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## A prospective study of comparison between stable and unstable paediatric femoral shaft fractures treated with titanium elastic nails

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**Abstract**

**Background:** Femoral shaft fractures account for 1.6% of all pediatric bony injuries. Angulation, malrotation and shortening are not always corrected effectively by conservative methods. These also depend on fracture anatomy; stable (transverse and oblique) and unstable (spiral and comminuted). Fixation of femur fractures in children & adolescents by flexible intra-medullary nailing is becoming widely accepted because of the lower chance of iatrogenic infection and prohibitive cost of in-hospital traction and Spica cast care. The objective of our prospective study was to compare stable and unstable diaphyseal fractures of femur in children aged between 5-15 years by using Titanium Elastic Nailing System. Subjective and objective study of clinical parameters like pain, comfort to the patients, early mobilization, operative technique, radiological evaluation for union, stages of weight bearing till complete recovery and any associated complications by using the above mentioned methods.

**Methodology:** Children and adolescents between the age group of 5-15 years with femoral shaft fractures who were admitted in Dr. B.R Ambedkar Medical College & Hospital meeting the inclusion criteria were selected. All patients underwent titanium elastic nailing for the femur fracture. Patients were followed up for a period of 6 months at 6, 12 and 24 weeks after surgery. 15 stable and 15 unstable fractures cases were studied.

**Results:** The outcome in stable fracture was good where as in unstable fractures there were 3 angular deformities and 1 case of limb length discrepancy.

**Conclusion:** Titanium elastic nails leads to rapid fracture union by preservation of fracture hematoma and limited soft tissue exposure. It also helps in preventing damage to the physis. A stable pediatric femoral diaphyseal fracture has very good results with minimal complications. Unstable pediatric femoral diaphyseal fractures though had good results in most cases but had angular deformities in 3 cases and 1 case developed limb shortening. According to our study it is better to use other operative techniques for severely unstable paediatric femoral diaphyseal fractures.

**Keywords:** Comminuted femur fracture, TENS nail, paediatric

**Introduction**

A femoral shaft fracture is the most common major paediatric orthopaedic injury that most Orthopaedician will treat routinely and is the most common pediatric orthopaedic injury requiring hospitalization.

Although paediatric femoral shaft fractures create substantial short-term disability, these injuries can generally be treated successfully with few long-term sequelae. For generations, traction and casting were standard treatment for all femoral shaft fractures in children, and femoral fractures ranked high in duration of hospitalization for a single diagnosis. And casting had many complications like plaster sore, problems in perineal toileting, loss of reduction. Over the past 20 years, however, there has been a dramatic and sustained trend towards the operative stabilization of femoral shaft fractures in school-aged children using flexible intra-medullary nails, dynamic compression plating, external fixation, and more recently, submuscular plates. These advances have decreased the substantial early disability for the children, as well as the family's burden of care during the recovery period<sup>[1]</sup>.

Older children are unlikely to have a femoral shaft fracture caused by abuse because their bone is sufficiently strong to tolerate forceful blows and is able to resist torque without fracture.

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In older children, femoral fractures are most likely to be caused by high-energy injuries during sports activities; also motor vehicle accidents [2].

Due to minimal soft tissue injury, preservation of fracture haematoma and no damage to physis; the flexible intramedullary nailing is more preferred now a days. The results of this depend on d fracture anatomy whether stable or unstable fractures [3].

### Materials and Methods

Patients having history of trauma and pain over thigh with X ray showing fracture shaft of femur, aged between 5-15 years who are admitted in Dr. B.R Ambedkar Medical College & Hospital, were selected for study after obtaining their consent. 15 stable (transverse and oblique) and 15 unstable (spiral and comminuted) cases were studied and compared.

### Inclusion criteria

- The patient with fracture shaft femur unilaterally or bilaterally.
- Aged between 5 - 15 years.

### Exclusion criteria

- Patients aged above 15 years.
- Patients with open fractures.
- Patients with pathological fractures. On admission the general condition of the patient was assessed with regards to hypovolemia, associated orthopaedic or other systemic injuries and resuscitative measures were taken accordingly. All patients were immobilised with Thomas splint, received analgesics in the form I.M injections and antibiotics I.V. A thorough clinical examination was performed including detailed history relating to age, sex, occupation, mode of injury, past and associated medical illness.

Routine investigations were done for all the patients. All patients were evaluated clinically and radio graphically to assess for any other injuries. Radiographs were taken in two planes, A-P and Lateral views. I.V antibiotics, cephalosporins were started for all the patients, patients were operated as early as possible, once the paediatric fitness is given for surgery.

Preoperatively the width of the nail was calculated by measuring the inner cortex width divided by two minus one. One medial and lateral entry were made using bone awl in distal femur above epiphysis under image intensifier guidance. Two equal sized nails were introduced one by one till the fracture site and then simultaneously advanced through fracture site after reduction. Nails advanced just short of proximal femoral physis. The nails were cut, bent and submerged below the soft tissue.

