

ORIGINAL RESEARCH

Percutaneous Titanium Elastic nail for femoral shaft fracture of children in 5- 15 years of age

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ABSTRACT

Background: The most common fractures among long bones are femoral fractures. Femoral shaft fractures account for 1.6% of all paediatric bony injuries. Children in the age group of 5-15 years are treated with either traction, hip spica, flexible/elastic stable retrograde intramedullary nail, or external fixators. We conducted a clinical prospective study on the use of Titanium Elastic Nailing System (TENS) for the treatment of femoral shaft fractures in children. **Materials & methods:** The study was conducted in a tertiary care centre from November 2019 to December 2022. A total of 30 subjects within the age group of five years to fifteen years were enrolled. The Inclusion Criteria were a) Age group of 5-15 years, b) Recent fracture of femur shaft c) Transverse, short oblique, minimally comminuted fractures. Preoperative radiographic examination was done in all the patients. All patients underwent surgery as early as possible with an average 3days from the day of admission. The results were evaluated using Flynn's scoring criteria. **Results:** After 23 months of follow up all thirty patients were available for evaluation. Radiological union were achieved in a mean time of 10 weeks. Mean duration of hospital stay was 14 days. According to Flynn's criteria of TENS outcome score results were excellent in 70% patients, Satisfactory in 26.7% patients, Poor in 3.3% patient. All patients had early return to school. **Conclusion:** Titanium elastic nailing is simple, rapid & effective treatment for displaced paediatric femoral shaft fractures.

Key words: Titanium, Nails, Femoral shaft

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INTRODUCTION

The treatment of diaphyseal femoral fractures in pediatric age has traditionally been a matter of debate. Several conservative and surgical treatments have been proposed(1). The treatment choice is typically based on patient's age, fracture type(2) associated injuries, and the physical characteristic of the child. Children younger than six years have high potential for healing and thus they can be managed conservatively with early reduction and traditional POP spica cast[3,4]. Young adolescents more than 15 years old are treated with intramedullary interlocking nail. Children in the age group of 6 to 14 years are treated with either traction, hip spica, flexible/ elastic stable retrograde intramedullary nail, or external fixators in cases of open fractures [5]. The management of the femoral shaft fracture in children of this age group remains a topic of debate [6]. Intramedullary nailing with titanium elastic nails (TENs) offers several advantages, including early union, lower rate of malunion, spare of the physis,

early mobilization and weight-bearing, mini-invasive approach with easy implant removal, and high patients' and parents' satisfaction rates. The present study was therefore undertaken to verify the clinical and surgical outcomes of intramedullary nailing with TEN in a sample of children between the age of 5-15 years presenting with diaphyseal femoral fractures.

MATERIALS & METHODS

the prospective study included 30 cases of fresh femoral shaft fractures (20 males, 10 females) out of which all 30 were closed Injuries which were operated with Titanium Elastic Nail System (TENS) (SYNTHES, Switzerland) between 2019-2022. The Inclusion Criteria were a) Age group of 5-15 years, b) Recent fracture of femur shaft c) Transverse, short oblique, minimally comminuted fractures. The Exclusion Criteria were a) Long oblique, long spiral, multifragmentary fractures b) Grade III open fractures, c) Pathological fractures, d) Patient below 5 years and above 15 years of age group. No control

group was used. All patients were evaluated and treated for life and limb threatening injuries. Displaced fractures were immobilized using skin traction with Thomas splint till the date of surgery. Surgical technique: On a fracture able, traction was applied under fluoroscopic guidance to reduce the fracture. Proper size Elastic nails of 2 to 3.5mm diameter were taken. Nails were bent in an even curve. The tip was further bent 2cm from one end at 40 degree. This facilitates the nail to bounce of the opposite cortex into the canal rather perforate it. After incising the skin, insertion points were made one on medial and another on lateral side of distal femur, 2cm proximal to the distal epiphyseal plate. The nails were introduced right up to fracture site. Than one of the nail was passed across the already reduced fracture site followed by second nail. The nails were directed in such a way that medial nail was introduced

into the neck and lateral just below trochanteric apophysis in a fan shaped manner. Two divergent Elastic nails provide adequate fixations and stability in adolescent femur. To prevent knee pain and problems of nail protrusion the distal end of nail should never project beyond distal epiphyseal plate and care should be taken to avoid bending the distal end of nails. Knee bending and quadriceps setting exercises were started as soon as the patient could tolerate it, usually within first 24 hrs itself. Non-weight bearing ambulation was started with in first few days, though partial weight bearing was permitted only after radiological evidence of callus formation. Full weight bearing was permitted only on radiological evidence of firm union. Assessments were done at 2, 6, 12 and 24 week. The final outcome based on the above observations was done as per Flynn’s criteria.

