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## A study of titanium elastic nailing system in paediatric femur fractures

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### Abstract

**Aim:** To analyse impact of Titanium Elastic Nailing System in Paediatric Femur Fractures.

**Material and Methods:** In this study, 35 cases of femoral fractures were studied, in the Department of Orthopaedic at Pad. Dr. D. Y. Patil Hospital Nerul, Navi Mumbai, from June '011 to April 2013. The age of the patient ranged from 5 years to 15 years. The method used for fracture fixation was closed reduction & internal fixation using Titanium Elastic Nailing System. Femur was the involved bone under study. The duration of follow up was up to one & half years.

**Results:** Most patients i.e., 85% (28) had complete union of fracture in about 6 weeks, about 10% on 8 weeks and remaining in as early as weeks. Period of full weight bearing: was an average of 6 weeks (seen after complete clinical and radiological union ensured). Only one type of complication i.e. infection at entry point was seen in 5% patients over a period of 1.5 year follow-up.

**Conclusion:** Titanium elastic nailing system allows rapid mobilization of children with little risk of physical injury or refractures. Titanium elastic nailing fixation can be thought as an internal splint that not only maintains length and alignment but also permits sufficient motion at the fracture site to generate excellent callus formation.

**Keywords:** titanium elastic nailing system, paediatric femur fractures

### Introduction

Traumatic injuries are very common in young children, and almost one-third of children suffer from a fracture before the age of seventeen <sup>[1]</sup>. Since femur is relatively weak and breaks under even the slightest pressure, paediatric Femur fracture is one of the most common injury requiring hospitalization <sup>[2]</sup>. Although challenging, however, are often associated with good outcomes <sup>[3]</sup>. Regardless of the type of fracture, location or treatment the fragments unite rapidly. However, poor outcomes like mal-union, deformities, non-union, vessel nerve traction etc are also seen in some cases. Treatment modalities for femur fracture date back to almost 480 BC by traditional reduction technique given by Hippocrates. A variety of techniques have developed since then, including spica casting, with or without traction; external fixation, flexible or rigid medullary nailing and plate fixation. Traditionally the fractures of shaft of femur in children were treated conservatively by traction <sup>[3,4]</sup>, immobilization in Hip spica cast <sup>[4-5]</sup>. In past Indications for surgical management were few & included children with associated injuries like head injury, abdominal injury, compound fracture with extensive soft tissue trauma. Conservative management with spica cast was associated with complications such as limb length discrepancy, torsional & angular deformities <sup>[7]</sup> also there were psychosocial problems associated with spica cast like separation of child from his environment & difficulty in taking care of child in spica cast <sup>[8,9]</sup> especially when both the parents are working. Because of the above complications surgical management has been a preferred modality for treating paediatric femoral shaft fractures <sup>[10,11]</sup>. The surgical treatment is reduction and fixation either with flexible nails, rigid intramedullary nails or plates. This study attempts to assess the treatment of fracture shaft of femur in children aged between 5 to 15 years treated using multiple flexible titanium elastic nails.

**Aim and objectives**

To study the morphology of diphyseal fracture of femur in paediatric age group.

1. To assess the outcomes of treatment of these fractures using titanium elastic nail fixation
2. To study complications of titanium elastic nailing
3. To set guidelines for management of these fracture in pediatric age group

**Material and Methods**

In this study, 35 cases of femoral fractures were studied, in the Department of Orthopaedic at Pad .Dr .D.Y .Patil Hospital Nerul, Navi Mumbai, from June '011 to April 2013.

**Participants****Inclusion criteria**

The age of the patient ranged from 5 years to 15 years.

**Exclusion criteria**

Patients to be treated conservatively were not included in the study

The method used for fracture fixation was closed reduction & internal fixation using Titanium Elastic Nailing System. Femur was the involved bone under study

The duration of follow up was up to one & half years.

