



## A CASE SERIES: FEMORAL DIAPHYSEAL FRACTURES IN THE PAEDIATRIC AGE GROUP TREATED USING THE TITANIUM ELASTIC NAILING SYSTEM

### Orthopaedics

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### ABSTRACT

**Background:** The management of femoral diaphyseal fractures in the age group of 6-16 years is highly debatable. Often treated conservatively, diaphyseal femur fractures are now increasingly managed surgically.

**Materials and Methods:** Thirty-four children (29 boys, 5 girls) amid the ages of 5-16 years with femoral diaphyseal fractures, of which 6 were open and 28 were closed, were fixed using Titanium Elastic Nails (TEN). The fractures were in proximal third (n=10), middle third (n=22) and in the distal third (n=2). Thirty-two patients underwent surgery within seven days of their injuries. The result was assessed by using Flynn's scoring criteria. With the help of Fischer's exact test, statistical analysis was completed.

**Results:** All 34 patients were available for evaluation after a mean of 15 months (12-22 months) of follow-up. Radiological union was seen in a mean duration of 8.9 weeks. Complete weight bearing was possible by an average duration of 8.8 weeks. The average duration of hospital stay was 11.2 days. The results were excellent in 23 patients (67.7%), successful in 6 (17.6%) and poor in 5 patients (14.7%).

**Conclusion:** In properly screened patients, amid the age group of 6-16 years, with diaphyseal fracture of the femur, intramedullary fixation with titanium elastic nailing is quite an effective mode of treatment.

### KEYWORDS

Femur fracture, Elastic titanium nailing, Intramedullary nail

### INTRODUCTION

Diaphyseal femoral fractures account for 1.6% of all pediatric skeletal injuries. In children of 5 years and below, early closed reduction and application of one and a half spica cast is an ideal treatment for most diaphyseal fracture<sup>1</sup>. In more skeletally matured adolescents, the use of a solid antegrade intra-medullary rod has become the gold of standard treatment. However, the best management for patients amid five to sixteen years of age is still debatable. Compared to the younger patients, patients in the intermediate age group have greater risks of mal-uniting and shortening when conservative measures are used<sup>2</sup>. Due to prolonged immobilization, children managed conservatively have to undergo several physical, social and psychological consequences. Different modalities including external fixators, plate and screw fixation and use of antegrade solid intramedullary nails are available. However, the risks of some complications, in particular, pin tract infections and re-fractures after using external fixators or osteonecrosis associated with solid nails, have decreased their frequent use. In the past decades, fixation using a flexible intramedullary nail has become a popular technique for stabilizing femoral shaft fractures in school going children. TENS fixation system is a simple, yet effective and minimally invasive. It gives a stable fixation with faster healing and early return to daily routine activities.

This study was done with the intent of assessing the results following management of pediatric and adolescent diaphyseal femoral fractures with a flexible intra medullary nail or elastic stable intramedullary technique. The advantage of TENS is that it gives a stable fixation allowing for early mobilization and decreased hospital stay with less disruption of patient and their family life<sup>1</sup>.

### MATERIALS AND METHODS

In this study 34 patients amid the ages of 5-16 years, with femoral diaphyseal fractures were treated using flexible intramedullary nails [Titanium elastic nailing system (TENS)] from November 2016 to September 2019. Children who were excluded from the study were less than five years and more than sixteen years of age, open femoral diaphyseal fractures other than Gartland type 1, comminuted and segmental fractures, pathologic fractures, having underlying neuro muscular disorders or metabolic bone disorders. The average age being 11.3 years. Majority were male 85.3% and majority had right sided injury 23 (67.6%). The commonest mechanism of injury was Road traffic accidents (22 patients). Initially skin traction was applied and almost all these patients were operated within 7 days of injury. Two Titanium Elastic Nails of duplicated diameters were preferred for each fracture. The diameter of the flexible nail was determined on the basis of the medullary canal size of

the child's femur, measured radiologically. These patients were evaluated radiologically and clinically for a maximum of 2 years. Post operatively, patients were kept on a de-rotation boot for 2-3 weeks. On bed mobilization was initiated as soon as possible. Partial weight bearing was allowed after 4 weeks, after a check X-ray and complete weight bearing was started depending on fracture pattern and callus formation at around 6 weeks. They were followed up clinically and radiologically at monthly intervals for first three months and then at three monthly intervals till maximum of two years after surgery. The final results were assessed using the Flynn's scoring criteria.