Table I: Flynn et al 10 (2001) criterion for assessment of results

Parameter	Excellent	Satisfactory	Poor
Limb length inequality	<1 cm	<2 cm	>2 cm
Malalignment	Upto 5°	5-10°	>10°
Pain	None	None	Present
Complication	None	Minor	major complication and/or lasting morbidity

RESULTS

The mean age was 8.72 years with left side more commonly affected (n = 17, 56.66%) than right. Most common mode of injury was road traffic accidents (n = 21, 70%). Associated injuries occurred in 3 patients (10%). 23 patients (76.66%) had fracture of middle third, 3 (10%) had fracture of proximal third and 4 (13.33%) had fracture of distal third of femoral shaft. 20 patients (66.66%) had transverse fracture, 7 (23.33%) had short oblique fracture and 3 (10%) had

minimally comminuted fracture. Majority of patients (n = 27, 90%) underwent surgery within one week and rest (n = 3, 10%) were operated within two weeks of trauma. Duration of surgery was < 30 mins in 1(3.3%) case, 30-60 mins in 10(33.3%) cases, 61-90 mins in another 14 (46.7%) cases and 91-120 mins in 5 (20%) of the cases. Results were excellent in 70% patients, Satisfactory in 26.7% patients, Poor in 3.3% patient.

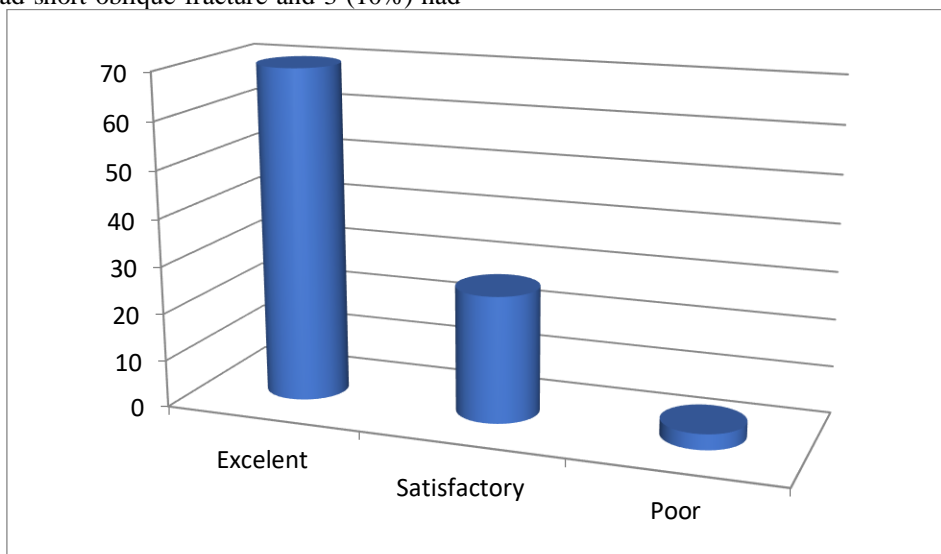


Table 1: Demographic variables

Variables	Number	Percentage
Males	20	66.66
Females	10	33.33
Mean age (years)	8.72	
Left side involved	17	56.66
Right side involved	12	40
Bilateral Involvement	1	3.33

Table 2: Outcome variables

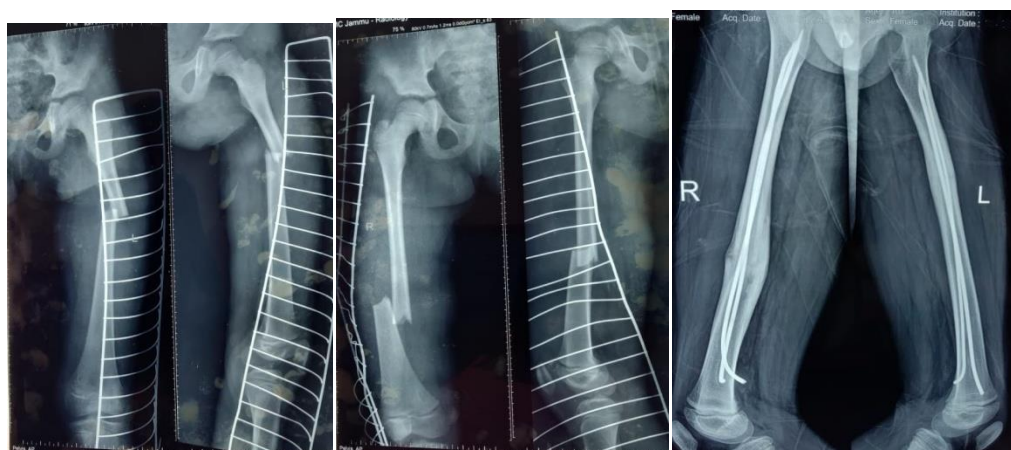
Variable	Mean	SD
Hospital stays (days)	14	1.8
Radiological union time (weeks)	11.3	2.1