The Following protocol was used for the management of these cases:

**A. Reception**

1. Administration of first aid on reception of the patient in casualty department.
2. Thorough examination of the patient to rule out head /chest/pelvic/spinal/abdomen injury.
3. Musculoskeletal examination to rule out associated fractures.]
4. Stabilization of the patient with IV Fluids Oxygen and blood transfusion whenever required.
5. Careful assessment of the injured limb as regards the deformity, knee instability and neurovascular status.
6. Primary immobilization of the involved limb in a Thomas' splint with a cotton pad below the distal fragment and the knee joint, the transportation of the patient to radiology department for the x-rays.
7. The patient was then admitted to the respective ward and evaluated in terms time and mode of injury, radiological assessment with anteroposterior and true lateral x-ray of the limb
8. Skin traction was applied to the injured lower limb. In few patients above knee slab was applied
9. Analgesics were administered and debridement for injuries was done at the earliest, if any.

**B. Preoperative preparation**

The patients admitted and selected for the operative method of treatment underwent the pre-op workup as per the standard protocol as follows \_

- Hemoglobin %
- BSL, BUL, SE, Sr.bilirubin.
- Blood group and Rh, typing.
- Chest x-ray and ECG.
- Medical and Surgical references, whenever indicated for operative fitness.

After anaesthetic fitness the patients were posted for surgery as early as Possible with the fulfillment of following

requirements:

1. Written and Informed consent for surgery & anaesthesia.
2. Adequate blood for transfusion was kept ready
3. Detailed pre-op planning in regards of the classification of the fractures, size of enders nail. In evaluating the radiograph, fracture lines that propagate beyond the obvious fracture was noted. The width of the canal was measured at the narrowest point in the diaphysis on both AP and lateral view and this number was divided by This represented the minimal diameter nail that could be used. Therefore if the medullary canal measured 8 mm, a 3.0-3.5 mm nail was used.
4. A greater emphasis was given on availability of complete range of Enders nail instruments, image intensifier and radiolucent table.

Procedure was explained to patient & relatives & operative consent taken and Quadriceps exercises were taught, preoperatively to the patients. Inj. Tetanus toxoid 0.5cc and Inj. Cefotaxime 500mg were administered preoperatively. Titanium Elastic Nails were used for fixation in all the 35 patients.

**Operative Procedure**

All patients were operated under general anaesthesia. The choice of procedure was closed, depending upon the fracture classification and the availability of 'C' arm image intensifier

- 1) **Patient Positioning:** We operated on all 35 patients in supine position on a radiolucent table. After the child was placed on the fracture table, the leg was prepared and draped with the thigh (Hip to knee) exposed. The image intensifier was used to localize the skin incisions by viewing the distal femur in the AP and lateral planes.
- 2) **Entry site:** both antegrade and retrograde insertions of titanium elastic nails have been described, but we chose retrograde insertion to avoid damage to the trochanteric physis entry site. Incisions were made on the medial and lateral side of the affected thigh distally. The nail insertion site was about 2-2.5 cm proximal to the distal femoral physis. A small bone awl was used to make the entry point in the bone.
- 3) **Closed technique:** Titanium nails were inserted from the medial and the lateral side and driven up to the level of the fracture. At this point the fracture was reduced using longitudinal traction. The first nail was driven across the fracture by about 2-3 cm. the second nail was driven across the fracture. The two nails then were driven into the proximal end of the femur with one driven toward the femoral neck and the other toward the greater trochanter. When placing the second nail across the fracture site and rotating it, care was taken not to wind one rod around the other. The 'C' arm image intensifier was used to confirm the reduction and position of the two Titanium Elastic Nails before they were seated in the proximal end of femur. The end of the nail was made to lie adjacent to the metaphysis and we tried to keep it at least 1 cm distal to the insertion hole, to allow ease in later removal.
- 4) **Post-operative care:** we shifted the patients to the respective wards after the recovery from anaesthesia. Post-op antibiotics were continued till day three when the first dressing was done. Patients were taught static quadriceps exercises on day one and knee flexion exercises on day five. Every patient was given a Thomas splint post-operatively for two weeks. Suture removal

was done on day fourteen. Partial weight bearing was started after suture removal. Hip spica was applied to the two patients who had a fracture of subtrochanteric region of the femur.

