

## Original Research Article

# Prospective study of surgical management of femoral shaft fractures in children using tens nail

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**Received:** 13 June 2023

**Revised:** 28 September 2023

**Accepted:** 04 November 2023

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### ABSTRACT

**Background:** Pediatric femoral shaft fractures are uncommon, constituting less than 2% of all fractures in children; yet they are a significant burden on healthcare systems and families as they are the most common fractures requiring hospitalization in children. In the recent studies, technique of flexible stable intra medullary pinning using titanium pins which is now popularly known as TENS has become the choice of operative management for pediatric femoral shaft fractures. We conducted a clinical prospective study on the use of Titanium Elastic Nailing System (TENS) for the treatment of femoral shaft fractures in children.

**Methods:** This prospective study was carried out at Al-Ameen Medical College and Hospital, Vijayapura. Forty patients (32 males and 8 females) aged between 5-15 years with diaphyseal femur fracture were included in our study. Patients were treated with closed reduction and internal fixation with TENS. They were followed up for 6 months both clinically and radiologically. The functional outcome was evaluated using Flynn's scoring criteria.

**Results:** Forty patients were followed up for 6 months and their results were evaluated. The functional outcome using Flynn's criteria was excellent in 24 patients, satisfactory in 14 patients and poor in 2 patients. Complications observed were limb length discrepancy, knee stiffness, superficial infection and nail protrusion.

**Conclusions:** TENS has the advantages of early union, early mobilization, and manageable complications, making it an excellent choice for treating paediatric shaft femur fractures in patients aged 5 to 15 years.

**Keywords:** Femur, Flynn's criteria, Paediatric fractures, TENS

### INTRODUCTION

Pediatric femoral shaft fractures are uncommon, constituting less than 2% of all fractures in children; yet they are a significant burden on healthcare systems and families as they are the most common fractures requiring hospitalization in children. These fractures are 2.6 times more common in boys than in girls. A bimodal distribution has been noted, with the first peak occurring in the age group of 1-3 years (usually low energy) and the second peak during early adolescence period (high energy), which constitutes the majority of the fractures. Although, the etiology of the fracture varies with the age of the child, the

most common cause of femur shaft fractures in children is fall from height and road traffic accidents.<sup>1</sup>

In children 5 years or younger, early closed reduction and application of a spica cast is an ideal treatment for most diaphyseal fracture. In skeletally mature adolescents, use of ante-grade solid intramedullary rod has become standard treatment. But, the best treatment for children between five to fifteen years of age is still debatable. Children managed with traction and spica cast as a treatment modality have to undergo various adverse physical, social, psychological and financial consequences in view of their prolonged immobilization. Various other

modalities like external fixation, plates and screws, use of solid ante-grade intramedullary nail are available. However, the risk of certain complications, particularly pin tract infection and re-fractures after external fixation or osteonecrosis with solid nails do not make them a favourable choice.<sup>2,3</sup>

Currently, operative methods of treatment generally are favored to allow early ambulation and shorter hospital stays and to avoid detrimental psychological and social effects often associated with prolonged non-operative treatment, and to avoid complications.<sup>4</sup>

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 callus forms. TENS offers these features and could be a good treatment option. The objective of this prospective study is to evaluate the results of treatment of pediatric femoral shaft fractures with titanium elastic nails (TENS).<sup>5</sup>

## METHODS

This prospective study was carried out at Al-Ameen Medical College and Hospital, Vijayapura between October 2020 and October 2022. Forty patients (32 males and 8 females) aged between 5-15 years with diaphyseal femur fracture were included in our study. Patients were treated with closed reduction and internal fixation with TENS. They were followed up for 6 months both clinically and radiologically. The functional outcome was evaluated using Flynn's scoring criteria. The study was approved by the Institutional Ethical Committee.

### *Inclusion criteria*

Children and adolescent patients from 5 to 15 year with diaphyseal femur fracture, children with closed displaced diaphyseal fractures of femur, children of both the sexes, patient fit for surgery are included in the study.

### *Exclusion criteria*

Patients less than 5 years of age and more than 16 years of age, all open fractures having secondary infections or suspected deep infections or late presentations (>10 days), all metaphyseal fractures with/without involvement of epiphysis, parents/patient not willing for surgery, all pathological fractures, and children suffering from epilepsy, heart diseases, neuro-muscular diseases and bleeding diathesis are excluded from our study.

### *Surgical techniques*

The patient was placed in supine position on a normal radiolucent table and spinal anaesthesia was administered.

Then we tried to reduce the fracture and simultaneously the alignment was checked in AP and lateral views using image intensifier.

