

Comparative Study of Intramedullary Flexible Nailing and External Fixator Result in the Management of Fractures Tibial Shaft. (Gustilo type II, type IIIA, and type IIIB)

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Learning Point of the Article:

Our study shows flexible IM nailing is better than external fixators in the fractures shaft tibia in Gustilo type II, IIIA, and IIIB.

Abstract

Introduction: Open tibial fractures, usually caused by high-energy trauma, are among the most common long-bone fractures. Clinically, the treatment of open tibial fractures remains a major therapeutic problem for surgeons because of the poor soft-tissue coverage and blood supply in the tibia, with resultant difficulties arising from infection and poor bone healing. In this study, we will assess the results of intramedullary flexible nailing and external fixators in the management of fractures shaft tibia (G.A. type II, IIIA, and IIIB).

Materials and Methods: Twenty-six patients who presented with open fractures of the tibial shaft type II, IIIA, and IIIB (Gustilo) were treated. We included patients of both sexes, aged between 18 and 65 years with diaphysal fractures 5 cm distal to the tibial tuberosity and at least 5 cm proximal to the tibial plafond, irrespective of fibula fracture. Thirteen patients were treated by external fixator and 13 patients by flexible intramedullary nailing and the outcomes were assessed.

Results: The mean age in our study was 36 years for the flexible intramedullary nailing group and 38 years for the external fixator group. Male involvement was 69.23% (18 patients) and female involvement was 30.76% (eight patients). In the present study, for external fixation mean age was 38 years (25–60), the union rate was 84.4%, the non-union rate was 16.6%, and the malunion was 33.3%, Pin track infection rate was 50%, the average time of union 27.08 weeks (26–30 weeks) and osteomyelitis is 16.6%. In the present study results for flexible intramedullary nailing, the mean age is 36 years (20–62 years), mal-union is 8.3%, pain at nail head rate is 16.6%, the average time of union is 25 weeks, and union achieved in all cases.

Conclusion: Flexible intramedullary nailing is more efficacious than external fixators in the management of fractured shaft tibia (Gustilo type II, IIIA, and IIIB). The advantages observed are maintaining limb alignment and fewer serious complications, fewer operations needed, and a better range of motion of adjacent joints obtained. It reduces the hospital stay of patients and later patients can return early to work, thus minimizing psychological trauma and financial burden. Flexible intramedullary nailing has an easy learning curve. The external fixator group had more disability and difficulties in daily routine activities such as sleeping, bathing, and other social activities.

Keywords: Gustilo Anderson classification of compound fracture, osteomyelitis, not applicable, intramedullary nail.

Introduction

Open tibial fractures, usually caused by high-energy trauma, are among the most common long-bone fractures [1]. Clinically, the

treatment of open tibial fractures remains a major therapeutic problem for surgeons because of the poor soft-tissue coverage and blood supply in the tibia, with resultant difficulties arising

