

**PROSPECTIVE STUDY OF CLINICAL OUTCOME OF FRACTURE SHAFT FEMUR IN CHILDREN TREATED WITH TITANIUM ELASTIC NAILING: OUR RESULTS**SAIYAM SHELENDRA<sup>1\*</sup>, UIKEY KISHOR<sup>1</sup>, CHOUHAN SHAILENDRA<sup>2</sup><sup>1</sup>Department of Orthopaedics Chhindwara Institute of Medical Sciences, Chhindwara Madhya Pradesh, India. <sup>2</sup>Department of Orthopaedics Government Medical college, Khandwa, Madhya Pradesh, India. Email: shailendrasaiyam@gmail.com

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**ABSTRACT**

**Objective:** Femur fracture in children between 5 and 15 years is a common injury with a variety of operative and non-operative management options. There remains debate as to the optimal treatment for a given patient and fracture. Our aim was to assess functional outcome of a large number of patients after their femur fractures with a titanium elastic nailing (TEN).

**Methods:** This was a prospective randomized study comprised 50 patients with displaced diaphyseal femur fractures treated with TEN. Two nails were used in fracture. The patients were followed up at 2<sup>nd</sup> week, 1 month, 3 months, and 6 month after surgery. Results were evaluated by Flynn's scoring criteria at each follow-up visit.

**Results:** At the end of 6 months, out of 50 patients, excellent result was achieved in 45 patients (90%) and good in five patients (10%). No poor outcome seen. Intramedullary fixation by Tens is an effective treatment of fracture of femur in properly selected patients of the 5–15 years age group.

**Conclusion:** The treatment with femoral shaft fracture in children between the age group of 5–15 years by titanium elastic nail is ideal as it hastens fracture union, reduce rate of mal union, shortening, and allow early rehabilitation.

**Keywords:** Fracture femur, Diaphysis, Titanium elastic nail, Internal fixation.

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**INTRODUCTION**

Femoral shaft fracture is an incapacitating wound in children [1,2]. The treatment options are age related, depends on the type of injury, associated injuries, and the location and kind of fracture. The aim of treatment is anatomical realignment, along with restoration of muscle and joint purpose as close as possible to the normal. Recovery is accelerated by the early movement, which encourages healing of fracture, preservation of tone of the strengths, and restoration of the activities of the joints.

Due to rapid therapeutic and spontaneous correction of angulations, record of femoral shaft fractures in children fresher than 6 years of age can be treated conservatively. If age is above 6 years of age all fractures when treated nonoperatively could lead to loss of reduction, malunion, intolerance, and complication associated with plaster [3,4]. Near the end of skeletal maturity accurate reduction is necessary as angular deformity is no longer correctable by growth. In skeletally mature adolescents, the use of an antegrade solid protected intramedullary nail has become the standard of treatment. In patients between 5 and 15 years of age, Titanium Elastic Nailing (TEN) which is variously known as variable elastic stable intramedullary nailing has develop the choice of stabilization in pediatric femoral shaft fracture. The present study is aimed at the assessment of intramedullary fixation with TEN in children with femoral fractures. Until recently, skeletal traction and application of a company were the preferred technique of treatment of diaphyseal femoral fractures in children and young adolescent. Such treatment in children has commonly result in malunion or joint stiffness, limb length discrepancy, delay in functional recovery, psychological, social, educational, and economic difficulties. An ideal device would be a single load shearing implant allowing mobilization and maintaining the alignment until bridging callus form without risking the physis or blood supply to femoral head. TEN fulfills that qualities in children aged 5–15 years.

**METHODS**

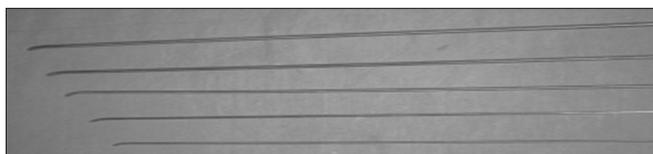
The study was conducted in Branch of Orthopedics Chhindwara, Institute of Medical Science, Chhindwara, Madhyapradesh. Fifty children in the age group of 5–15 years with femoral shaft fracture were stabilized with TEN from January 2020 to January 2022. The predominant mode of wound was due to fall from height (50%). Right-sided involvement was seen in 30 cases (60%) and left side in 20 cases (40%). Mid-diaphyseal fracture of femur was found in 90% cases of 50 patients and subtrochanteric fracture in 5% cases and 5% cases of lower third femur fracture. All patients underwent surgery within 48–72 h of their injury. They underwent intramedullary nailing with a pair of equal size titanium elastic nails. Open grade 3, segmental, winquist 3, 4, and pathological fracture were excluded in our study. Nail comes in five widths from 2.5 mm to 4.5 mm in a fixed length. The nails are colour coded for identification. The nails (Fig. 1) are conventional except for a bent tip. Special instruments include radiolucent discount tool, nail holder, nail bender, insertion device, nail ex-tractor, and a nail impactor which were used. As soon as anaesthesia was effective, the patient was located supine on fracture table. The limb was prepared and draped to give access to the entire femur and knee joint and to permit manual manipulation of the thigh. The image intensifier was placed so that one could get antero-posterior and lateral opinion of the femoral shaft. The selection of the insertion opinion for the nails was medial and lateral at the top of the flare of the medial and lateral condyles so that after insertion they would tend to bind against the flare of the condyles. In adding, the insertion should be posterior to mid line of the shaft so that if the nails backout, they determination be less likely to enter the synovial pouch. A 5 mm incision was made on the side side of the knee spreading about two finger breadth above the superior pole of the patella. (The superior pole of the patella lies slightly above the level of the physis). Using a curved bone awl was passed at 45° angulation at the level of the superior pole of the patella, the hole is extended cephalad to elongate the hole and avoid extremely of the cortex when the rod is inserted. The medial entry hole was similarly elongated using a curved bone awl in

