

A prospective study of functional outcome of treatment of fracture shaft femur in children using titanium elastic nails system

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Abstract

Introduction: Femoral shaft fractures are common fractures in paediatric age group. Males are affected more commonly than females, they represent 1.6% of all bony injuries in children. In children, fractures of the femoral shaft have been traditionally treated mostly by conservatively immobilization in a Spica cast, either immediately or after a period of traction. But this safe form of treatment has two major drawbacks. First prolonged bed rest separates the child from his normal environment; and the second the cost of such periods in hospital stay is more and the use of beds which might serve other needy patients. **Materials and Methods:** This is a prospective study carried out to evaluate the outcome, time taken for union of fracture and complication with use of TENS. Thirty consecutive patients of fracture shaft femur in children between 6-16 years admitted in Department of Orthopaedics, Maharaja Institute of Medical Sciences, Nellimarla, Vizianagaram were considered for the study. All patients were taken up surgery within seven days of their injury. Informed consent was taken from all patients. Patient selected on basis according to inclusion and exclusion criteria as under. **Results:** Age of patients was between 7 to 15 years with mean of 11.3 years. Male patients were double the number of females. Right femur was more frequently involve and pattern of fracture was predominantly transverse 60 %. Mean hospital stay was 6.47 days with a range of 5-7 days. Time between injury and operation was between 5 to 7 days and mean of 7.73 days. In all patient active and passive movement was possible 3 weeks. Partial weight bearing was started after 3 weeks and full weight bearing was possible after union in maximum of 10 weeks' time. Bridging callus at least three cortices was first noted on follow-up radiograph at an average of 3 weeks at which time partial weight bearing was started. Majority of the patients (25) achieved union by 6 weeks with average time to union being after 10 weeks and at this time full weight bearing was started. **Conclusion:** Titanium elastic nails are a relatively easy to use, minimally invasive, physal-protective implant system with high rate of good and excellent outcomes in children aged 6-16 years. Technical pitfalls can be eliminated by adhering to the basic principles.

Keywords: Femoral shaft fractures, Titanium elastic nails, immobilization.

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Introduction

Femoral shaft fractures are common fractures in paediatric age group. Males are affected more commonly than females, they represent 1.6% of all bony injuries in children. In children, fractures of the femoral shaft have been traditionally treated mostly by conservatively immobilization in a Spica cast, either immediately or after a period of traction[1]. But this safe form of treatment has two major drawbacks. First prolonged bed rest separates the child from his normal environment; and the second the cost of such periods in hospital stay is more and the use of beds which might serve other needy patients[2]. Time and experience of many clinicians have shown that children with diaphyseal femur fracture do not always recover with conservative treatment. Angulations, malrotation and shortening are not always corrected effectively. The management of paediatric femoral shaft fractures gradually has evolved towards a more operative approach in the past decade. More recently, there has been a growing trend towards surgical treatment with widening of the indications to include isolated femoral fractures. The methods have included external fixation, compression plating and intramedullary nailing with either rigid or flexible nails[3]. Elastic stable intramedullary nailing (ESIN) or Titanium elastic nailing system (TENS) is a recent technique which allows stable reduction, maintenance of reduction and early mobilization. It aims to develop

early bridging callus and contributes to rapid restoration of bone continuity. Titanium elastic nail is advantageous over other surgical methods particularly in 5-14 years age group because it is a simple, is a load sharing internal splint that doesn't violate open physis, allows early mobilization and maintains alignment[4]. Titanium elastic nailing system (TENS) works on the basic principle of three-point fixation-providing flexible, axial, translational and rotational stability. Micro-motion conferred by the elasticity of the fixation promotes faster external bridging callus formation. The periosteum is not disturbed and being a closed procedure there is no disturbance of fracture hematoma, there by less risk of infection[5]. Also, minimally invasive and early implant removal as compared to plates. It is necessary to evaluate the efficacy and safety of titanium elastic nails fixation in paediatric long bones fractures of lower limbs.⁶ We wanted to study the functional outcome following the use of TENS (titanium elastic nailing system) for fracture shaft of femur in children. We also wanted to study the duration of union and complications of fracture shaft femoral after treatment with TENS.