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Author's Photo Gallery



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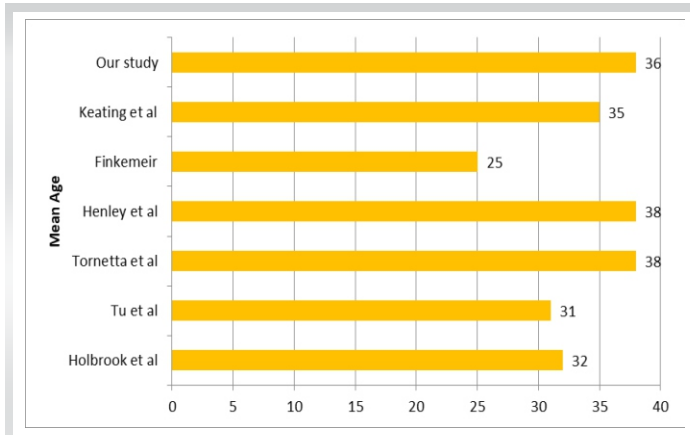
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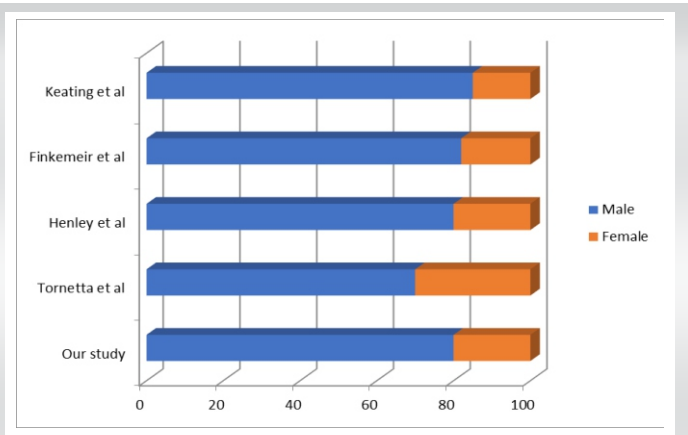
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Graph 1: Mean age.



Graph 2: Involvement.

from infection and poor bone healing [2,3]. Both bone instability and disrupted soft tissues are the current focus of all orthopedic and plastic surgeons.

The treatment of open tibia fractures remains controversial. The precarious blood supply and lack of soft-tissue cover of the shaft of the tibia make these fractures vulnerable to non-union and infection. The rate of infection may be as high as 50% in grade-IIIB open fractures [1]. Attempts to reduce these complications have led to aggressive protocols which include immediate intravenous antibiotics, repeated soft-tissue debridement, stabilization of the fracture, early soft-tissue cover, and prophylactic bone-grafting [2, 3].

External fixation has been popular because of the relative ease of application and the limited effect on the blood supply of the tibia, but these advantages have been outweighed by a high incidence of pin-track infection, difficulties related to soft-tissue management, and the potential for mal-union [4-7].

However, with the use of systemic antibiotics and better avoidance of bone gaps [8] nowadays also prefer flexible intramedullary nailing, which provides a relatively more stable fixation and better bone union efficacy with less bone cavity

exposure and less bone marrow-related complications [9]. We reviewed the results of comparative studies and controlled trials designed to determine the therapeutic effects of the two different methods. As the choice of these two methods remained inconsistent, our purpose was to better define their advantages and disadvantages, thereby enabling better decision-making in a tertiary-level health facility.

Materials and Methods

This is a retrospective and prospective study at the Department of Orthopaedic in LNCT Medical College and Sewakunj Hospital and Research Centre Indore from June 2021 to March 2023. Twenty-six patients who presented with open fractures of the tibial shaft type II, IIIA, and IIIB (Gustilo) were treated. In this study, we included patients of both sexes, aged between 18 and 65 years with diaphysial fractures 5 cm distal to the tibial tuberosity and at least 5 cm proximal to the tibial plafond, irrespective of fibula fracture and open fractures type II, IIIA, and IIIB according to Gustilo Anderson classification. We excluded the patients with intra-articular fractures of the proximal and distal tibia, closed fractures and Gustilo type IIIC

Road traffic accident	21	81.00%
Sport injury	1	4.00%
Assault	0	0%
Fall from height	4	15.00%
Total	26	100%

Table 1: Distribution According To Mode Of Injury.

Level of fracture	External fixator (n=13)	percent	Ender's nail(n=13)	percent
Upper (1/3)	4	30.77%	3	23.08%
Middle (1/3)	7	53.85%	6	46.15%
Lower (1/3)	2	15.38%	4	30.77%
	13	100.00%	13	100

Table 2: Distribution According To Level Of Injury.



Type of fracture	External fixator (n=13)		Flexible intramedullary nail(n=13)	
	n	%	n	%
transverse	4	30.77%	9	69.23%
oblique	3	23.08%	3	23.08%
segmental	1	7.69%	0	0
comminuted	5	38.46%	1	7.69%

Table 3: Distribution According To Type Of Fracture.

