial diaphyseal fractures admitted in this hospital between June 2010 to June 2015 which were

treated with Enders nailing and external fixator were included in this study. Our study is a prospective study. 21 Patients who were admitted in Ortho II UNIT where managed by External Fixator and 29 patients were admitted in ortho I Unit were managed with enders nailing.

Three weekly periodic follow up using AP and lateral roentgenograms were done.

Patients were assessed for union, range of motion at knee and ankle, Axial and rotational alignment of the limb, signs of infection.

### Statistical analysis

Statistical analysis in our study was done with the help of SPSS version 14.0 (Statistical Package for Social Sciences V.14.0, For Windows, SPSS Inc. Chicago, Illinois). In case of two parametric variables we used *Independent t tests* and in case of more than two parametric variables we used *ANOVA tests*. In case of non parametric variables we used *Chi-Square tests*. P value of less than 0.05 was taken as significant.

### Age of the Patients

- Distribution of Sex of Patients
- Distribution of Side of Fracture
- Mode of Injury
- Associated Injuries
- Type of Flap Coverage
- Level of Fracture
- Gustilo and Anderson Classification

parameter		External fixation	Enders nail	P-value
Age		39.4+/-13.3	33.9+/-11.3	0.12
Sex	Male	18	27	
	Female	04	01	
Side	Right	15	11	0.43
	Left	07	17	
Trauma Mechanism	High Energy	17	26	0.31
	Low Energy	04	03	
Associated Injuries	Present	12	15	0.67
	Absent	10	13	
Gustilo-Anderson Classification	Type2	04	06	0.74
	Type 3A	01	03	
	Type 3B	16	20	
Flap Coverage	Required	17	03	0.88
	Not Required	04	06	
Types Of Flap Coverage	Local Flap	08	13	0.28
	Free Flap	08	07	
Level Of The Fracture	Middle1/3	04	08	0.193
	Middle To Upper1/3	03	09	
	Middle To Lower 1/3	14	12	

### Results

Evaluation of outcome parameters in ender and external fixator group with respect to

A. Duration For Fracture Union

B. Number Of Surgeries Required

C. Incidence Of Infection

D. Malalignment

Parameter		Duration Of Fracture Union(Weeks)	P Value
Fixation Method	Enders Nail	25+-7.03	0.86
	External Fixation	37.4+-14.44	
Gustilo-Anderson Classification	Type2	22.3+-7.43	0.1
	Type3a	22.4+-4.44	
	Type3b	29.8+-11.9	
Level Of Fracture	Middle1/3	26.7+-15.53	0.9
	Middle-Upper 1/3	27.9+-7.9	
	Middle-Lower 1/3	28.1+-10.4	
Associated Injuries	Ipsilateral	28.7+-12.43	0.4
	Contralateral	29.5+-12.7	

	Head Injury	22.1+-4.2	
Soft Tissue Coverage	Required	29.1+-11.6	0.09
	Not Required	22.26+-7.4	
Types Of Flap	Local Flap	29+-11.49	0.886
	Free Flap	30.26+-12.78	

## Discussion

Tibia fractures are the most common fractures of long bones in the human body.<sup>1</sup> The tibial diaphysis is one of the most common sites of an open fracture<sup>3</sup>, a fracture that involves a break in the skin and soft tissues communicating with the fracture or its hematoma, or both. The type of treatment selected for open tibial fractures depends on the individual characteristics of the fracture and the concomitant soft-tissue injury, making experience and clinical judgment an important part of the decision making during the formulation of treatment plan.<sup>3, 10</sup> The management of open fractures of the tibia may be complicated by infection, malunion, delayed union, or nonunion. Specific problems are inherent to every treatment method, making each method less than ideal. The advantages of external fixation include relatively stable fixation without additional soft tissue stripping, early range of motion of both knee and ankle, and unique adaptability to diverse fracture patterns. The disadvantages are, frequent pin tract problems, the potential for neurovascular damage during pin insertion, and the potential for fracture through a pin tract, cosmesis. In addition, the relative noncompliance of many patients may interfere with pin tract care and fixator durability. The advantages of intramedullary fixation include high patient acceptance, easiness for soft tissue coverage, control of alignment and rotation, early mobilization, and the potential for biomechanically safe early weight bearing. The major advantage of unreamed flexible intramedullary nails is that alignment is maintained without additional periosteal damage and theoretically with minimal disruption of the medullary vasculature. The disadvantages include difficulty in controlling alignment of proximal one-third fractures,

hardware failure due to the small nail size, and potential spread of infection throughout the medullary canal.

## Distribution of Age, Sex, Mode of injury and Associated injuries

Open fractures evaluated in our study were mostly young males who had sustained high velocity trauma and more than half of them had multiple injuries. There were 45 males (90%) and 5 females (10%) in our series. Most of the patients were in the range of 21-40 yr age group (70%) with a mean age of 36.2 (+/-) 12.4 years. 86% of these patients sustained fractures due to road traffic accidents. 46% of the associated injuries were ipsilateral fractures some of which needed surgical intervention and 8% had head injury. This distribution of age, sex and mechanism of injury is very much in agreement with previous literature published in relation to open fractures<sup>[24, 25, 26, 32, 48, 49]</sup>.