cephalad direction. The diameter of nail should be 2/5 of the internal distance of the medullary canal (Nail diameter = 0.4 × Canal diameter); ideally, the lateral nail must extend to the level of the greater trochanter and the medial nail into the femoral neck. The amount of prebending should be equal for both the nails (The amount of bending should be three times the inner width of the shaft). Both the nails were inserted through the entry fleabags one after another and were driven up to the fracture site. When the nail was at its final location, it was marked with a pen or clamp about 10–20 mm from the insertion hole. The nails were cut at the marked level and progressive so that they lay in contradiction of the supracondylar flare of the femur to evade problems at the insertion site. The patients were advised to perform actions at the knee

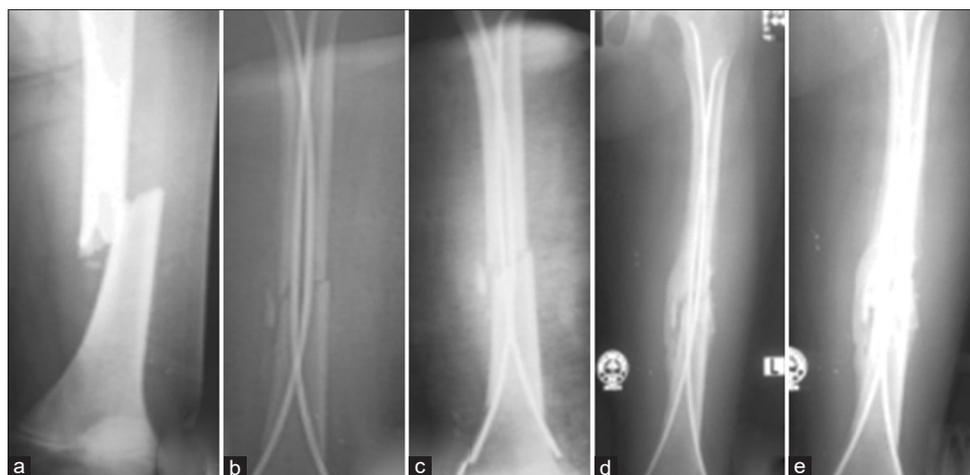
joint and three point touchdown exercises the day after surgery. When early callus formation is observed, weight bearing can be increased. External support like crutch can be discontinued when radiographic healing is complete. It is important that the patients bear heft, because this provides the motion at the splintering site that leads to first callus formation. In all cases post-operative, X-rays anteroposterior and lateral views were taken. In the post-operative period, parenteral antibiotics were continual for 5 days, and then, oral antibiotics were given till stitch elimination. Lengthways with antibiotics, hematinics, serratiopeptidase, calcium, and multivitamins were given. Stitches were removed on the 14<sup>th</sup> post-operative day. After removal of stitch by 13–14<sup>th</sup> day post-operative but patients were discharged 5<sup>th</sup> post-operative day. Patients underwent regular follow-up in the outpatient department for clinical and radiological evaluation. Around 2<sup>nd</sup> months after radiograph shows good callus formation. There were no post-operative complications.

