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Dr. Sanjeev Chincholi
Associate Professor, Dept. of Orthopedics, Gulbarga institute of Medical Sciences, Kalburgi, Karnataka, India

Correspondence
Dr. Sanjeev Chincholi
Associate Professor, Dept. of Orthopedics, Gulbarga institute of Medical Sciences, Kalburgi, Karnataka, India

Management of paediatric femoral shaft fractures with titanium elastic nails

Dr. Sanjeev Chincholi

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Abstract
Femoral shaft fractures are the most common major paediatric injuries managed by the orthopaedic surgeon. Management is influenced by associated injuries or multiple trauma, fractures, personality, age and cost. Non-surgical management usually with early spica cast application is preferred in younger children. Surgery is common for the school age child and for patients with high energy trauma. In the older child, traction followed by casting, external fixation, flexible IM nails and plate fixation have specific indications. Potential complications of treatment include shortening, angular or rotational deformity, delayed union, non-union, overgrowth, infection, skin problems and scarring. Risks of surgical management includes refracture after external fixator or plate removal, osteonecrosis after rigid IM nail fixation and soft tissue irrigation caused by ends of flexible nails.

Keywords: Paediatric femoral shaft fractures, titanium elastic nail (TEN), flexible nails

1. Introduction
Femoral shaft fracture along with subtrochanteric and supracondylar fractures represents about 1.6 % of all bony injuries in children. It is one of the common major paediatric orthopaedic injury treated by orthopaedic surgeons.
During the past few decades some forms of internal fixation in the form of plate fixation, Rigid IM nailing, Enders nailing, Titanium nailing have been advocated but the controversy regarding the ideal implant still exists. The ideal device to treat would be a simple, load sharing internal splint that allows mobilization and maintenance of alignment and extremity length until bridging calls forms. TENS offers these features though is a good treatment option, it is not free of complications.

2. Materials
A retrospective study was conducted in Ashwini Hospital Kalaburagi over a period of two years from may 2010 to Apr 2012 on 30 patients with closed shaft temur fractures in the age group of 07-14 yrs of either sex. The inclusion criteria also included those without any other fracture to either lower limb and whose fixation was done within 5 days of injury. The surgical indications were cases with closed or grade I and grade II open fractures. Polytrauma patients were also included in the study. The excision criteria were children < 7years and > 14 Years of age, femoral metaphyseal fractures, open grade III femoral diaphyseal fractures, undertaking neuro musllar disorder, pathological and metabolic bone disorder fractures. TENS with standard length of 440mm and children ranging from 2.00 mm to 4.00 mm were used. To determine the size of the nails femoral diaphyseal internal diameter was measured on both Antero posterior and lateral roentgenograms and was dinded by 2 and 0.5 mm is subtracted for the eventual nail diameter as determined by

Kasser and Beaty: Nail Size : $\left[\frac{\text{Internal diameter}}{2}\right]$**-0.5mm**

Fractures were reduced using fluoroscopic guidance. A 1cm-2cm long technical incision was made over the lateral surface of distal femur, starting 2cm proximal to the distal femoral epiphyseal plate. After soft tissue dissection, distal femoral metaphysis was exposed and opened using an AWL at a point 2.5cm proximal to distal femoral epiphysis. The nail diameter was determined pre-operatively.

Two nails of similar diameter in a symmetrical construct alignment, face to face with the maximum curvature of the fracture site were used. The nails were put in a double 'C' construct to ensure a three point fixation, so that early mobilization could be done with toe touching once the fractures site was reduced, both the nails were inserted by medial and lateral incisions in a retrograde manner and pushed into the proximal fragment. The two nails were then driven into the proximal end of the femur one just distal to the trochanteric physis and the other at the same level pointing towards the cal care region of the femoral neck. Distally the nail was cut so that 1cm of nail remained outside the cortex. Too much bending was avoided to prevent the formation of painful bursa over nail ends. All this was line firmed under images intensifier guidance. Postoperatively, the patients were placed in the supine position with elenation of the operated limb over a pillow. Partial weight bearing was started three weeks and full weight bearing by six to eight weeks depending on the fractures configuration and callus formation. The final criteria were evaluator using the criteria of Flynn etc.

