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A Study of Functional Outcomes by Using Titanium Elastic Nails System for the Treatment of Femur Shaft Fractures in Children

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Abstract

Background *Fractures of the femur are the most incapacitating fractures. For children aged 6-16 years, there is no clear consensus as to the preferred treatment. The conventional treatment of traction and casting is no longer preferred. We report our experience in titanium elastic nailing for the treatment of pediatric femoral diaphyseal fractures. Objectives: To study the functional outcome following the use of flexible titanium nails for femoral shaft fractures in children and to study the duration of the union in the above-mentioned fractures. To study the complications of fracture shaft femoral after intramedullary nailing.* ***Methods*** *Thirty patients in the age group of 6-16 years with displaced diaphyseal femoral fractures were stabilized with titanium elastic nails Patients were followed up clinically and radiologically for a minimum period of 6 months to 1 year. The final results were evaluated using Flynn's criteria. Technical difficulties and complications associated with the procedure were also analyzed.* ***Results:*** *Overall results were excellent in 23 cases and satisfactory in 02 cases. No patient had a poor result. The average hospital stay was 6.47 days. All the fractures healed in 70 days (10 weeks) of times with an average time of union of 60 days (7.5 weeks). The most common complication encountered was soft tissue irritation at the nail entry site seen in 2 cases. Clinically, shortening was noticed in 3 cases, while no patient had lengthened. Malalignment was seen in only 6 cases. There was no iatrogenic bone injury, delayed injury and non-union, bending or breaking of implant, refracture and avascular necrosis of femoral head. There was no evidence of physeal injury on follow up.* ***Conclusions:*** *Titanium elastic nails are relatively easy to use, minimally invasive, physeal-protective implant system with a 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*: Titanium, Nails, Fractures, Bone, Femur, Pediatrics*

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Introduction

Femur fractures are the most crippling fractures in children. The frequency is 1.6% of all bony fractures in children [1]. Fractures of the femoral shaft in children have been traditionally treated by immobilization in a Spica cast, either immediately or after a period of traction. Surgical management is reserved for open fracture or patient with head injury or multiple injuries [2]. Conservatively treated cases required prolong stay in the hospital for traction and subsequent immobilization in an uncomfortable cast. This treatment is not well tolerated especially in adolescence [3]. In adolescent patients because of the end of growth accurate reduction is required as malunion is no longer correctable by bony maturation [4]. There is a difference of opinion regarding the treatment of

femur shaft fractures in children less than 6 years and adults of more than 16 years of age. For children, aged between 6 – 16 years several surgical and nonsurgical treatment approaches are available without any clear consensus regarding the preferred method of treatment [5]. A recent survey of the pediatric orthopedic society of North America shows that surgery is the preferred method for older children with high energy injuries [6,7]. Operative management includes the use of flexible and locked intramedullary nails, external fixators and compression and bridge plating [8]. The disadvantage of plate osteosynthesis is large exposure and relatively longer immobilization and delayed union and infection with a large dissection during plate removal [8]. External fixators provide good stability and early mobility however they are also associated with risks of pin tract infections and take a longer time for weight-bearing [8]. The titanium elastic nail system has advantages over the other surgical methods because it is relatively simple, and the load-sharing internal splint and does not violate open physis allows early mobilization and maintain alignment. The elasticity of nails provides micromotion and promotes faster external bridging callus formation. The periosteum is not disturbed and since it is a closed procedure there is no disturbance of fracture hematoma [9]. Therefore, with relatively sparse data available in our study group we in the present study tried to evaluate the outcomes of treatment of fractures of the femur with titanium elastic nail system in a group of patients of 6-16 years presenting with femoral shaft fractures in an orthopedic emergency in our tertiary care hospital.

Materials and Methods

The present study was conducted in the Department of Orthopedics, Prathima Institute of Medical Sciences, Naganoor, Karimnagar. Institutional Ethical committee permission was obtained for the study.