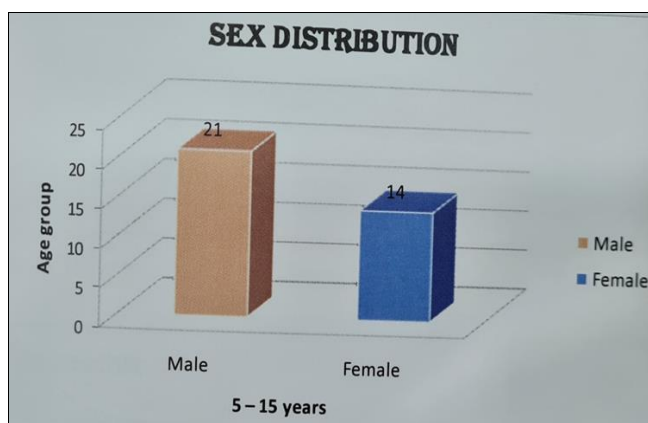
- 5) **Follow up:** Average follow-up was three months (3 to 15 months). Every patient was assessed clinically and radiologically at 4 weeks post op and every 4 weekly thereafter till 3 months. Partial weight bearing was advised only after confirming radiological bridging callus and proper gait training. Full weight bearing was allowed after sound clinical and radiological union which was generally by 8 weeks.

### The clinical data of each patient was collected

**Statistical analysis:** Data was collected and subjected to statistical analysis using SPSS software version 24.

### Results

Baseline demographics: All the participants included, belonged to the age group of 5 -15 years. The mean age was 8 years. Majority were males (60% i.e. 21) as shown in graph 1



Graph 1: Demographic data

### Classification

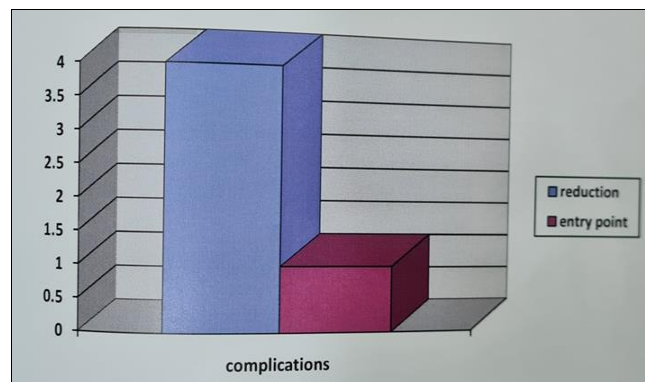
- **Cause of the injury:** Majority of the injuries i.e. 70% (25) were due to road traffic accident. 20%, due to fall from a height and the remaining, due to other reasons like fall of a heavy object or an assault.
- **Level of fracture:** 90% of the participants had a fracture at the middle third of the diaphysis. Remaining had a fracture at the upper third of the diaphysis, including one which required application of the single hip spica post-operatively.
- **Type of fracture (Radiologically):** 80% of the participants i.e. 28 out of 35 had a transverse fracture, 10% had an oblique and remaining had a comminuted fracture.
- **Presence of an associated injury:** 12% of the participants had an additional injury associated with the primary fracture. Out of these, 50% had a fracture of the forearm and remaining 50% had either fracture of the humerus or a chest trauma.