Gustilo classification	Flexible intramedullary nail		External fixator	
	n=13	%	n=13	%
II	5	38.46%	4	30.77%
III A	5	38.46%	6	46.15%
III B	3	23.08%	3	23.08%

Table 4: Distribution According To Treatment.

fractures, multiple comorbidities, surgically unfit patients, and unwilling patients. In this study, 18 males and eight females were included. Other than the fixation method, standard treatment protocol was followed for both groups. Thirteen patients were treated by an external fixator and 13 patients by flexible intramedullary nailing.

Observation and Results

In this study, younger patients were more prone to open fractures because they were more active and outside workers. The incidence is higher in the male population due to the distribution of high energy and heavy work in the male population as compared to the female population. According to the side extremities, the right and left side are injured equally in our study (Tables 1-5).

External fixator group

The patients in the external fixator group comprised 13 patients. The average age of the patients was 38 years (25–60 years). All fracture patients were stabilized by an external fixator, in all cases delta configuration for fixation was used. Ten fractures (76.92%) used six Schanz pins per case and three patients (23.08%) used seven pins per case. The average time in external fixation was 12 weeks. After removal of the fixator, 10

fracture patients were treated with a cast, but two patients required a second surgery as bone grafting. Three patients required muscle flap surgery to cover the bone. The time of union averaged 27.08 weeks (26–30 weeks); the average time for union was 26 weeks for grade II, 26.75 weeks for grade IIIA, and 27.66 weeks for grade IIIB.

Two fractures (15.38%) had 7° of valgus angulation; 2 (15.38%) had 7° of varus mal-union, three patients had between 7 and 10° of recurvatum, two patients present with comminuted fracture healed with shortening of 1 cm. Eight fractures had between 110 and 130° knee flexion, four patients had 100 or less knee flexion, and two patients had 5° of extension deficit. Two patients had a major loss of dorsiflexion of the ankle. Two patients had equine contracture. Three fracture patients (23%) had loosening of the Schanz pin from the insertion site. Seven patients were associated with mild pain in the leg, and pain usually was exacerbated by activity, no neurovascular complications were associated with the insertion of pins.

The total number of operations averaged 2.3 including debridement, delayed primary closure, removal of fixator and application of a cast, iliac-crest bone grafting, split-thickness skin grafting, and local or free flap coverage. In 6 patients (46.15%), a pin-track infection developed. Five patients' infection cleared after application of betadine pin-track dressing and antibiotics but one needed curettage of the infected tract. Two patients (15.38%) with grade IIIB developed a deep infection (chronic osteomyelitis) with pus discharging sinus and were converted into infected non-union.

Flexible intramedullary nailing group

The flexible intramedullary nailing group consisted of 13 fracture patients. The average age of the patients was 36 years (range 20–62 years). Eight fractures (61.54%) needed only two flexible intramedullary nails, 3 fractures (23.08%) were stabilized with three nails, and 2 (15.38%) had four nails. The average duration of immobilization, generally with slab, was 2.7

	Flexible intramedullary nail (n=13)	External fixator(n=13)
Muscle flap	2(15.38%)	3(23.07%)
Bone grafting	NA	2(15.38%)
split-thickness skin grafting	4 (30.77)	5(38.46)

Table 5: Requirement Of Additional Surgical Procedure On Second Sitting.