Table 3: Outcome

Outcome	Number	Percentage
Excellent	21	70
Fair	8	26.7
Poor	1	3.3
Total	30	100



CASE1- Flynn Criteria Excellent result





CASE 2` - Bilateral SOF Excellent Result

DISCUSSION

The optimal mode of treatment among the wide variety of surgical and nonsurgical treatment options for children between 5 and 15 years of age continues to be controversial. Unlike younger children, patients in this intermediate age group have a higher risk of shortening and malunion from early closed reduction and the use of a spica cast. Two or three weeks of traction prior to the application of the cast can maintain length until early healing has occurred. Notably, the older children who are managed with traction and a spica cast may miss several months of school until full union has been achieved, and so various operative strategies have been used for them with the aim of avoiding the adverse physical, social, psychological, and financial consequences associated with prolonged immobilization. Those methods include flexible intramedullary and antegrade solid nails, external fixation, plates, and screws. Each procedure carries the risk of certain complications, particularly pin track infection and refracture after fixation with a solid antegrade intramedullary nail (IMN).^(7,8,9) The present study was conducted for evaluation of outcome of percutaneous Titanium Elastic nail for femoral shaft fracture of children in 5-15 years of age.

All children achieved union in a mean time of 10 weeks. This was in similar findings with Bagul Rahul R et al.¹⁰ study where mean duration of union was 10 weeks. Whereas in the study conducted by Vishal Kumar Mishra et al.¹¹ mean duration of union was 8.2 weeks. In our study, closed reduction of the fracture, leading to preservation of fracture hematoma, improved biomechanical stability and minimal soft tissue dissection led to rapid union of the fracture compared to compression plate fixation. The average time of full weightbearing was 11.5 weeks. Saikia et al in their study allowed full weight bearing was at average of 8.8 weeks.⁶ Singh et al in their study allowed full weight bearing depending on the clinical and roentgenographic progress of fracture union with an average time of 8.3

weeks.¹² No patient in our study had major limb length discrepancy (i.e. $> \pm 2\text{cm}$). Khazzam et al reported, three patients had overgrowth of more than 2 cm.¹³ Ferguson et al noted more than 2cm shortening in 4 children after spica treatment of pediatric femoral shaft fracture.¹⁴ In the present study, limb length discrepancy of more than 10mm was present in 3 (10%) cases. Comparing to limb length discrepancy in conservative methods, limb length discrepancy in our study was within the acceptable limits. Two (6.66%) patient presented with varus (4°) angulation. Flynn et al reported 10 (4.3%) cases of minor angulation out of 234 fractures treated with titanium elastic nails.¹⁵ Herndon et al compared the results of femoral shaft fractures by spica casting and intramedullary nailing in adolescents.¹⁶ They noticed varus angulation ranging from 7 to 25° in 4 patients treated with spica casting and no varus angulation in surgical group. A difference of more than 10° has been the criterion of significant deformity. No patient in our study had significant rotational deformity. In the present study, the final outcome was excellent in 21 (70%) cases, satisfactory in 8 (26.7%) cases and there was one patient with poor outcome. Flynn et al treated 234 femoral shaft fractures and the outcome was excellent in 150 (65%) cases, satisfactory in 57 (25%) cases and poor in 23 (10%) of the cases.¹⁵ Singh et al treated 112 patients of femoral fractures, 86 had excellent results, 24 had satisfactory results, and 2 had poor results.¹⁷ Saikia et al in their study of 22 children with femoral diaphyseal fractures reported 13 (59%) excellent, 6 (27.2%) satisfactory and 3 (13.6%) poor results.⁶

CONCLUSION

TENS (Titanium Elastic Nailing System) is very effective in management of paediatric shaft femur fractures in the age group of 5-15 years with advantages of early union, early mobilization and minimum complications. The complications can be avoided by strictly following the surgical technique. It

overall yields excellent results in majority of the patients.

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