### Surgical intervention

- **Time interval between admission and surgery:** Since titanium nailing was the intervention selected for the patients, surgery was initiated only after the patient's condition was stable. Also the availability of implants, operative technique and post-operative protocol. The interval between admission and surgery ranged from 1-6

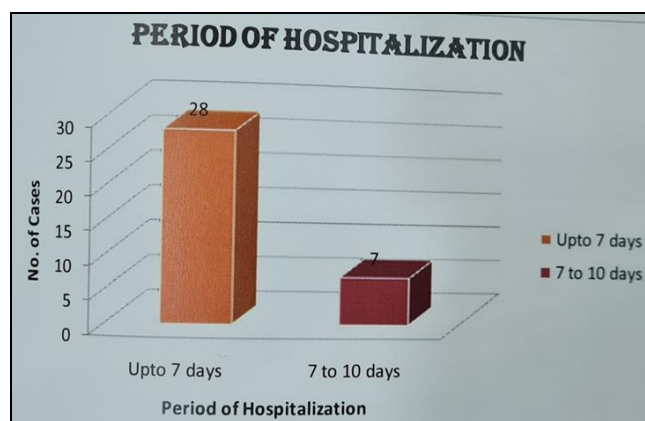
days. With all these factors taken into consideration, the interval was 1-3 days in majority of the patients i.e. 80%. The average interval was 2 days.

- **Intra-operative difficulties:** 11% participants there was difficulty in achieving closed reduction and had to be treated with open reduction. In 1 case i.e. 3% of the participants there was difficulty in making an entry point (Graph 2).



Graph 2: Intra-operative difficulties

**Total period of hospitalization:** Majority of the participants i.e. 80% were admitted for about 7 days. The remaining were admitted 7-10 days (graph 3).



Graph 3: Period of hospitalization

### Follow-up

- **Time required for complete union of fragments:** Most patients i.e., 85% (28) had complete union of fracture in about 6 weeks, about 10% on 8 weeks and remaining in as early as weeks.
- **Period of full weight bearing:** was an average of 6 weeks (seen after complete clinical and radiological union ensured).
- **Complications:** only one type of complication i.e. infection at entry point was seen in 5% patients over a period of 1.5 year follow-up.

### Discussion

Skeletal traction and application of a cast has been a preferred and a time tested technique, which is conservative and permanent complications are rare. However, complications like limb length discrepancy, angular and torsional defects are associated with this. Also psychosocial problems associated with separation of the child from environment and difficulties in taking care of a child in spica. Hence surgical management has gained popularity. However, operative treatment options

like compression plating is often associated with increased blood loss, fracture hematoma, chance of infection which requires an additional surgery. Also, external fixator application is associated with knee stiffness, angular deformities, refracture after removal or delayed union. Rigid medullary nailing can damage to the blood supply of femoral head causing its avascular necrosis or arresting growth of greater trochanter causing coxa valga, hence not advisable in children below 15 years. An ideal technique for management of femur fracture, should be a simple load sharing internal splint that allows mobilization and maintenance of alignment until callus formation. In order to exploit dense metaphyseal bone, rapid healing and ability to remodel without damaging physis or blood supply to the capital femoral epiphysis. Titanium elastic nailing offers all these benefits. Retrograde flexible nailing avoids risk of avascular necrosis that's caused by anterograde rigid nailing.

Our study attempted to use titanium elastic nailing in diaphyseal femur fractures in 5-15 year old children. Mean age was 8 years, which is in accordance with previous studies done in this age group. The average age reported in similar studies is 6-10 years. Our study showed a male preponderance, with a ratio of 3: 2, which is similar to that reported in the literature. This could be attributed to more active lifestyle of young males than females.

The predominant cause of injury in our study was road traffic accident. Similar findings have been reported by studies by Bar-On-E *et al.*, 1997 and Ligier JN *et al.*, 1988. Most of the children in our study reportedly experienced were struck by a vehicle while playing. The other mode of injury observed was due to fall from a height or falling of an object.