Inclusion Criteria

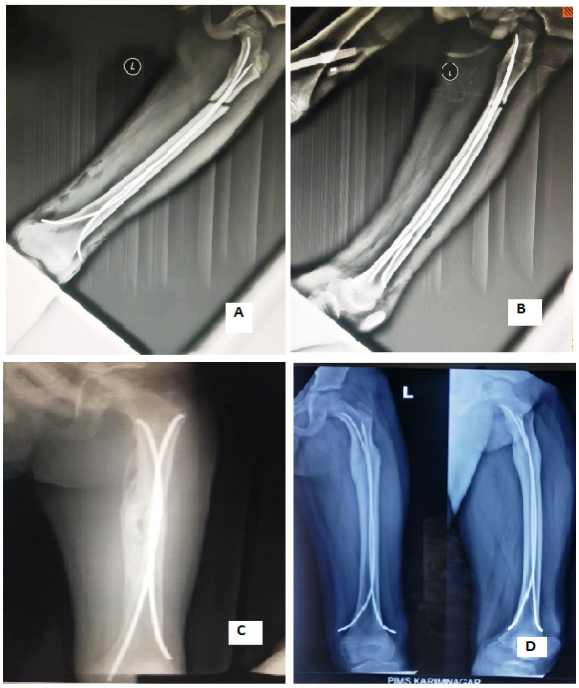
1. Simple/closed fracture shaft of the femur.
2. Age 6 to 16 years.
3. Both male and female.

Exclusion criteria

1. Age below 6 years to above 16 years
2. Compound fracture
3. Pathological fracture
4. Fracture near metaphysis.
5. Other associated fractures

All the procedures were performed in General Anesthesia the patient was placed on a fracture table in the supine position with or without traction boots depending upon whether reduction could be accomplished with manual traction or not. Standard nails pre-curved at an angle of 30 – 40 degrees were selected. The apex of the curvature of nails is kept at the level of fracture site to establish a good equilibrium of reduction and stabilization forces. The nails were prepared by bending them at an angle of 45 degrees at a distance of 2 cm from the proximal end to facilitate its entry into the medullary canal and it also helps the nail to avoid the opposite cortex at the time of insertion. The image intensifier was positioned on the opposite side of the affected femur. The set up allowed the surgeon to access both medial and lateral aspects of the distal femur. The reduction of fracture of was done and confirmed by C ARM intensifier in 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 a cortical hole. The drill bit was kept perpendicular to the bone for penetration. The cortical hole was enlarged by using a curved bone awl at an angle of 45 degrees. The two nails of selected were inserted through entry points one after the other. Image intensifier was used when each nail was driven using T-handle by rotatory movements up to the fracture site. The nail was advanced up to 2cm into the proximal fragment with the convexity of the nail glancing off from the opposite cortex. The second nail was also similarly advanced to enter the proximal fragment and traction was released to avoid distraction. Care was taken not to advance the first nail far till the other nail has crossed the fracture site. Any deformity was corrected by altering the position of nails. The two nails were kept in symmetrical alignment face to face with maximum curvature of nails at the level of the fracture. In cases where the open reduction was required a 3-5 cm incision was done at the fracture site on the

lateral aspect for management of fracture alignment. Distally nails were cut leaving only 1-2cm outside the cortex. The extra-osseous portion of nails was slightly bent away from the bone to facilitate removal later on. In all cases, the same diameter nails were used to make 3-point stable fixation. The wound was closed in layers and the aseptic dressing was done. Patients were started with quadriceps and knee bending exercises on the 2nd post-operative day. All patients started partial weight-bearing after 3 weeks and full weight-bearing after 10 weeks. After discharge, the patients were followed for every week to two months and then at monthly intervals for a period of 6 months. The available data were recorded in the MS Excel spreadsheet and analyzed using SPSS version 17 on windows format.



A & B : Immediate Post operative images; C: 3 months post operative D: 6 months post operative showing good solid union in progression with complete union.

Results

Table 1: Demographic profile of patients

Age Years	Male	Female	Total	%
6–8	2	0	2	8
9–10	4	1	5	20
11–12	3	6	9	36
13–15	7	2	9	36
Total	16	9	25	100

The Age of patients was ranged between 7 to 15 years with a mean age was 11.3 years. The males were n=16 and females were n=9. The male to female ratio was 2:1 approximately.