	External fixator (n=13)	Flexible intramedullary nail (n=13)
Age mean (year)	38years	36 years
Union duration	27.08weeks	25 weeks
Union rate (%)	10(76.92%)	13(100%)
Malunion	4(30.76%)	2(15.38%)
Non-union	2(15.38%)	NA
Pain		
• Mild activity	6(50%)	NA
• Nail head	NA	2(15.38%)
No. Of surgical procedure	2.3	1.8
Loss of motion		
• <100 degree of knee flexion	4(30.76%)	2(15.38%)
• Restriction of dorsiflexion	2(15.38%)	NA
Implant failure	3(23.07%)	2(15.38%)
Pin track infection	6(46.15%)	NA
Osteomyelitis(OM)	2(15.38%)	NA

Table 6: The results of this study allow direct comparison of the results of external fixation and enders nailing.

months. The 4.0 mm nail was most commonly used, although the 4.5 mm nail was inserted in young patients who had a large medullary canal. Union occurred in all patients. The time to union averaged 25 weeks (range 22–28 weeks); the average time of union was 23.5 weeks for grade II fractures; 25.6 weeks for grade IIIA; and 26.5 weeks for grade IIIB. One fracture (7.69%) had 8° of valgus angulation, and 1 fracture (7.69%) had 7° of recurvatum. Ten fractures (76.92%) had 130° knee flexion, 2 patients (15.38%) had 120 or less knee flexion; no one patient had extension deficit; ankle movement was normal in all patients. In two patients one nail backed out through the skin, and no nail broke in the shaft portion. Two (15.38%) patients complained of nail insertion site pain, patients needed the removal of nails for relief of pain. Three patients (23.08%) were associated with mild activity-related pain in the leg at the level of fracture. The total number of operations averaged 1.8 including debridement, delayed primary closure, skin grafting, local or free flap coverage, and removal of nails.

Discussion

With all methods of treatment of compound tibia fractures the major problem encountered are infection, non-union, joint

stiffness and mal alignment. All these complications prolong the patient's disability.

Mean age in our study was 36 years for flexible intramedullary nailing group and 38 years for external fixator group which was quite comparable to other studies (Graph 1). All these studies show that these injuries occur in a younger age group [10-12].

In present study male involvement was in 69.23% (18 patients) and female involvement was 30.76% (8 patients). Which is almost identical to other studies in the literature. (Graph 2).

Several series of patients who were treated only by external fixation have been published. Dr. Muhammedimran et al (2007) [13] conducted study on 25 patients with open fractures of the tibia diaphysis. The end result of the external fixation of 25 tibia shaft fractures; 18 (72%) men and 7 (28%) women with average age of 37.7 years (16-65 years). The union rate was 83%, non-union rate was 12% and mal-union was 5%. Pin track infection rate was 10% and average time of union was 28.5 weeks (15-22 weeks). John and Holbrook et al (1989) [14] conducted study on sixty-three open tibia fractures using external fixation in twenty-eight patients. Average age 25 years, average time of union 26 wks, mal-union in ten patients (36%) non-union was in 3 patients (11%), pin track infection presents in 6 patients (21%).

In present study for external fixation mean age was 38 years (25-60). The union rate was 84.4%, non-union rate 16.6% and malunion was 33.3%. Pin track infection rate was 50%. And average time of union 27.08 weeks (26-30 weeks). A shikali et al (2010) [15] fixation of compound fractures of distal tibia with external fixator mean time of union 24 weeks. Tucker et al [16] and schatzker [17] in separate studies reported union time of 25.6 weeks and 21.9 weeks respectively. Similarly, wheelwright and court brown [18] and antich et al [19] reported a union rate of 27.5 weeks and 26 weeks respectively. Kaftandziev [20] in his study produced union in 71.1% of the patients. bratislav stojkovic [21] reported a union rate of 83.68% in his 49 patients. Kimmel [22] reviewed fifteen open tibia fractures that were treated with external fixation noted a 7 percent rate of non-union, a 50 percent rate of pin tract drainage, a 47 percent rate of osteomyelitis, and 26 percent rate of malunion. In present study rate of osteomyelitis is 16.6%. which is lower then above study. Velazco and fleming [23] studied on fourty open tibial fractures, noted an 80 percent rate of pin tract infection, a 12.5 percent rate of delayed union, and 12.5 percent rate of amputation. Malunion were not described. Because of the disadvantage of external fixation, interest in nailing without reaming of tibia fractures is increasing. Dobozi et al [24] reported on 192 tibial fractures, including sixty-one open fractures that were treated with flexible intramedullary nailing. They noted a 5 percent of malunion, a 3 percent rate non-union,

and 3 percent of deep infection in the open fracture group.