Then the patient was prepared from hip to knee. The pre bending of the nail is essential as the nail must make good contact with the inner side of the cortex in order to accomplish three point fixation. The fracture site should be the centre of a bow-shaped bend in the nail and usually it is bent up to 30 degrees.<sup>11</sup>

The selection of entry points for the nails in the medial and lateral was at the top of the flare of the femoral condyles, so that after insertion, they will tend to bind against the flare of the condyles. It should be kept in mind that if the nail insertion is too low it will tend to back out. Then an incision is made on the lateral side of leg 1-2 cm above the physis and extending distally for 2.5cm. The fascia lata is incised and vastus lateralis is retracted. The next largest drill bit relative to diameter of nail is selected, drill sleeves was used to protect the soft tissues. The drill bit was started perpendicular to the bone surface to penetrate the cortex. Then a curved bone awl was used to enlarge the hole in 45° angulations. Similarly medial entry point was made in the same manner.

Both the nails were inserted through entry points one after the other and were advanced up to the fracture site. Using 'C' arm the nail tip was aligned so that the convex side glanced off from far cortex. It is very important that sufficient reduction of the fragments is achieved so that about half of medullary canal gets overlapped. The 'F' tool was used for reduction which is a radiolucent device. While viewing through the image intensifier it was noted that, which nail will be easier to drive across the fracture site. Then this nail was advanced 2cm into proximal fragment and then rotated. Motion of the proximal fragment demonstrated that the nail was in the proximal fragment and at this point it was advanced further. By rotating the nail, further reduction of fracture was accomplished, and then second nail was inserted. It is to be kept in mind that the first rod should not be advanced so far until the second rod crossed the fracture site because, if the first rod is advanced too far, it would shift the fragments and makes passing of the second rod difficult.<sup>9</sup>

The traction was released and both the nails were advanced to their full length. Any deformity if present was corrected by altering the position of nail. Varus or valgus angulation was corrected by rotating the nail whose concavity faces same direction of deformation through 180°. Opposing the deforming force and correcting axial deformation with saggital angulations, the two nails were directed so that their convexity opposes deformation. At this stage if there is any significant mal-rotation, the child must be repositioned and nailing redone. The cut off point for the nail should be 1 to 2 cm outside the cortex. The wound was closed in layers and suturing done. A sterile waterproof dressing was applied over the surgical site.

Postoperatively once the pain was reduced, knee and hip mobilization were started to avoid stiffness. Weight bearing depends upon the fracture pattern and stability of fixation. Weight bearing was advised when callus formation and signs of healing were noted radiographically which was usually after 3 weeks. And patients were asked to come for follow up every week until the fracture unites.<sup>9</sup>

**Statistical analysis**

The data obtained from the present study were tabulated and percentages were calculated accordingly. All the data were analyzed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office 2007.

**RESULTS**

In the present study, forty cases of fractures of shaft of femur in children aged 5-15 treated with TENs nailing between October 2020 to October 2022 at Al-Ameen Medical College Hospital, Vijayapura were included. The following observations were made in the present study.

**Age incidence**

In our study the mean age group was 10.75 years with standard deviation (SD) 2.86.

**Table 1: Age incidence.**

Age in years	No. of patients	%
5-8	8	20
9-12	20	50
13-15	12	30
<b>Total</b>	40	100

Mean±SD: 10.75±2.86

**Gender distribution of patients**

In our study male patients were 32 and female patients were 8.

**Table 2: Gender distribution.**

Gender	No. of patients	%
Male	32	80
Female	8	20
<b>Total</b>	40	100

**Pattern of fracture**

The most common type of fracture pattern in our study was transverse type of fracture of shaft femur which was around 70%.

**Table 3: Pattern of fracture.**

Pattern of fracture	No. of patients	Percentage
Transverse	28	70
Oblique	10	25
Spiral	2	5

**Frequency of side of injury**

In our study, right femur was mostly involved in the injury of the patients which was nearly 70%.

**Table 4: Frequency of side of injury.**

Frequency of side	No. of patients	Percentage
Right	28	70
Left	12	30
<b>Total</b>	40	100

**Time for union**

In our study, most of the cases united with Mean±SD: 10.1±1.37 weeks.

**Table 5: Time for union.**

Time for union	No. of patients	Percentage
8 weeks	8	20
10 weeks	22	55
12 weeks	10	25

**Complications**

In our study, limb lengthening was present in 8 cases, out of which 5 cases had <5 mm of limb length discrepancy and 3 had nearly 1 cm of limb length discrepancy. No patient in our study had significant limb length discrepancy which is >2 cms. Superficial infection was seen in 2 cases, which was controlled by thorough antibiotics infusion.