Graph 1: Distribution pattern of fractures

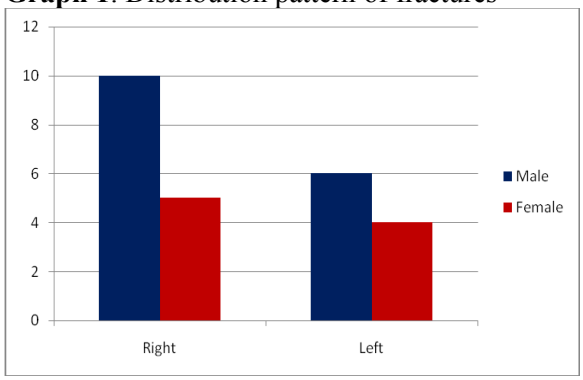


Table 2: Type of fractures of the femur shaft

Type of fractures	Male	Female	Total (%)
Simple Spiral Fractures	2	1	3(12%)
Simple Oblique Fractures	4	3	7(28%)
Simple Transverse Fractures	10	5	15(60%)

The right femur was more frequently involve and the pattern of fracture was predominantly transverse 60%. Mean hospital stay was 6.47 days with a range of 5-7 days. The time between injury and operation was between 5 to 7 days and a mean of 7.73 days. In all patients, the active and passive movement was possible for 3 weeks. Partial weight-bearing was started after 3 weeks and full weight-bearing was possible after union in a maximum of 10 weeks. 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. The majority of the patients n=22 achieved union by 6 weeks with an average time to the union being after 10 weeks and at this time full weight-bearing was started.

The time of union according to weight bearing was found to be 24 weeks in n=19(76%) and 22 weeks in n=2(8%) and 20 weeks in n=4(16%). The majority of the patients (20) achieved a full range of knee motion for up to 12 weeks. Three cases had a terminal restriction of knee flexion (20°-30°), which improved after nail removal. Results were evaluated using Flynn's 8 criteria and were seen excellent in 23 (92.0%) cases, while it was satisfactory in 02 (8.0%) cases. No

patient had poor results. 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 cases were soft tissue irritation other complication limb length discrepancy in 3 cases is not significant and is an excellent category as per Flynn criteria. Angulation was seen in only 8 cases and no one had more than 10 degrees of angle. Radiological outcomes showed no malalignment in n=19(76%) cases, 10 degree of sagittal angulation in n=2(8%) and 15% sagittal angle in n=1(4%) and 5-degree coronal angle in n=4(12%) of cases.

Discussion

Until recently, skeletal traction and application of a Plaster of Paris cast are the preferred methods for the treatment of diaphyseal femoral fractures in children and young adolescents [9]. However, orthopedicians have tried a variety of methods to avoid prolonged immobilization and provide better nursing care. Recent studies have also increased our awareness of the psychosocial and economic effects of spica cast immobilization on children and their families [10,11]. 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. In our study average hospitalization time was 6.47 days. This is significantly less than an average of 28 days reported by Herndon et al; [12] 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; [13] (5.3 days) and Heybeli M et al;[14] (5.5 days). However, the results were similar to other studies conducted in Indian setup by Saikia et al; [15] (9.8 days) and in the surgical group averaged 17 days, which was significant. Flynn et al; [16] reported that compared with children treated with traction and cast, those treated with titanium elastic nails had shorter hospitalization, walked early. 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; [16] (4 weeks) but significantly more than 3 weeks reported by Cramer et al; [17] (3 weeks) of our study averaged 7.73 weeks. It was only then the patients were started on full weight-bearing. As reported by Flynn et al;[9] Cramer et al; [17] Mann et al; [18] in our study to there was no case of delayed and nonunion. In our study, the majority of the patients achieved a 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; [2] and Cramer et al; [17]. In our study LLD (shortening) of 5 mm in 2 cases and 10 mm in one case was not clinically significantly an is in the 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, the apex of the curvature was not at the fracture site resulting in malalignment. Herndon et al; [12] reported malunion in 7 of 24 patients treated with traction no malunion was observed in n=21 children treated using TENS nailing. Intraoperative difficulties encountered in our study were the failure of closed reduction seen in n=5 cases mainly because they were operated late (after one week of injury) and soft tissue interposition has seen in one case.

Conclusion

The present study concluded that children between 6-16 years of age with fracture of shaft of femur the use of Titanium Elastic Nailing System is a good alternative method of treatment. 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 physeal growth disturbance or avascular necrosis head of the femur as seen with rigid nailing.

Conflict of Interest: *None declared*
Source of Support: *Nil*
Ethical Permission: *Obtained*

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