When classified according to the level of diaphysis fracture, majority had a fracture in the middle third. This was in accordance with the study by Erik N Kubaik, 2005. Remaining patients had fracture at the upper third of diaphysis, making fracture fixation unstable, hence requiring application of single hip spica.

Radiological classification in our study revealed majority of patients with transverse fracture and remaining with oblique or comminuted. Similar findings were reported in the study by Iyer *et al.*, 2005.

In our study, associated injuries were seen in 10% of the cases, which was fracture of both forearms and remaining cases had fracture of shaft of the humerus or chest trauma. Studies by Kubaik E *et al.*, 2005 and Iyer *et al.*, 2005; both reported forearm fracture as common associated injury. Our study did not report any injuries associated with head, abdomen or pelvis. Also associated injuries did not influence the outcome or prolong hospital stay.

Average hospital stay in our study was 2 days (1-6 days). Some cases had a prolonged stay due to late presentation to the hospital. An average stay of 3 days was reported by Bar-On E *et al.*, 1997 and Ligier *et al.*, 1988. Kuabik EN *et al.*, 2005 reported an average stay of 2.5 days and Iyer V *et al.*, 2005 reported a stay of 5 days.

Our study reported closed retrograde nailing in 90% of the cases and remaining had open reduction. Similar findings were reported by Iyer V *et al.*, 2005.

In terms of intra-operative difficulties, our study reported difficulties in achieving closed reduction in patients due to late presentation, subsequently increasing the surgery interval and had to be managed with open reduction. Iyer V *et al.*, 2005 reported similar findings. Kubaik EN *et al.*, 2005 reported problems in Ender's nail negotiation through femoral canal.

The average period of hospitalization reported in our study was about 7 days and remaining was about 7-10 days. This included the period from admission discharge. Other studies reported an average period ranging from 5- 21 days. It was also observed in our study that closed reduction reduced the period hospitalization by virtue of early mobilization and minimum surgical trauma.

Time required for clinical and radiographic union in majority of patients was about 6 weeks. Younger children i.e. 5 year old had an early union (10%), while remaining took 8 weeks for the union. Study by Iyer V *et al.*, 2005 reported an average period of 4-6 weeks, while Kubaik EN *et al.*, 2005 and Ligier JN *et al.*, 1988 reported an average period of 7 weeks. Clinical and radiological union was earlier than other studies as titanium elastic nail provided stable 3 point fixation in comparison with methods like external fixator. An important characteristic of titanium elastic nail fixation is abundant early callus formation, providing elastic fixation.

Our study reported an average period of 6 weeks for complete weight bearing, while Ligier *et al.*, 1988 and Kubaik EN *et al.*, 2005 reported 7 and 7.5 weeks respectively.

The only complication encountered in our study was infection at the site of entry, nails were removed in these cases and a hip spica was applied. Other two cases, distal end of the nail was very long and bent. Other studies reported complications like entry site bursitis, mild valgus and varus deformities. Study by Ligier *et al.* reported mean lengthening of 1.2 mm and residual angulation never exceeding 10 degrees.

## Conclusion

Orthopaedic surgeons have been motivated to consider alternatives to traction and application of spica cast to avoid the adverse physical, psychological and social consequences of prolonged immobilization of school aged child. Titanium elastic nailing system allows rapid mobilization of children with little risk of physical injury or refractures. Titanium elastic nailing fixation can be thought as an internal splint that not only maintains length and alignment but also permits sufficient motion at the fracture site to generate excellent callus formation. The elastic fixation provided by Titanium Elastic Nailing System generates abundant callus formation. Two Titanium Elastic Nails by creating a 3 point fixation provide stable fixation.

On the basis of the results of the present study, we recommend that elastic stable Titanium Elastic Nailing System may be a good choice for the treatment of femoral shaft fractures in skeletally immature patients in need of surgical stabilization.

Titanium Elastic Nailing System is a minimally invasive technique requiring a small incision, leading to good callus formation, early mobilization, full recovery of function with minimal complications.

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