## Duration for fracture union

The mean period for fracture union in our enders group was 25 +/- 7 weeks, while in external fixator group the mean period was 37.4 +/- 14 weeks though fractures managed by enders united early, the difference was not statistically significant. Our study was comparable with standard series<sup>[25, 26, 27]</sup>. In our study, Enders group had more delayed union and external fixator group had more non union which is in contradictory to *Holbrook et al.*<sup>[25]</sup> which showed rates of non-union were similar, but the rate of delayed union was considerably higher for the external-fixation group. *In series Whitelaw et al.*<sup>[26]</sup> Both delayed union and non union were more in external fixator group.

Gustilo and Anderson Classification	Our study		Holbrook et al <sup>25</sup>		Whitelaw et al <sup>26</sup>	
	ENDERS	EXT FIX	ENDERS	EXT FIX	ENDERS	EXT FIX
<b>I</b>	-	-	19.6	19.2	21.2	17.3
<b>II</b>	21.4	22.4	25.2	26.8	19.4	26.8
<b>III</b>	26.1	29.3	27.2	29.6	24.6	27.9
<b>AVERAGE</b>	25	37.4	23.6	26.4	21.7	26.7

Type 2 and Type 3A fractures united early with mean duration of 22 weeks as compared to Type 3B with mean duration of 29 weeks. This was comparable to *Henley M.B. et al.*<sup>24</sup> series which showed that more severe.

Distal third fractures took marginally higher time for union compared to proximal and middle third fractures. An anatomic factor that commonly determines the rate of union of tibial fractures is the degree of preservation of the tibial blood supply.

Fractures associated with head injury united faster. The results of *matthew boes et al.*<sup>10</sup> support data from previous studies have suggested an increased osteogenic potential and an enhancement of fracture-healing secondary to traumatic brain injury.

## Number of Surgeries required for attaining fracture union

Total number surgeries required for attaining fracture union was significantly high in external fixator group in comparison to enders group. While (24/29) of our enders cases required only 3 surgeries or less, (15/21) of our external fixator group needed 4 surgeries or more. In the present study external fixator group had more number of infection so to eradicate infection repeated debridment was done. In enders group secondary surgical procedures required were only bone grafting or intramedullary interlocking nailing and enders nail removal was done at the same time during IMIL nailing. Whereas external fixator group, required different secondary surgical procedures like bone grafting, open reduction and internal fixation, intramedullary interlocking nailing, and even ilizarow fixation in patients with severe infection which

required bone resection. Our study was comparable to other series [25, 26, 28, 49].

### Incidence of infection

We had 12 cases infection all were belonging to external fixator group.

Our results were comparable to *G.P. Whitelaw et al.* 26 series which had no infection in enders group. In series of *Holbrook et al.* [25] has shown incidence of osteomyelitis was twice as high in the external-fixation group (14 compared with 7 per

cent). Out of 12 patients who had infection 11 patients were belonging to Gustilo Anderson type Type IIIB. So the patients in whom soft tissue coverage required had good results with enders group. Our results were comparable to *G. P. Whitelaw et al.* [26] Three cases of Osteomyelitis, 2 in grade II and 1 in grade IIIA, 2 patients developed major pin tract infection. In series of *Holbrook et al.*, [25] There were 4 infection in Gustilo Anderson type Type III and 3infection in Gustilo Anderson type Type II.

Parameter		Incidence Of Infection(N)		P Value
		Yes	No	
Type Of Fixation	Enders Nail	0	29	0.00
	External Fixation	12	09	
Gestilo-Anderson Classification	Type 2	1	09	0.20
	Type 3A	0	04	
	Type 3B	11	25	
Wound Coverage	Present	11	29	0.246
	Absent	01	09	
Flap Coverage	Local Flap	05	15	0.326
	Free Flap	06	10	
No. Of Surgeries	3 Or Less	03	27	0.005
	4 or more	09	11	

### Malalignment

External fixator group patients had more malalignment as compared to patients in enders group. This is consistent with other studies. *G.P. Whitelaw et al* 26 has noted 6(35%) of malunion in external fixator group as compared to 2(4%) of malunion in enders group. In series of *Holbrook et al* 25 showed that Ender-nailing group had a significantly lower rate of malunion. Meta-analysis of *Mohit Bhandari*28 concluded that unreamed nails offer significant advantages in reducing malunion as compared to external fixator. The results of this study demonstrate that though there was no statistically significant difference in the time required for union and malalignment, patients operated with external fixator underwent more number of secondary operative procedures than those operated with enders nailing. Infection was more in external fixator group. These findings are comparable to other prospective studies. We are aware of the fact that we have recruited a fewer numbers of patients, which reduces the power (1- $\beta$ ) of the study. A larger randomized trial or may be a multi-center trial can further improve the interpretation of the results.

### Conclusion

1. Open tibial fractures treated with enders nail united earlier than external fixator.
2. Total number of surgeries to achieve union in external fixator group was significantly higher.
3. Infection rate was significantly higher in external fixator group.
4. Malalignment was more common in external fixator group.

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