Original Research Article

Fractures of tibia diaphysis managed with internal fixation by elastic nails: an alternative approach

Abstract:

Background: Intramedullary nailing techniques specially using elastic nails like Enders nail are a good treatment option, owing to their cost effectiveness, less use of fluroscopy and ease of procedure with short learning curve. This study is aimed to bring evidence to the hypothesis that Ender nails can be used successfully in tibia shaft fractures under certain indications. Due to the economic nature and easy procedure, we aimed specifically to demonstrate that elastic IM nailing, esp. Ender nails can be a good alternative to interlock nailing for select cases of diaphyseal fractures. The study aims at evaluating outcome of Enders nail in diaphyseal tibia fractures.

Material and Methods: This study was carried on in the Department of Orthopaedics, tertiary care hospital during the period of April 2019 to March 2020. It is a prospective type of study. Patients were evaluated based on functionality and radiology, post-surgery.

Results: A total of 30 patients of tibial shaft fractures were selected and managed with closed reduction and internal fixation with Enders nail. Male to female ratio was 4:1. 24 (80%) patients sustained injury from motor vehicular accidents. 40% patients with open fracture and 60% closed fracture patients were involved. 60% if the patients showed clinic-radiological union in 12-14 weeks, while 50% of the patients achieved a post operative knee range of movement of 0 to 131-140 degrees.

Conclusion: Closed reduction with internal fixation by Enders nail can be a good alternative for management of tibia diaphysis fractures, when performed after proper patient selection and patient counselling.

Key Words – Tibia, internal fixation, elastic nail, trauma

Introduction

Most common long bone fracture in humans is tibial shaft fractures.[1] Treating these fractures may be difficult and time taking due to associated bone and soft tissue injuries. Most common modality of treatment for these fractures is surgery, excluding minimally displaced fractures caused due to low energy trauma.

Introduction of Ender's nails was done in 1969, by Ender, an Austrian surgeon from University of Vienna, for the purpose of fixation of peri-trochanteric fractures. [2] In most orthopaedic textbooks, the indications for Ender's nailing are limited. [3] With the introduction of interlock nails, Ender's nail use for treatment of tibia shaft fractures in adults has significantly reduced.

Plate osteosynthesis is usually not used in open fractures due to the risk of infective complications. Plating also has limited use in severely communited fractures. For open fractures (Gustilo Anderson type II & III), external fixation is preferred management modality. Other alternative for these fractures are unreamed intramedullary devices.

Despite its ease of use and easy availability, there is not much literature describing the utility of Ender's and other flexible nails in tibia shaft fractures. So, this study was aimed to evaluate outcome of Enders nails in the diaphyseal tibia fractures.

Aims & Objectives:

Aim: To study the utility of fixation with Ender's nailing in tibial diaphyseal fractures.

Objectives:

1. To appraise the fracture union post Ender's nailing in tibia shaft fractures.
2. To assess functional outcome post Ender's nailing in tibia shaft fractures.
3. To judge the limitations in the use of Ender's nail in tibia shaft fractures.
4. To gauge the use of Ender's nailing in compound fractures and distal or proximal end shaft fractures.

Materials and Methods

This prospective study was conducted in the Department of Orthopaedics, in a Tertiary care hospital. The subjects for this study were patients presenting to Orthopaedics or Emergency Medicine department with tibial shaft fractures.

Inclusion Criteria:

1. All patients with tibial diaphyseal fractures open and closed.
2. Patients willing for surgery and to participate in study.

Exclusion Criteria:

1. Fractures older than 1 week from injury.
2. Patients with uncontrolled systemic conditions rendering them unfit for surgery.
3. Associated neuro-vascular injuries
4. Patients not willing for surgery.

Each case was submitted to a detailed history and physical examination. General and systemic examination was done and a thorough local examination including the neighbouring joints was done. A clinical diagnosis was established and urgent primary care was provided to the patient in form of oxygen inhalation with mask, fluid resuscitation, universal or Thomas splint application on the affected limb, and wound care and haemostasis. After stabilization of general conditions, patient was subjected to radiological and haematological investigations.

Patients were given Injection Diclofenac Sodium 75mg deep intramuscular stat for immediate analgesia followed by oral non-steroidal anti-inflammatory drugs for continuation. Broad spectrum antibiotics: Injection Ceftriaxone + Sulbactum 1.5mg IV 12 hourly and Injection Metronidazole 400mg IV 8 hourly were started for open fractures, along with tetanus prophylaxis. Other required medical management was provided to the patients.

Under spinal anaesthesia, all patients were managed with reduction and fixation with Ender's nailing under fluoroscopy guidance. Reduction was achieved with traction and manipulation. Incision followed by entry of nail was made on anterior part of proximal medial and lateral metaphysis, 2cm distal to proximal physis, next to the tibial tuberosity. Nails of thickness 3.5 or 4mm were used and extended distally up to just above the ankle joint, to allow sliding compression.

Post operative protocol:

1. Above knee slab was applied.
2. Surgical site was check dressed on post-op day 2 & sutures removed on day 11.
3. Active joint mobilisation was started at the earliest.
4. Partial weight bearing mobilisation with support of a walker was initiated within one week of surgery. Full weight bearing was permitted on clinico -radiological union.