**OBSERVATION AND RESULTS**

This study was conducted in the Department of Orthopedics, Chhindwara Institute of Medical Science for 24 months to assess functional outcome of displaced diaphyseal femur fractures treated



**Fig. 1: TEN with different length and diameter**



**Fig. 2: A 8-year-old male child was treated with TENS (a) Pre-operative X-ray, (b) just post-operative X-ray, (c) 1-month follow-up X-ray, (d) 2-month follow-up X-ray, and (e) 3 month follow-up X-ray**



**Fig. 3: (a-f) Clinical images of the patient showing range of movements**

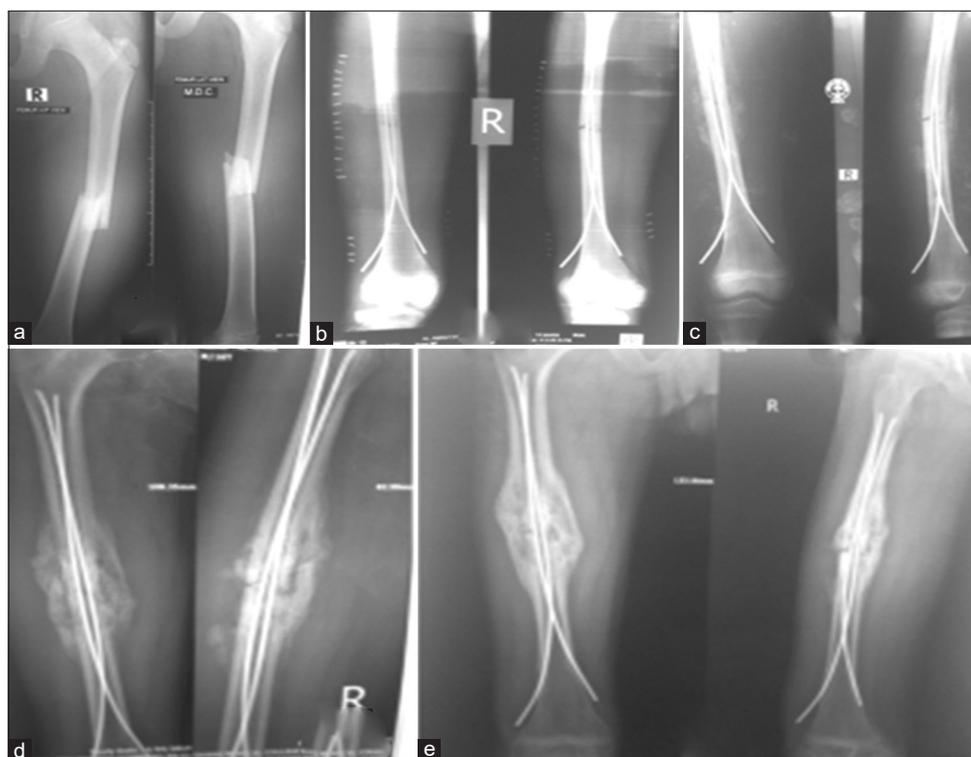


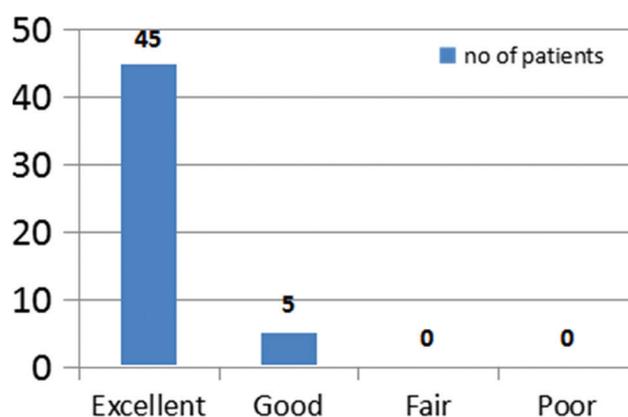
Fig. 4: A 10-year-old male child was treated with TENS (a) pre-operative X-ray, (b) just post-operative X-ray, (c) 1-month follow-up X-ray, (d) 2-month follow-up X-ray, and (e) 3-month follow-up X-rays

Table 1: Flynn’s scoring system [1]

Criteria	Excellent	Successful	Poor
Limb length	<1 cm	<2 cm	>2 cm
Malalignment	5°	10°	>10°
Pain	Absent	Absent	Present
complication	Absent	Mild	Major complication and/or extended period for resolvable morbidity

with TEN. The mean duration of the surgery was 52 min (45–100 min). All patients were available for evaluation. All patients were fortified to do hip and knee non-weight-bearing exercises from 1<sup>st</sup> post-operative day. Weight bearing was allowed according to the fracture geography and fixation. At the end of 1<sup>st</sup> post-operative week. All patients were made ambulatory on crutches agreeing weight bearing according to the quality of fixation. By 8<sup>th</sup> week, all the patients were allowed to bear weight. No broken nails were detected in any of the cases. There were no post-operative complications. No leg length inequality seen. Out of 50 patients, malalignment was noted in only in five patients, five degree varus was found in three, while five degree valgus was present in five patients. No malalignment was found in rest of the patients. No pain complained at the end of study and more than 130° knee flexion was present in all 50 patients. The functional results were assessed according to the criteria of Flynn’s scoring system and were excellent. The excellent and successful results were considered as satisfactory. The poor results were considered as unsatisfactory. Clinical outcome assess with modified sylvia scoring system. According to modified Silvia’s score, final outcome of elastic nailing in this study was 12.80±1.751, where 95% confidence interval was 11.55–14.05. Hence, it is 95% sure that among whole population of femoral diaphyseal fractures in children with ages 5–15 years treated by elastic nailing, minimum Silvia’s score will be about 11; a “Good” outcome. There is a significant relationship (p<0.05; Pearson Chi-square test) between preoperative and Silvia’s score after elastic nailing for femoral diaphyseal fractures in children with ages 5–15 years.