Materials and methods

This is a prospective study carried out to evaluate the outcome, time taken for union of fracture and complication with use of TENS. Thirty consecutive patients of fracture shaft femur in children between 6-16 years admitted in Department of Orthopaedics, Maharaja Institute of Medical Sciences, Nellimarla, Vizianagaram were considered for the study. All patients were taken up surgery within seven days of their injury. Informed consent was taken from all patients. Patient selected on basis according to inclusion and exclusion criteria as under.

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Inclusion Criteria

- Simple/closed fracture shaft of femur.
- Age 6 to 16 years.
- Both male and female.
- Patient willing for operative procedure.

Exclusion criteria:

- Age below 6 years to above 16 years
- Compound fracture
- Pathological fracture
- Fracture near metaphysis.
- Other associated fracture.

These nails are pre-curved to an angle of 30-45 degrees. The apex of the curvature of the nails should be at the level of the fracture site to ensure a good equilibrium of reduction and stabilization forces. Nails were prepared by bending them at 45 degrees about 2 cm from proximal end to facilitate its entry into the medullary canal and also to allow the nail to bounce off the opposite cortex at the time of insertion. Under general anaesthesia, the patient was placed on a fracture table in supine position with or without traction boots depending upon whether reduction could be accomplished with manual traction or not. Image intensifier was positioned on the contralateral side of the affected femur. The set up allowed the surgeon to access both medial and lateral aspects of the distal femur. Fracture was reduced and alignment confirmed under C ARM image intensifier in both AP and lateral views an incision was made on the lateral side of thigh 2.5 cm above the distal physis and extending proximally for 1-2 cms. Drill bit size higher than the selected diameter, nail along with drill sleeve (to protect soft tissues) was used to make cortical hole. Drill bit was kept perpendicular to bone for penetration. A curved bone awl, at angle of 45 degree to the cortex was used to enlarge the hole. Both the nails of the selected size were inserted through entry points one after the other. Under image intensifier control, each nail was driven with a T-handle by rotatory movement up to the fracture site. By rotation movements of the T-handle with or without limb manipulation, the nail was advanced about 2 cm into the proximal fragment with convexity of nail glancing off from the opposite cortex. At the same time the second nail was similarly advanced to enter the proximal fragment

and in the meantime any traction was released to avoid any distraction. The 1st nail was not advanced so far till the other nail crossed the fracture site. Any deformity was corrected by altering the position of the nails. The two-nail construct was kept in a symmetrical alignment face to face with the maximum curvature of the nails at the level of the fracture. In cases which required open reduction, a 3-5 cm incision was used at the fracture site on lateral aspect for manipulation of the fracture alignment. Distally the nails were cut leaving only 1-2 cm outside the cortex. The extra osseous portion of the nails was slightly bent away from the bone to facilitate removal later on. In all cases same diameter nails were used with aim to make 3-point stable fixation. Wound was closed in layers and aseptic dressing was done.

Results

Age of patients was between 7 to 15 years with mean of 11.3 years. Male patients were double the number of females. Right femur was more frequently involve and pattern of fracture was predominantly transverse 60 %. Mean hospital stay was 6.47 days with a range of 5-7 days. Time between injury and operation was between 5 to 7 days and mean of 7.73 days. In all patient active and passive movement was possible 3 weeks. Partial weight bearing was started after 3 weeks and full weight bearing was possible after union in maximum of 10 weeks' time. Bridging callus at least three cortices was first noted on follow-up radiograph at an average of 3 weeks at which time partial weight bearing was started. Majority of the patients (25) achieved union by 6 weeks with average time to union being after 10 weeks and at this time full weight bearing was started.

Majority of the patients (20) achieved full range of knee motion up to 12 weeks. Three cases had terminal restriction of knee flexion (20°-30°), which improved after nail removal. Results were evaluated using Flynn's criteria and was seen excellent in 28 (93.33%) cases, while it was satisfactory in 02 (6.66%) cases. No patient had poor result. The results were excellent in 60% of the transverse fractures followed by 36.66% of the oblique fractures and 3.34 % of the spiral fractures. Two case was soft tissue irritation other complication limb length discrepancy in 3 cases is not significant and is excellent category as per Flynn criteria. Angulation was seen in only 8 cases and no one had more than 10 degrees of angulation.