Table 1: Frequency of side of injury

Side	Frequency	Percentage
Right	24	80
Left	6	20
Total	30	100

Table 2: Sex Distribution

Sex	Frequency	Percentage
Male	15	50
Female	15	50
Total	30	100

Table 3: Mechanism of injury

Mechanism	Frequency	Percentage
h/o fall	12	40
h/o RTA	18	60
Total	30	100

Table 4: Type of open fracture

Type	Frequency	Percentage
Grade-I	03	60
Grade-II	02	40
Total	05	100

4. Results

Thirty patients of paediatric femur fractures in the age group of 07-14 yers with TENS was evaluated. The median duration of surgery was 75min (60-min-110min), The mean hospital stay was 9 days (7-20 days) All 30 patients were available for evaluation after a period of 24 months follow up. Radiological union was achieved in all cases in a meantime of 8 weeks (6week -12 weeks). Full weight bearing was achieved in a meantime of 8 weeks (6 weeks -12 weeks) the results were excellent in 21 patient (70%) successful in 6 (20%) and poor in 3 patient (10%) as per the scoring criteria for TEN by Flynn *et al*. Two patients had varus angulation (10^0 and 5^0 each) where as one had valgus angulation (16^0). Entry site irritation occurred in 4 patients limb lengthening (<1.5cm) was found in 3 cases both clinically and radiologically, which was clinically insignificant nail removal at 5^{th} month, due to wound breakdown at entry sets in one case.

Results were better for children in less than 10yers of age. Functional range of movement was achieved in an average of 8 weeks (6weeks – 30 weeks).

Table 5: Clinical Results

Clinical results	No of cases	Percentage
Excellent	21	70
Successful	06	20
Poor	03	10
Total	30	100

5. Discussion

Paediatric femoral shaft fracture constitute about 2% of all paediatric fracture about 2% of all paediatric fractures. The operative approach has been gaining popularity in the last two decades. Plate osteosynthesis is still widely used along with external fixators, IM knails and IM interlocking nails and cannot be used in our selected age group of patients.

TEN seems advantageous over other surgical methods particularly in this age group because it is simple, is a load sharing internal splint that doesn't violate open physis, allows early mobilization and maintains alignment micromotion at the fracture site conformed by the elasticity of the fixation promotes faster external bridging callus formation. The periosteum is not disturbed and being a closed procedure, these is no disturbance of fracture haematoma there by use risk of infection. Flynn *et al* found TEN advantages over hip spica in children similarly narayanan etal found good outcome in 79 femoral fractures stabilized with TEN.

There is no comparative study regarding the efficacy of ender nail, Rush nail or TEN all the nails give good results. Ender nail and rush nail have poor rotational stability and require multiple nails to achieve good fixation. And ender nail is not elastic and flexible enough for paediatric fractures as stated by ligier.

Fractures geometry and the location is an important determinant for selection of surgical implant. Transverse, short oblique and minimally communicated fractures for suitable for TEN as started by Flymetal. Narayanana *et al* started that transverse, short obliqe and short spiral fractures with minimum comminution in 6 year-12 years. Age were the best indications for TEN. Lascombes *et al* started that TEN could be indicated in all femoral diaphyseal fractures of children above 6 years of age till epiphysis closed except serve type III open fractures. TEN does not provide adequate stability in comminuted long oblique or long spiral fractures. Even if it is done, post op immobilization is necessary.

The most common complication of TEN is Entry site irritation and pain. Other complications include limb length discrepancy, angulation of fracture and inflation entry site irritation was seen in 4 cases in our series. We found that the entry site irritation was significantly associated with long and prominent nail end (72cm) similarly, smaller and mismatch nail diameter were associated with increased incidence of varus/valgus angulations.

6. Conclusion

The titanium elastic nail (TEN) is an effective and acceptable form of treatment in selected cases of femoral diaphyseal fractures.

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