Follow up:

After discharge, follow up was done on 3 weeks, 3 months and 6 months. Patients' clinical picture was assessed and they were evaluated for union, functionality and knee & ankle range of movement. Radiographs of leg (antero-posterior and lateral views) were obtained and union was evaluated using Lane & Sandhu radiological scoring system. [A-118] The functional outcome was evaluated by Alho & Ekeland criteria. [B-]

All statistical analysis was done by Statistical Package for Social Sciences (SPSS) version 26.

Table 1: Lane and Sandhu radiological score system:

Bone formation	
No evidence of bone formation	0
Bone formation occupying 25 % of the defect	1
Bone formation occupying 50 % of the defect	2
Bone formation occupying 75 % of the defect	3
Bone formation occupying 100 % of the defect	4
Union (proximal and distal evaluated separately)	
No union	0
Possible union	1
Radiographic union	2
Remodeling	
No evidence of remodeling	0
Remodeling of medullary canal	1
Full remodeling of cortex	2
Total points possible per category	
Bone formation	4
Proximal union	2
Distal union	2
Remodeling	2
Maximum score	10

Table 2: Alho & Ekeland criteria:

Criteria	Grade 1	Grade 2	Grade 3	Grade 4
	Excellent	Good	Fair	Poor
A.Tibial malalignment and Varus/Valgus				
(Degrees)	2.5º	5º	10º	>10º
Shortening (cm)	1	2	3	>3
B. Range of knee motion				
Flexion	>120	120	90	<90
Extension Defects	<10º	10º	15º	>15º
C. Range of ankle motion				
Dorsiflexion	>20º	20º	10º	<10º
Planterflexion	>30º	30º	20º	<20º
D. Foot motion (as compared to normal)	5/5	2/3	1/3	<1/3"
E. Pain in the Limb	None	Sporadic	Significant	Severe
F. Swelling	None	Minor	Significant	Severe

Observations and Results

1. A total of 30 patients were included in this study. The patients' age group ranged between 16 and 56 years with majority of the patients (40%) in the range of 26-35 years, followed by (30%) under 18 years. There was a male predominance with 80% male subjects.
2. On evaluating the mode of injury, most patients (80%) had a road traffic accident as the cause, followed by injury due to fall from height in 10% of the patients. 60% of the patients had right leg injury while 40% had left sided trauma.
3. Open (12) to Closed (18) fractures ratio was 2:3, with the most common fracture site being distal third in 70% patients and mid shaft fractures in 26.6% patients. The most common systemic illness found was systemic hypertension (30%), followed by diabetes mellitus (16.6%). Only 20% of the patients presented within 1 day of injury, while 80% of the patients took within 3-5 days.
4. Full weight bearing timeline (Table 3):

Time duration from surgery (in weeks)	No of patients	% of Patients starting full weight bearing
5-10	18	60%
11-15	6	20%
16-20	3	10%

5. There was union rate of 96.67 % in mean period of 20 weeks. The union timeline is as follows (Table 4):

Time duration from surgery (in weeks)	No of patients	% of Patients attaining satisfactory union
12-14	18	60%
15-17	9	30%

18-20	2	6.66%
>20	0	0%
Non-union	1	3.33%

6. Knee range of movement on final follow up, from complete extension, as attained by patients is shown below (Table 5):

Knee range of movement (in degrees)	No of patients	% of Patients
0 to <100	3	10%
0 to 111-120	3	10%
0 to 121-130	9	30%
0 to 131-140	15	50%

Discussion

Many modalities are practised for management of tibia diaphysis fractures. The modalities range from closed reduction & cast application to operative procedures. One cast application method is groin-to-toe cast, but this conservative approach leads to stiff joints, atrophy of muscles, osteoporosis, and compromise in activities of daily living. A more popular cast option is the Patellar Tendon Bearing cast (Sarmiento cast), along with early weight bearing, but this may lead to loss of alignment and even loss of reduction in some cases, and this method is known to cause shortening of 6.4mm on an average angulations of 8 degrees, with a 5.7 months average healing time.[4, 5, 6] But of course, closed reduction and cast application methods can be applied on only limited types of fractures. Open reduction with internal fixation is the common surgical procedure but it is not recommended for (a) high-energy trauma, (b) compound fracture , and (c) fractures with gross soft tissue injury, as there is an increased risk of infection.[7]

A more recent advancement in fixation technique is the use of AO compressive osteosynthesis. The main advantage of this method is that it offers perfect anatomic reduction and an option of early mobilisation. But the cons of this method are the learning curve, cost ineffective and poor availability.

A good union rate of 96.67% was achieved in this study in the mean time interval of 20 weeks. This data can be considered acceptable and is significantly comparable to other studies regarding the topic. Such high union rates was achieved even after inclusion of big number of high energy trauma open fractures in the study which are known to go into non- or delayed union. The current literature suggests union time in closed as well as open fractures as 18 to 22 weeks, and union time in the present study is well within this range.