Hip and Knee mobilization, quadriceps strengthening exercises and non- weight bearing crutch walking was initiated with subsidence of pain. Post operatively cases were followed up for a period of 6 months with 3 visits (6, 12 and 24 weeks). Partial weight bearing was initiated at 6 weeks; it was progressively increased to full weight bearing on evidence of fracture union on Antero-posterior and lateral view X-rays.

Patients were observed for time of fracture union, complications like superficial infection, deep infection, and implant prominence or backing out, fracture angulations, loss of reduction, fracture collapse n limb shortening.

### Results

Closed reduction and internal fixation with Titanium elastic nailing for pediatric femoral fractures gave better results.

Thirty paediatric patients who sustained femoral fractures (15 stable and 15 unstable) were treated with titanium nailing over a period of 2 years between June 2017 to July 2019.

There were 19 patients 5-10 years and 11 patients 10-15 years of age. The mode of injury mainly road traffic accident (15 cases, 50%); self-fall (12 cases, 40%); fall from height (3 cases, 10%).

Sex distribution was predominantly male (60%, Male 18 - Female 12). Side affected was predominantly right (60%, right 18 - left 12). The fracture pattern distribution was transverse - 6, oblique - 9, spiral - 5, and comminuted - 10.

The level of the fracture was upper third - 9, middle third - 15, lower third - 6.

The time interval between trauma and surgery majority was within 48hours (24 cases) and other 6 cases operated after 48 hours due to respiratory infections and parent's negligence.

The duration of surgery was less than 1 hour for 22 cases and more than one hour for 8 cases.

Duration of hospital stay was 0-7 days in 3 cases (10%), 8-10days in 21 cases (70%),

11-14 days in 6 cases (20%).

Complications were 1) pain at the entry site – 6 cases; 2) superficial infection – 3 cases; 3) angulation < 10degrees (unstable fractures); 4) limb shortening - 1 case (unstable fractures).



Fig 1: Transverse fracture of shaft of femur.



Fig 2: Immediate post-operative X-Ray with TENS nailing.



**Fig 3:** Spiral fracture of shaft of femur.



**Fig 4:** 3 months old spiral fracture with TENS nail.

The outcome was assessed using Flynn's criteria based on 1) limb length in equality, 2) malalignment, 3) unresolved pain and 4) other complications.

The outcome was excellent in 21 cases (70%), satisfactory in 9 cases (30%) and there were no poor results. Fracture union occurred in all cases within 3 months and the average fracture union was 11.1 weeks. The average fracture union in stable fractures was - 10.8 weeks and unstable fractures was - 11.6 weeks.

### Discussion

Paediatric femoral fractures are the most common paediatric orthopaedic injuries requiring hospital admission and active surgical intervention. Earlier it was treated by conservative means like Thomas splint, hip Spica cast which had associated complications like improper perineal toileting, plaster sores, loss of reduction and angulation. So now-a-days surgical intervention are more preferably done. In among the operative technique the flexible intra-medullary nails like titanium elastic nail is more commonly used<sup>[4]</sup>.

Titanium elastic nail works on the basic principle of three point fixation, provided by symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which rests against the inner bone at three points. This produces following four properties: flexural, axial, translational and rotational stability. All four are essential for achieving optimal result<sup>[5]</sup>. The ends of nails are anchored firstly in their entry points, secondly in the metaphysis at the other end of bone. The curvature of nail is achieved by bending it beyond its elastic limit from this new position of stability, it resists the tendency to be straightened out (thus creating some tension within intramedullary canal) as well as a tendency to be further bent, thus minimizing the risk of deformation. Three nail into single bone is unnecessary because this unbalances the bipolar matched construct<sup>[6]</sup>.

Once inserted into the medullary canal, the nail resists angular, compressive and rotational forces by virtue of elastic quality of material and balanced insertional construct. Titanium alloy has a modular elasticity and handling characteristic very suitable to a child's diaphysis. It allows stable reduction, maintenance of reduction and early mobilization.

The titanium elastic nailing gave best results in transverse and oblique (stable) fracture patterns in terms of fracture union, no angulation and loss of reduction/collapse where as in spiral and comminuted (unstable) though there were excellent and

satisfactory results there were collapse/loss of reduction and angulation were seen<sup>[7]</sup>.

### Conclusion

Based on our study, we conclude that Titanium Elastic Nailing System is an ideal method for treatment of paediatric femoral fractures. It gives elastic mobility promoting rapid union at fracture site and stability which is ideal for early mobilization with lower complication rate, good outcome when compared with other methods of treatment.

It is a simple, easy, rapid, reliable and effective method for management of paediatric femoral fractures between the age of 5 to 15 years, with shorter operative time, minimally invasive, lesser blood loss, lesser radiation exposure, shorter hospital stay, and reasonable time to bone healing.

Because of early weight bearing, rapid healing and minimal disturbance of bone growth, intramedullary fixation by TENS may be considered to be a physiological method of treatment. Stable pediatric femoral diaphyseal fractures have very good results with minimal complications. Unstable pediatric femoral diaphyseal fractures though had good results in most cases but had angular deformities in 3 cases and 1 case with limb shortening.

According to our study it is better to use other operative technique for severely unstable paediatric femoral diaphyseal fractures.

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**Consent:** was taken from the institutional ethical committee.

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