

Original Research Article

Short term functional outcomes of titanium elastic nailing for fractures of shaft of tibia in children and adolescents

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Abstract: Paediatric tibial diaphyseal fractures constitute 15% of paediatric long bone injuries. The periosteal support to fracture is better in children less than 8 years of age. Titanium elastic nailing (TENS) offers a reliable surgical alternative to treat these types of fractures. The nailing procedure has advantage of minimal blood loss and postoperative morbidity. It ensures early weight bearing and consistently good functional outcomes. The present study was a prospective study done at Sree Balaji Medical College and Hospital, Chromepet, Chennai between March 2013 to March 2016. The study had 32 children in age group of 5 to 16 years, both boys and girls with tibial diaphyseal fractures treated with titanium elastic nailing. All fractures went on for sound union at average time of 11 weeks, allowing full weight bearing in 10.8 weeks. The outcomes were assessed with Flynn's outcome criteria. We had 100% satisfactory to excellent results, with 87.5% excellent and 12.5% satisfactory results.

Keywords: Paediatric, Diaphyseal tibial fractures, TENS nailing, Flynn's Criteria, prospective study.

INTRODUCTION:

Fractures of shaft of tibia and fibula represent the third most common pediatric long bone injuries (15%)[1-3]. Shaft of tibia fractures in paediatric patients are isolated injuries in 70% of patients, associated ipsilateral fibula fractures in 30%. This fracture in children can be incomplete (torus, green stick) or complete. Tibial shaft fractures in children under 11 years of age are caused by torsional force[4].

In infants and young children, the periosteum is strong and this imparts great structural stability to the fracture and limits displacement and prevents shortening [5]. In contrast, the adolescent tibial shaft has a thinner and weaker periosteum. Fractures in the adolescent age group are more often the result of high-energy trauma and are associated with greater fracture displacement, comminution, and relatively slower healing rates, when compared to younger children[5]. The remodeling potential of the tibia is limited. Infants and toddlers can correct approximately 50% of residual angulation with growth. In children older than 10 years, only 25% of the axial malalignment improves. In general, varus malalignment seems to remodel more completely than valgus deformity. Attempts should be made to maintain alignment within 10 degrees of angulation in any direction for children older than

6 years and within 15 degrees of angulation for younger children [1, 4-6]. Rotational deformity may not remodel at all, however external rotation deformity is better tolerated than internal rotation deformity[1,5]. When shaft of tibia and fibula are both fractured, a major problem is shortening. Acceptable shortening in the age group of 1 to 5 years is upto 10 mm and in the age group of 5 to 10 years it is upto 5 mm. Varus and procurvatum deformity are not acceptable. The ability to compensate for shortening decreases with age. Overgrowth is not routinely seen in girls older than 8 years or boys older than 10 years.

Between the age of 5 to 16 years, the available options for these fractures are: external fixation, flexible stable intramedullary nails, plate fixation, and locked intramedullary nailing. The goals are to stabilize the fracture, to control length and alignment. Titanium elastic nail (TEN) fixation represents an optimal treatment method in between conservative treatment and others surgical treatments with satisfactory results and minimal complications [7].

MATERIALS AND METHODS:

All children in the age group 5-16 years, both male and female, with diaphyseal fractures of tibia admitted to Sree Balaji Medical College and Hospital,

chromepet, Chennai, from March 2013 to March 2016 were studied.

Inclusion criteria:

1. Children upto 6-16 years of age.
2. Diaphyseal fractures both displaced and undisplaced.
3. Closed fractures.

Exclusion criteria:

4. Children lesser than 6 years and more than 16 years of age.
5. Comminuted fractures or segmental fractures or open fractures.
6. Very distal (or) very proximal fractures that precludes nail insertion.

Plain radiographs of antero-posterior and lateral views of the leg including knee and ankle were taken to assess the extent of fracture comminution, the geometry and the dimensions of the fracture. Selected patients were worked up for surgery and after anaesthetic fitness, were taken up for surgery under general anaesthesia.

Preoperative planning:

The diameter of the individual nail is selected as per Flynn et al's formula.

Flynn et al's formula:

Diameter of nail= width of the narrowest point of the medullary canal on Anteroposterior and lateral view x 0.4mm. Diameter of the nail is chosen so that each nail occupies atleast 30% to 40% of the medullary cavity. Lay one of the selected nails over the leg, and determine that it is of the appropriate length by fluoroscopy. The nail for tibia should extend 2cm beyond the proximal physis till 5mm proximal to the distal physis.