RESULTS



Grading	Score
Excellent	15
Good	14-10
Fair	9-7
Bad	<7

DISCUSSION

In our study, TEN was used as a type of fixation in changed types of femoral fractures in children between ages 5 and 15 years. Fifty cases were treated and evaluated radiologically, clinically and functionally for the efficacy of TEN. In our study, results were excellent in 45 cases (90%). Heinrich et al. [2] reported that 22% of their patients had a postponement over 5 mm, and 10% had a shortening under 5 mm. In a study comparing several methods including TEN, the maximum fat was observed in the early casting group shadowed by external fixator group, whereas lengthening was experimental only in the external fixator group. In our study, none of the case showed shortening. Herndon

Table 2: Modified Sylvia scoring system

Score	Shortening	Angle deviations (varus/valgus)	Range of joint movement
0	Greater than surgery/gross shortening		
1		05-10o	
2	Existing as previous/shortening present	<5i	Flexion up to 90i
3	Lower limbs equalization	No deviation	Normal

Table 3: Clinical outcome of the patients under study

No. of patients	Full weight bearing at 8 weeks	Complications	Leg length inequality	Malalignment	Pain	Knee flexion degree	Results		
							Excellent	Good	Poor
50	All 50 patients	Nil	3	5	Non	>130°	45	5	Nil

Table 4: Clinical outcome as per modified sylvia scoring system

Modified sylvia score	Number of patients
Excellent (score 15)	45
Good (score 10-14)	05
Fair	0
Bad	0

*et al.* [5] reported that malunion industrialized in seven of 24 patients who were preserved with traction, while no malunion was observed in 21 children who remained treated by TEN. In a study likening anterograde versus retrograde TEN by Galpin *et al.* [6], it was reported that 35 out of 37 patients had outstanding improvement in footings of angular deformity. We had angulation <05° toward varus/valgus or antero/posterior in five patients (10%). In our series, union progressed acceptably in all 50 cases. At the end of 8 weeks, ten cases showed fair to good callus creation. No bone splicing was required in any of the cases. Flynn *et al.* [1] found TEN advantageous over hip-spica in treatment of femoral shaft fractures in children. Buechsenschuetz *et al.* [7] recognized TEN to be superior in terms of union, scar creation overall patient satisfaction when equaled to grip and molding. Ligier *et al.* [8] treated 123 femoral trough fractures with TEN. All breaks united with excellent long period outcome. All patients remained encouraged to do hip and knee non-weight manner exercises from 1<sup>st</sup> post-operative day. At the close of 1<sup>st</sup> post-operative week, all patients were complete ambulatory on crutches, allowing weight-bearing rendering to the quality of fixation. Flynn *et al.* [1] used a knee fixating device to control the pain, to support quadriceps, and to stop the end of nail causing any soft-tissue crossness in the knee until the callus tissue appears (4-6 weeks). The patients remained able to gait on day 9 on an average with the help of gear and at week 8.5 on regular lacking the equipment. In our series, patients were through ambulatory on crutches after 1<sup>st</sup> post-operative week. Limited weight-bearing was allowed at 6 weeks and full weight-bearing was allowed at 8 weeks. The results of the present series are comparable to those of the other series on controlling of femoral shaft fracture in broods. It has definite advantages terminated the other conventional implants that have been used in the management of pediatric fractures. Distinguished advantages of this system are early

union due to repeated micro-motion early weight bearing, scar acceptance, easy manipulation complicated in implant removal, and high patient satisfaction rate. Besides these, unlike additional implants TEN does not endanger either the epiphysis or the blood supply to femoral head. The excellent biocompatibility and elasticity of titanium have, further, enhanced the virtues of TEN. High grade of elasticity of titanium bounds the degree and permanence of deformation that the nail undergoes during insertion. More highly elasticity promotes callus formation by limiting stress shielding.

#### CONCLUSION

It can be concluded that treatment of femoral shaft fracture in children aged 5-15 years by TEN is ideal, as it hastens fracture union, reduce the rate of mal union, shortening, and allow early rehabilitation.

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