Chiu et al compared interlock and Ender nails and found no significant difference in outcome between two in cases with cortical comminution less than 50%.[8]
They concluded fractures with gross comminution can be considered as not good candidates for Ender nailing. Similar finding has been seen in our study also.
Even Wiss et at [9] in their study having 111 cases found that minimally 25% intact cortex at fracture site is needed for lower complication rate.

30% of patients belonged to younger age group (below 18 yrs) in this study and they showed excellent outcomes with minimum to no complication rates, hence making Ender nails an ideal option in children, which can be used without growth plate damages. Titanium Elastic Nails (TENS) for fixation of pediatric age group fractures are in many cases similar to Enders nail, but have good stability for fracture fixation.

A complication commonly observed was irritation of soft tissue at introduction site where nail impinges. This is largely due to improper technique like failure to bury nail at entry point.

There are two studies that compare the outcomes of external fixators with Enders nail [12,13]. There was no significant difference in the outcomes of two studies, which were conducted on two groups of patients (one treated with external fixators application and other with Enders nail). Enders nail had fewer issues in several ways, yet union rates were comparable. The average recovery time in our study was 16 weeks.

The tibia showed union in average of 16 weeks in our study, which is close to literature, which shows that tibia union was seen in average of 20 weeks. Merianos et al. [14] reported that 31 tibial shaft fractures treated by closed Enders nailing and early weight bearing, all of which healed in 6 to 16 weeks, with an average healing period of 15.2 weeks.

Mayer et al. [15] published study having 49 individuals who were treated with Enders Nail in 1985. They discovered 96 percent union rate, 24 week time to union, and a 3.9 percent infection rate. They came to the conclusion that Enders Nail could be best implant for high-energy trauma with large soft tissue injury.

Marianos et al. [14] reported that Ender Nails were effective in treating 143 tibia fractures. They discovered a 98 percent union rate, a period to union of 5.4 months (23 weeks), and infection rate of less than 2%.

In 2004, Zehtab [16] evaluated 56 patients with diaphyseal tibial fractures and concluded that Ender Nail had great results. He reported a 98.2 percent union rate, a 4.7-month (19.8-week) time to union, and a 0% infection rate. Many writers have examined treatment outcomes of tibial fractures with Enders and interconnecting nails and got no statistically significant differences, particularly for stable forms [17]. In 1996, Chiu et al. [19] published study having 116 tibial fracture patients, 60 of whom were treated with interlocking nails while 56

with Enders nail. In fractures with less than 50% diaphyseal diameter comminution, their findings were similar.

Soleimanpour et al. [18] discovered a 92.8 percent to 100 percent union rate and a period to union ranging from 4.21.4 to 4.71.1 months for Ender Nails and interlocking nails. Sakaki et al. [30] compared the results of 24 fractures treated with Enders nail with 20 fractures treated with interlocking nails.

In a study of fifty-two patients, Wiss [10] found that 48 of 52 fractures healed in average of 16.8 weeks, with nil incidences of profound infection or osteomyelitis. In 32 of cases, the fracture was closed, while the other 28 were open.

Huang et al. [9] showed similar results and concluded that Ender nail is helpful in the treatment of less comminuted and unstable tibial shaft fractures, but must be used with caution in treatment of more comminuted and unstable tibial shaft fractures.

In study of 280 fractures, Ando et al. [11] discovered that Enders nail is excellent semi conservative management for tibia shaft fractures, preserving appropriate elasticity at fracture site where significant callus is generated and resulting in a satisfactory union. The unionisation rate was 97 percent.

Based on the findings of the study and literature ,we feel that Enders nail can be highly beneficial and effective procedure for fixing of tibial fractures by a simple methodology and minimal usage of imaging if performed correctly in a properly selected patient.

It is straightforward and cost effective when comparing to implants like interlock nails, locking and rest of the plates. Closed fractures have a lower risk of infection and compound fractures have a better management of infection. This is an extra benefit of Enders nailing over rest of the implants, yet one will never discount utility and effectiveness of interlock nails. (Table 6).

Table 6: Summary of results for management of tibia fracture with Enders nail.

Investigator	No of patient in study	% of open fracture	% of Union	Important remarks
Mayer et al. (1985)	51	49	96	2 malunions, two Infections
Merlanos et al.	143	28	95	Eight malunions

(1985)				
Wiss (1986)	50	56	96	
Rinaldi et al. (1987)	32	?	98	
Semenovicz et al. (1996)	46	39	100	In type IIA open fractures, nails are contraindicated One infection
Ando et al. (2000)	280	?	97	
Hussain et al. (2001)	39	30	87	

Conclusion

In view of the findings, it should be concluded that Enders nail would be a better alternative for the treatment of diaphyseal tibial fracture in certain circumstances because it is a successful method that allows for early ambulation and weight bearing, as well as reduced reliance. It shortens patients' hospital stays and allows them to return to work sooner, reducing the patient's psychological trauma and financial burden. In terms of union and functional outcomes, this produces satisfactory results. It's done with basic procedure that's easy to pick up. When used in appropriately selected situations, Enders nail is a excellent semi conservative management modality for tibia shaft fracture, keeping appropriate elasticity and micro-mobility at site of fracture, which facilitates union of fracture.

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