John and Holbrook et al (1989) conducted study on sixty three open tibia fractures used enders nailing in twenty-nine patients, average age 28 years, average time of union 24 wks, mal-union in 6 patients (21%) non-union rate was 10%, pain at nail head in 11 patients (38%). In present study results for flexible intramedullary nailing, the mean age is 36 years (20-62 years), mal-union is 8.3%, pain at nail head rate is 16.6%. And average time of union is 25 weeks. Union achieved in all cases. These study result were approximately same to above mentioned studies.

Flexible intramedullary nail offers advantages of Good fixation and control of alignment without periosteal stripping or risk of pin tract infection, early walking with weight-bearing, low incidence of infection, good access for care of the wound and early mobilisation of the joint. Flexible intramedullary nails have some disadvantages also like frequent use of a second surgery for nail removal procedure, the necessity for surgical expertise in closed nailing, less secure fixation in fracture of the distal and proximal one-thirds of the tibia and in comminuted fractures, possibility of loss of reduction, discomfort in the knee joint from prominent nail-heads, the risk of extension of infection throughout the medullary canal. (Table 6)

Limb alignment was better maintained by flexible intramedullary nail group than by external fixation. Fracture treated with flexible intramedullary nail had fewer infection/inflammations than did those treated with external fixator, as expected the external fixator group was prone to pin tract problems, and these problems contributed to a statistically significant higher incidence of these complications at surgical interfaces for this fixation method. The incidence of osteomyelitis was higher in external fixation group. The patients in the external fixation group needed considerably more operative procedures. In external fixator group three patients required muscle flap surgery for wound closure. Many patients in the external fixation group complained of pain at the fracture site due to mild activity compared with the patients in the enders nailing group. The rate of discomfort in the knee joint due to prominent nail-head was problem in ender nailing group and was similar to that in the other reported series

Postoperative hospital staying was varied 5-7 days in flexible

intramedullary nail group but in external fixator hospital stay duration more than flexible intramedullary nail group because patients need proper physiotherapy training and learned self-pin track dressing. In external fixator group were required readmission of two patient for non-union treatment. Final Functional result on modified Ketenjian criteria of flexible intramedullary nail is excellent (83.3%), good (16.6%) as compared to external fixator is excellent (50%), good (25%), fair (8.3%), and poor (16.6%).

Conclusion

This study of 26 patients with open tibia fractures, treated using a prospective, systematically allocated protocol, shows that flexible intramedullary nailing is more efficacious than external fixators. The advantages observed are maintaining limb alignment and fewer serious complications, fewer operations needed, and a better range of motion of adjacent joints obtained. It reduces the hospital stay of patients and later patients can return early to work, thus minimizing psychological trauma and financial burden. Flexible intramedullary nailing has an easy learning curve. The external fixator group had more disability and difficulties in daily routine activities such as sleeping, bathing, and other social activities. Intramedullary nailing for Gustilo's grade I is established worldwide. Availability of plastic surgery facilities, better asepsis, and newer broad-spectrum antibiotics are encouraging nailing in grade II also. The dilemma between rigid nailing and external fixators persists in grades II, IIIA, and IIIB. Authors feel the role of flexible intramedullary nailing is better than external fixators in these fractures.

Clinical Message

Open tibial fractures are among the most common long bone fractures. Clinically, the treatment of open tibial fractures remains a major therapeutic problem for surgeons because of the poor soft-tissue coverage and blood supply in the tibia. This study shows that flexible intramedullary nailing is more efficacious than external fixators because by nail maintaining limb alignment is better, fewer serious complications, fewer operations are needed, and a better range of motion of adjacent joints is obtained.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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