### DISCUSSION

Surgical intervention is indicated in pediatric femoral shaft fracture in the age group of 5-16 for open fractures, poly traumas and with associated neurovascular injuries. However, there are number of publications, suggesting that surgery can also be considered for isolated femoral fractures<sup>3</sup>, which may be closed fractures. Due to accomplishments such as earlier functional return, decreased joint stiffness, decreased complications such as malunion, non-union, and reduced duration of hospital stay, it makes intramedullary nailing one of the convenient methods of surgical intervention of choice in children with femoral diaphyseal fractures<sup>4</sup>. In children, intervention using elastic nails are technically easier than the use of rigid nails. Using ender nails is more challenging since it is harder and the canal diameter is a restricting factor in ender nail<sup>1</sup>. Studies have shown that the intramedullary fixation with TENS can be performed successfully in age group of 5-16 years. The mean age of the patients was 11.2 years. Some authors have reported using elastic nails in compound fracture up to Grade 3. We have used TENS for 5 cases of compound Grade-I injuries in our series.

Most of the femoral fractures we treated were transverse. However, Ligier et al<sup>14</sup> have demonstrated that it can be successfully used in oblique and spiral fractures. Flynn et al<sup>12</sup> & Ligier et al<sup>14</sup> reported mean hospitalization was about 5-10 days in this method. In our series mean hospitalization was 11.2 days. The most common complication in treating femoral diaphyseal fractures in children was limb length discrepancy (LLD). Significant discrepancy is LLD > 2cm. We had 13 cases of <5mm LLD and 2 cases of LLD between 5mm and 1 cm. It didn't amount to significant gait issue for the patients.

Another complication in a pediatric femoral diaphyseal fracture is malunion. Herndon et al<sup>1</sup> reported 7 of his 24 patients treated with spica casting developed malunion but none of his 21 patients who were treated by elastic nail developed malunion. Gaplin et al<sup>1</sup> had 2 patients

out of 35 developed malunion by this technique and they had excellent improvement in angulation deformity in the final follow up. We had 2 cases of malunion of varus angulation of 10° and 12° which did not affect our patients functionally or cosmetically. We analyzed rotational deformities by clinically measuring the foot progression angle and looking for intoeing or outtoeing when in standing. Rotatory malunion was not encountered in our study.

Other complications encountered in this series include the protrusion of nail in 3 cases causing skin irritation and knee stiffness. Luhmann et al indicated that the technical problem can be minimized if the part of the nail which is left outside the femur is kept smaller than 2.5cm.

Flynn et al<sup>12</sup> found very few complications in a study with 58 cases on whom they performed TENS. First callus tissue emerged in four weeks on the average. In this study the nail was routinely removed in the 6<sup>th</sup> month. Early removal was required in five cases due to soft tissue irritation, but it did not affect stability. We have removed the implants after 6 to 9 months in our study. Following surgery in Flynn series 2 children had 15° of rotational asymmetry and 6 patients had limb length discrepancy of 1-2 cm. 2 patients had deep tissue infection. Studies with ender nails for pediatric femoral shaft fracture by Karaoglu et al<sup>10</sup> and Ozturkmen et al<sup>11</sup> found increased incidence of varus - valgus angulation when compared with elastic nails. Baron et al<sup>13</sup> compared ESIN with external fixation for pediatric femoral shaft fractures and concluded that increase in number of complications is associated with external fixation technique.

Many studies recommended initiating walking using crutches after the pain subsided. But Flynn et al<sup>12</sup> suggested that it is ideal to allow partial weight bearing, when there is development of callus and full weight bearing only after clinical and radiographically complete union has occurred.

Kieli compared the application of two nails in 'C' shape and two nails one in S shape and another in 'C' shape on the basis of biomechanics and concluded that there was basically no difference between these 2 groups. Several case reports of avascular necrosis of femoral head<sup>5</sup> were observed while using antegrade rigid interlocked nails for children but these complications were not reported in the elastic nailing technique.

In our studies, passive bedside physiotherapy was initiated within 24 to 72 hours post operatively. After removal of the de-rotation boot by 2 weeks, non-weight bearing ambulation was initiated. Partial weight bearing was initiated between 4 to 6 weeks post operatively. Complete weight bearing was initiated after 6 weeks post operatively.

## CONCLUSION

As per Flynn's criteria for TENS system, our study yielded 67.7% of excellent, 17.6% of successful and 14.7% of poor results. Those constituting the poor results had concomitant head injury which postponed the surgery. Titanium elastic nailing is a good option for fixation of femoral diaphyseal fractures amid the age group of 5-16 years. It is a relatively easier and quicker technique that provides stable fixation, promotes rapid union at the site of the fracture and assists in early ambulation and early return to school. It is minimally invasive and more affordable with decreased reported complications compared to other surgical methods.

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