Operative technique (figure 1):

Under general anesthesia, patient was placed in supine position on a radiolucent table. The operative extremity was then prepared and draped. Under fluoroscopy, the fracture site and proximal tibial physis

were identified. The starting point for nail insertion was 1.5 to 2.0 cm distal to the proximal physis, sufficiently posterior in the sagittal plane in order to avoid injury to the tibial tubercle apophysis. A longitudinal 2 cm incision was made on both the lateral and medial side of the tibia metaphysis, just proximal to the desired bony entry point. Using a hemostat, the soft tissues were bluntly dissected down to bone. Based on preoperative measurements, appropriately sized implant was selected so that the nail diameter was 40% of the diameter of the narrowest portion of the medullary canal. A drill roughly 0.5 cm larger than the selected nail was then used to open the cortex at the nail entry site; angling the drill distally down the shaft. Both nails were then inserted through the entry holes and advanced to the level of the fracture site. Under fluoroscopic guidance, the fracture is reduced, in both the coronal and sagittal planes, and the first nail was advanced past the fracture site. If proper intramedullary position of the nail distal to the fracture site is confirmed on anteroposterior and lateral views, then the second nail was tapped across the fracture site. Both nails were then advanced until the tips lie just proximal to the distal tibial physis. Fluoroscopy is again used to confirm proper fracture reduction as well as nail position. In order to minimize soft tissue irritation, the nails were backed out a few centimeters and the cut along proximal tibial metaphysis. Less than 1 cm of nail lay outside of bone. The two incisions for nail entry were then closed in a layered fashion, and the wounds are dressed.

Post-operative protocol:

Patients were treated with antibiotics and analgesics for 48 to 72 hours. Sutures were removed on the 12th postoperative day, after periodical wound inspection. Above knee plaster cast was applied after suture removal and retained for a period of 6 weeks. Above knee cast was changed to PTB cast at six weeks and started on partial weight bearing walking with walker, proceeding to full weight bearing by 10th week based on clinical and radiological assessment done every four weeks. The outcomes were assessed with Flynn's criteria[8].



Fig 1: Instrumentation



Fig-2: Operative technique

Table-1: Flynn’s Criteria [8]

Variables	Excellent	Satisfactory	Poor
Limb-length inequality	< 1.0cm	<2.0cm	>2.0cm
Malalignment	5 degrees	10 degrees	>10 degrees
Unresolved pain	Absent	Absent	Present
Other complications	None	Minor and resolved	Major and lasting morbidity

RESULTS:

The present study included 32 children with tibial diaphyseal fractures. Of these 9(28.1%) were in the age group of 5 to 8 years, 5(15.6%) were in the age group of 9 to 12 years and 18(56.3%) were in the age group of 13 to 16 years. We had 24(75%) boys and 8(25%) girls in our study.

The mode of injury was road traffic accidents in 14(43.8%) children, self-fall in 15(46.9%), fall from height in 2(6.2%) and fall of heavy object in 1(3.1%) child. Right tibia was fractured in 18(56.2%) children and left tibia was fractured in 14(43.8%) children. We had 16(50%) transverse fractures, 10(31.2%) oblique and 6 (18.8%) spiral based on fracture pattern. 9(28.1%) had proximal shaft, 18(56.2%) had a midshaft and 5 (15.7%) had a distal shaft fractures. The time interval between trauma and

surgery was between 6 and 48 hours with a mean of 13 hours. The average duration of surgery was 50 minutes ranging from 30 to 70 minutes. The mean time of post-operative immobilization was 6 weeks ranging from 5 to 8 weeks. The duration of hospital stay in the present study was between 5 to 8 days. The mean time for union was found to be 11 weeks, ranging from 9 to 14 weeks. The average time for full weight bearing was 10.8 weeks ranging from 9 to 14 weeks.

In the present study, the final outcome as assessed by Flynn’s criteria was excellent to satisfactory in 100%, excellent in 28 (87.5%) cases, satisfactory in 5(12.5%) cases and there were no poor outcomes. Major complications included pain in 2(6.25%) children, nail site irritation in 2(6.25%) children and limb shortening by 1cm in 1(3.1%) child.

Table-2: Functional Outcome:

Flynn’s criteria	Number of Patients (n = 32)	Percentage
Excellent	28	87.5%
Satisfactory	4	12.5%
Poor	0	0

Case Illustrations

Case 1:

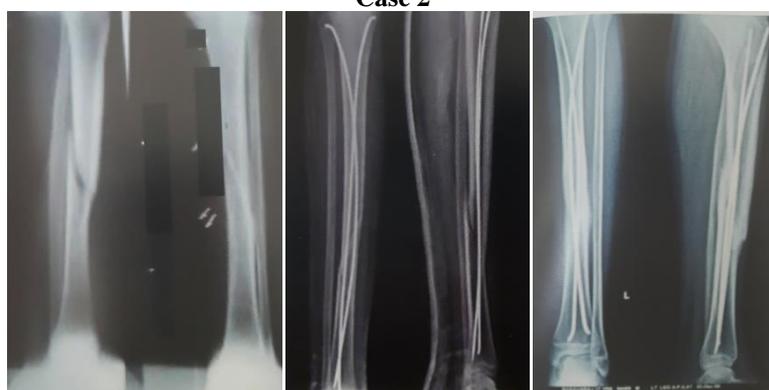


Pre-op

4 weeks

10 weeks

Case 2



Pre op

postop

10 weeks

DISCUSSION:

Flexible nailing achieves biomechanical stability from the divergent 'C' configuration which creates six points of fixation and allows the construct to act as an internal splint. Controlled micro motion at the fracture site, results in early healing by bridging external callus.

