Surgical Management of Long Bone Fracture of Lower Limb in Pediatric by Titanium Elastic Nails

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Abstract

Background: Skeletal trauma accounts for 10-15% of all childhood injuries. The increasing incidence of fractures in children mainly attributed to increased road traffic accidents and sports participation.

Materials and Methods: The study was conducted from October 2012 to April 2015 at Terna Medical College, Navi Mumbai. A 28 pediatric patients (20 male and 8 female), who came to emergency department with long bone fractures subsequently, underwent surgical fixation of long bones by titanium elastic nailing (TENS) were included in this prospective study.

Results: Road traffic accident was the main mode of injuries. The most common long bone fracture was femur 40% and 60% tibia fracture. Pattern of fracture 33.3% transverse, 13.3% comminuted, 20% oblique, 26.7% spira, 6.7% segmental. The level of fracture 80% middle third. The time interval between trauma and surgery was average 3.65 days. Average duration in 50.20 min. Average duration of immobilization is 7.2 weeks. Duration of stay in hospital was 10.25 days. Time of union is 10.35 weeks. Time of weight bearing in the present study is 11.8 weeks. Follow-up done for period of 24 weeks. According to Flynn’s criteria, 89% of patients were excellent and 11% satisfied; no patients reported their outcome as not satisfied.

Conclusion: TENS is the method of choice for the management of long bone fractures in children, because its elastic mobility promoting rapid union at fractures site, stability ideal for early mobilization. It gives lower complication rate, good outcome. It allows an early functional and cast-free follow-up, quick pain reduction compared plating technique including a minimally invasive technique. A less time-consuming procedure and easier metal work removal, cosmetically a small scar. Our study results provide new evidence that expands the inclusion criteria for this treatment and shows that TENS can be successfully used regardless of fracture location and fracture pattern.

Keywords: Diaphyseal fractures, Femur, Long bone, Pediatric, Shaft fractures, Tibia, Titanium elastic nail

INTRODUCTION

Treatment of pediatric fractures dramatically changed in 1982, when Métaizeau and the team from Nancy, France, developed the technique of elastic stable intramedullary nailing (ESIN) using titanium.¹ In the last two decades, there was an increased interest in the operative treatment of pediatric fractures, although debate persisted over its indications. In the past 7 years fixation with flexible intramedullary nails have become popular technique, for stabilizing femoral fracture in school-aged children gradually applied too there long bone fractures in children, as it represents a compromise between conservative and surgical therapeutic approaches with satisfactory results and minimal complications.² Orthopedic surgeons will continue to be challenged to treat this age group with less morbidity at a lower cost, as no clear guidelines have been available until now despite efforts done initially by French surgeons, later on by European surgeons and recently by the Pediatric Orthopedic Society of North America. The purpose of this study was to present our results following fixation of unstable long shaft fractures with ESIN.

We have evaluated all patients for fracture reduction, return to activity, complications, and clinical outcome given in accordance to Flynn criteria.³
MATERIALS AND METHODS

Patients aged 5-15 years that underwent titanium elastic nailing (TENS) fixation of long bone fractures from October 2012 to April 2015 at our institution was the subjects of the study. The study was approved by our institutional review. About 28 cases (20 males and 8 females) of the average age of 9.8 years were included in the study were followed up for mean of 24 weeks. The 28 cases admitted were thoroughly investigated. A detailed history regarding mode of trauma was taken. X-rays of affected limb anteroposterior and lateral views were taken. Mode of Injuries was due to motor vehicle accident, fall from height and sports related injuries. In 23 patients, the fracture was reduced by closed means whilst in the other 5 open reduction was required due to difficulty in reduction and soft tissue interposition. Indication for surgery was inability to attain stable reduction with closed treatment. None of the patients developed complications during their course of treatment. After consent planning for surgeries were done. Among long bone fractures 40% femur, 60% tibia. Fractures classified according to AO classification, such as 33.3% transverse, 13.3% comminuted, 20% oblique, 26.7% spiral, 6.7% segmental.

Surgical procedure was performed in supine position. Selection of nail done by Flynn et al’s. formula or intraoperatively assessed. In Femur distal to proximally, extension of the nail the distal femoral physis to approximately 2 cm distal to the capital femoral physis 1 cm distal to the greater trochanteric physis. In Tibia nail inserted from proximal to distally, nail extension 2 cm from the proximal physisto 5 mm proximal to the distal physis. Bone was exposed with a longitudinal incision. Soft tissue was spread using artery forceps. The periosteum was incised longitudinally with cortex exposed. With the help of sharp awl, entry was made through the cortex to obtain access to the medullary cavity. Care was taken to ensure that growth plate was not breached in any of the cases while making the entry point. In the lower limbs two nails were inserted for tibia and femur, these nails were bent prior to insertion and were inserted manually using T-insertion handle. Once fracture site was reached two nails then fracture was manipulated under C-arm guidance to obtain reduction and nails were passed further into metaphysis and adequate three point fixation was ensured with tip of nails facing opposite directions by this symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points was followed. Position of the nail was confirmed in anteroposterior and Lateral views. All the patients were followed up in Out Patient Department every 4th week after surgery for 6 months and at each follow-up clinical and radiological examination was done to assess stability and callus formation. At the end of 24 weeks of follow-up the patients were evaluated clinically by using Flynn’s criteria (Figures 1-3).

RESULTS

No major complications encountered in any of the 28 patients. However, one case with superficial infection and bursa at nail insertion was noted. Outcome was graded as excellent in comparison to Flynn’s criteria.