Table 1: Distribution of Time Taken for Union

Time to union (weeks)	No of cases	Percentage
7 weeks	8	26.7%
8 weeks	17	56.7%
9 weeks	4	13.3%
10 weeks	1	3.3%
Total	30	100%

Table 2: Distribution of Time Taken for Full Weight Bearing

Follow Up (Weeks)	No of cases	Percentage
20 weeks	5	16.7%
22 weeks	2	6.7%
24 weeks	23	76.7%
Total	30	100%

Table 3. Distribution of Study Participants According to Radiological Malalignment

Radiological Malalignment	No of cases	Percentage
0	22	73.3%
10 Saggital	3	10%
15 Saggital	1	3.3%
5 Coronal	4	13.3%
Total	30	100%

Discussion

Until recently, skeletal traction and application of a Plaster of Paris cast are the preferred method for treatment of diaphyseal femoral

fractures in children and young adolescents[8]. However, orthopedics have tried a variety of methods to avoid prolonged immobilization and provide better nursing care[7]. Recent studies have also

increased our awareness of the psychosocial and economic effects of Spica cast immobilization on children and their families. In recent years, perhaps the best results have been achieved by flexible intramedullary nailing. Titanium elastic nail with its newer design and better material seems advantageous over other surgical methods particularly in this age group because it is a load sharing internal splint that does not violate physes, allows early mobilization and maintains alignment[8].

Hospitalization Stay

In our study average hospitalization time was 6.47 days. This is significantly less than average of 28 days reported by Herndon et al showed that the hospital stay in the nonsurgical group averaged 28 days. This was much higher than reported in the study by Ann Ho et al (5.3 days) and Heybeli et al (5.5 days). However, the results were similar to other studies conducted in Indian setup by Saikia et al (9.8 days) and in the surgical group averaged 17 days, which was significant. Flynn et al reported that compared with children treated with traction and cast, those treated with titanium elastic nails had shorter hospitalization, walked early[9].

Union

In the present study, bridging callus was first noted on follow-up radiographs at an average of 4.53 weeks. This is similar to the study conducted by Flynn et al (4 weeks) but significantly more than 3 weeks reported by Cramer et al (3 weeks) our study averaged 7.73 weeks. It was only then the patients were started on full weight bearing. As reported by Flynn et al, Cramer et al Mann et al and Galpin et al, in our study too there was no case of delayed and nonunion

Full Range of Motion

In our study, majority of the patients achieved full range of knee motion by 3 weeks. The patients were typically taught a home exercise program including a range of motion exercises, hip abductor and knee extensor strengthening exercises during the perioperative period. Similar findings were noted in the study conducted by Bar-On et al and Cramer et al. In our study on functional outcome and complications of treatment of fracture shaft femur with Titanium Elastic Nailing System, youngest patient was 7 yr. old & the oldest was 15 yr. old with a mean age of 11.3 yrs. Male: female ratio was (2:1). Most common mode of injury was roadside accident followed by fall from height or while playing and due to slipping. Most common pattern of fracture was transverse. Most common side involved was right. Most of the patients were operated within week time after injury and 2 days after admission and required hospitalization for 5-7 days with mean 6.47 days. Joint movement started on 2nd post-operative were possible to full extent at 3 week time and were painless. All patient started partial weight bearing after 3 weeks and full weight bearing after 10 weeks. Angulation of 5°-10° was seen in 4 patients was not clinically significance same was true about LLD which was between 5-10 mm, shortening. There was no deep infection, superficial infection in few patients resolved without any intervention. There was no disturbance in physal growth or vascularity of head of femur.

Complication

In our study LLD (shortening) of 5 mm in 2 cases and 10 mm in one case was not clinically significantly an is in excellent category as per Flynn criteria. Malalignment was seen in patients in our study and no

patient had more than 10 degrees of angulation. In the remaining 3 cases, apex of the curvature was not at the fracture site resulting in malalignment. Herndon et al reported malunion in of 24 patients treated with traction no malunion was observed in 21 children treated using TENS nailing. Intraoperative difficulties encountered in our study were failure of closed reduction seen in 5 cases mainly because they were operated late (after one week of injury) and soft tissue interposition seen in one case.

Conclusion

In children between 6years and 16 years of age, Titanium Elastic Nailing System is a good alternate method of treatment: It offers the following advantages over conservative treatment-

- Early joint mobilization.
- Less period of hospitalization and bed restriction.
- Early weight bearing both partial and complete.
- Insignificant LLD and angulation deformity or bone infection.

There is added advantage of better patient and attendant satisfaction, due to psychological, social, educational and economic factors. There is no or very little risk of physal growth disturbance or avascular necrosis head of femur.

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