The endosteal blood supply is not compromised. This technique allows early weight-bearing in a Sarmiento-type cast brace[9]. It is important to emphasize that both nails are of equal diameter, or else, differential loading of opposite cortices may lead to an angular deformity at the fracture site.

Todd O' Brien *et al.*; over a 5 year period treated 16 unstable tibia fractures in 14 patients with flexible Titanium Intramedullary nails. The average age was 10 years 4 months. All fractures healed at an average of 8 weeks. There were no incidences of growth arrest or refracture[10]. In our study the average union time was 11 weeks ranging from 9 to 14 weeks.

Vallamshetla *et al.*; retrospectively reviewed the records and radiographs of 56 unstable fractures of the tibia in 54 children treated with elastic stable intramedullary nailing and found that there were no cases of non-union and the average radiological

union time was 10 weeks. All achieved an excellent functional outcome. They concluded that the flexible intramedullary fixation is an easy and effective method of management of both open and closed unstable fractures of tibia in children[11].

Wudbhav N. Sankar *et al.*; studied 19 consecutive patients between 7.2 and 16 years of age treated with elastic stable intramedullary nailing for unstable tibial shaft fractures. All patients achieved complete healing at a mean of 11 weeks. According to the Flynn criteria, they had 12 excellent, 6 satisfactory and 1 poor result. They concluded that elastic stable intramedullary nailing is an effective surgical technique which allows rapid healing of tibial shaft fractures with an acceptable rate of complications[12]. In our study, we had 87.5% excellent results, 12.5% satisfactory results and no poor results.

Adarsh K Srivastava *et al.*; retrospectively reviewed 24 tibial shaft fractures in 24 patients, which were treated operatively by elastic stable intramedullary nailing. The average union time in their study was however a prolonged to 20.4 weeks. They encountered complications: 8% neurovascular, 8% infection, 8% malunion and 4% leg length discrepancy. Their study however included open fractures and complex fractures[13].

In comparison, our study had nail irritation in 2(6.25%) cases, 1(3.1%) case had one cm of limb length discrepancy and 2(6.25%) cases developed pain at the site of nail insertion which subsided with analgesics. Our average union time was comparable at 11 weeks, ranging from 9 to 14 weeks. We had no infection in our study.

CONCLUSION:

Titanium elastic nailing is a relatively simple, rapid, reliable and effective method for treating displaced tibial shaft fractures in children and adolescents, with fewer complications and an excellent functional outcome. It allows early mobilization, thereby decreasing the patients' morbidity and duration of hospital stay.

The deduced advantage of TENS include-

- a) Easy learning curve.
- b) Short procedure under anaesthesia.
- c) Near nil blood loss.
- d) Low postoperative morbidity.
- e) Preservation of physis.
- f) Early union due to fracture site micromotion.
- g) Early joint mobilization and early weight bearing.
- h) Acceptable small scar, easy implant exit and good patient satisfaction.

REFERENCES:

1. Shannak AO; Tibial fracture in children: follow-up study. *J Pediatr Orthop* 1988;8: 306-310.
2. Steinert VV, Bennek J; unterschenkelfrakturen I'm Kind Esalter. *Zentralbl Chir* 1966; 91:1387-1392.
3. Rockwood and Wilkins Fractures in Children Seventh Edition 930-943.
4. Yang J, Letts M; isolated fractures of tibia with intact fibula in children: a review of 95 patients. *J Pediatric Orthop* 1997; 17:347-351.
5. Lovell and Winters *Pediatric Orthopedics* 6th edition, 1504.
6. Hansen B, Grieff J; Fractures of the tibia in children. *Acta Orthop Scand* 1976; 47:448.
7. El-Adl G, Mostafa M.F, Khalil M.A, Enan A; Titanium Elastic nail fixation for pediatric femoral and tibial fractures. *Acta Orthop. Belg* 2009; 75: 512- 520.
8. Flynn JM, Hresko T, Reynolds RA, Blasler RD, Davidson R, Kasser J; Titanium nails for pediatric femur fractures – a multicenter study of early results with analysis of complications. *J. Pediatr Orthop* 2001; 21(1): 4-8.
9. Sarmiento A; A Functional below the knee cast for tibial fractures. *J Bone Joint Surg[Am]* 1967; 49-A: 855-875.
10. O'Brien TJ, Weisman DS, Ronchetti P, Piller CP, Maloney M; Flexible Titanium nailing for the treatment of the unstable pediatric tibial

fractures. *J Pediatr Orthop* 2004; 24-6: 601 – 609.

11. Vallamshetla VR, De Silva U, Bache CE, Gibbons PJ; Flexible intramedullary nails for unstable fractures of the tibia in children: An Eight year experience. *J. Bone Joint Surg* 2006; 88-B: 536 – 540.
12. Sankar W.N, Jones K.J, Horn B.D, Wells L; Titanium Elastic nails for pediatric tibial shaft fractures. *J.Child Orthop* 2007; 1(5): 281 – 286.
13. Srivastava A.K, Mehlman C.T, Wall E.J, Do T.T; Elastic stable intramedullary nailing of the tibial shaft fractures in children. *J.Pediatr Orthop* 2008; 28(2): 152 – 158.