P Value Analysis

There was no significant association ($P > 0.3$) observed between variables (age, gender, mode of injury, bone affected, pattern of fracture, and time interval between trauma and surgery) and incidence of complication.
Age distribution of patients studied was ranging from 5 to 16 years (Graph 1).

The mode of injuries varied from road traffic accident, sport injuries and fall from height. Most common mode of injury was due to road traffic accident (Graph 2).

The most common bone which was affected was femur and tibia among which tibia bone were affected more as compared to femur (Graph 3).

Graph 4 depicts the list of various complications associated.

**DISCUSSIONS**

Surgical management of long bones of the lower extremity in pediatric age group has been controversial. Multiple treatment options have been tried over past two to three decades. Complications were found to be associated with every treatment option: Immobilization with spica cast alone or along with traction was found to be associated with complications like limb-length discrepancy, angulations, psychological and economic complications. Furthermore, it involved prolonged bed rest and loss of days from school for adolescents and school-aged children and it added to the babysitting problem in homes with both the parents working.4

External fixator resulted in pin tract infection, loss of reduction; refracture after removal of external fixator, malunion and loss of days from school. Plating as a treatment modality is not practiced commonly for pediatric fractures in children as it involves bigger surgical incision leading to higher likelihood of infection, stripping of periosteum and loss of fracture hematoma.

Wound infection and impingement were found to be associated with minimally invasive plate osteosynthesis (MIPO) used in the management of pediatric tibial fractures. In case of femoral fractures, MIPO has been associated with malalignment and delayed union. Limb length discrepancy is most common complicated with intramedullary nail which pierce the epiphysis and physis.5

Intramedullary K-wire fixation has also been used for pediatric femoral fracture. But stability and fracture angulation is a disadvantage to be taken care of.6

An ideal implant for the treatment of pediatric lower extremity long bone fractures should be load sharing, allowing early mobilization, without disrupting the blood supply of epiphyseal growth plates, maintains limb length, and alignment till the fracture healing marked by bridging callus occurs.5

TENS has been designed for the treatment of diaphyseal fractures in children and is being used presently for
the treatment of pediatric femoral fractures, and, increasingly, for surgical management of pediatric tibial fractures. It is based on the principle of three point fixation that works by balancing forces between two opposing flexible implants.6

This balance is attained by using a nail diameter of 40% of narrowest canal diameter leading to a double-C construct. This is in contrast to Enders nails that achieve stability from nail stacking and canal fill.5,7

Titanium nails provide stable and elastic fixation, leading to controlled motion at the fracture site leading to healing by callus formation.3

The bone provides axial stability provided that there is no overlap at the fracture site. This is ensured either by cortical contact in end-to-end reduction or by anchoring the nails in the metaphysis. The cancellous bone of children is very dense so that the nail-drop seen in the elderly patient is less common. The soft tissues also have an important role. The muscles, in particular, serve as guy-ropes. This helps to explain the spontaneous post-operative correction of slight angular deviation, the rarity of excessive callus and the retention of the normal anterior bow of the femoral shaft.1

The development of the TENS fixation method has put an end to criticism of the surgical treatment of pediatric long bone fractures, as it avoids any growth disturbance by preserving the epiphyseal growth plate, it avoids bone damage or weakening through the elasticity of the construct, which provides a load sharing, biocompatible internal splint, and finally it entails a minimal risk of bone infection.7

Micromotion conferred by the elasticity of the fixation promotes faster external bridging callus formation. The periosteum is not disturbed and being a closed procedure there is no disturbance of the fracture hematoma, thereby less risk of infection.4

Rotational malalignment was not noted in this study due to utmost care being taken during intraoperative limb positioning.

Ligier et al.,1 Flynn et al.3 and Gamal et al.5 have reported a similar finding, supporting the concept that TENS can give rotational stability provided adequate care is taken during nail insertion and following operation.

None of the patients in our study developed compartment syndrome during their course of treatment which was different from findings of Sanker at al who reported four patients developing compartment syndrome during course of treatment and three patients with impending compartment syndrome for whom fasciotomies were performed at the time of index surgery.2

None of the patients in our series required any secondary surgical intervention or readmission following discharge, except for nail removal.

Limb shortening was observed in two cases (6.7%) with an average of 1 cm (range 0.7-1.3 cm) for which authors believe that a longer follow-up duration is required to determine its persistence or correction.

The goal of managing long bone fractures in pediatric lower extremities by TENS is to preserve epiphysis, lower the complication rates, provide early weight bearing and cast free follow-up. Operative intervention is intended to convey stability of fracture, allow for the correction of deformities, and optimize cast free follow-up. This study used stabilization of the fracture by TENS in long bones of children.

In the present study average age incidence is 9.8 years. 70% were males, 30% were females. 53.3% of cases due to RTA. Among the long bones affected 40% femur, tibia 60%. Pattern of fracture is 33.3% transverse, 13.3% comminuted, 20% oblique, 26.7% spiral and segmental fracture 6.7%. The time interval between trauma and surgery was average 3.65 days. The average duration in 50.20 min. The average duration of immobilization is 7.2 weeks. Duration of stay was 10.25 days. Time of union is 10.35 weeks. Time of weight bearing in present study is 11.8 weeks. No major complications were encountered but few minor complications were like superficial infection, limb shortening, and bursa at tip of nail.

Outcome was graded by Flynn’s criteria as excellent, satisfactory and poor. In our present study, we achieved 90% excellent outcome 10% satisfactory, no poor outcome.

REFERENCES


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