**Table 6: Complications.**

Complications	No. of patients	Percentage
Limb lengthening	8	20
Infection	2	5
Nail protrusion	4	10
Malalignment	6	15

Nail protrusion was seen in 4 cases due to which skin irritation occurred in them. Hence, nail was removed within 6 months in 1 case and within 8 months in 3 cases.

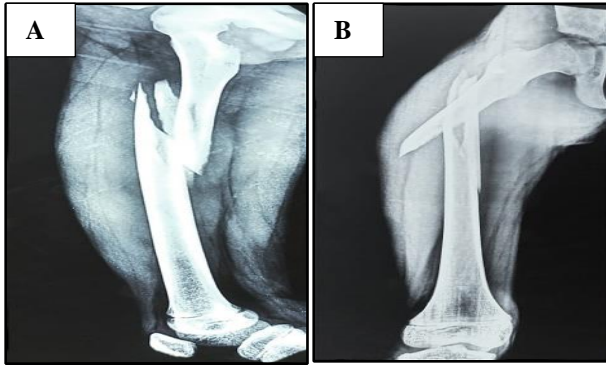
There were 6 cases of varus malalignment in our study out of which 4 cases had 10° and 2 cases had 12° of malalignment. No cases of valgus, anteroposterior or rotational malalignment was observed.

**Functional outcome**

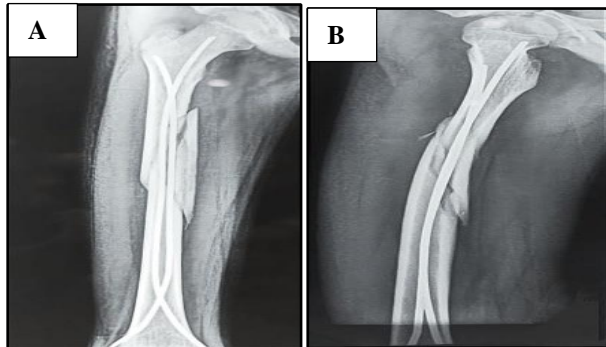
The functional outcome which was calculated using Flynn’s scoring system was excellent in 24, satisfactory in 14 and poor in 2 patients respectively.

**Table 7: Functional outcome.**

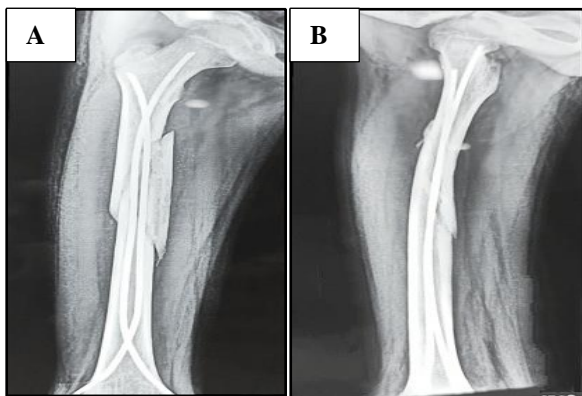
Functional outcome	No. of patients	Percentage
Excellent	24	60
Satisfactory	14	35
Poor	2	5



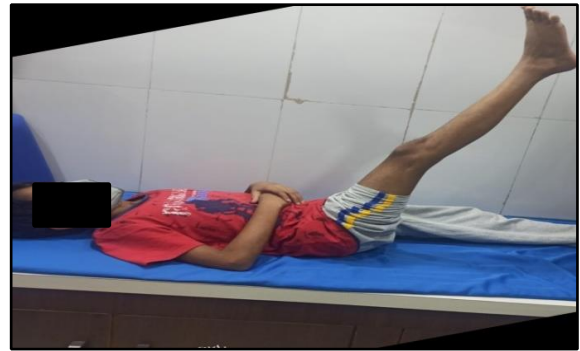
**Figure 1: Pre-op X-ray.**



**Figure 2: Post-op X-ray.**



**Figure 3: Follow-up X-ray.**



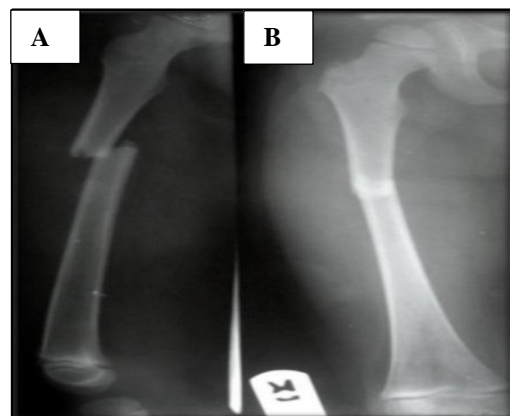
**Figure 4: Straight leg rais (Case 1).**



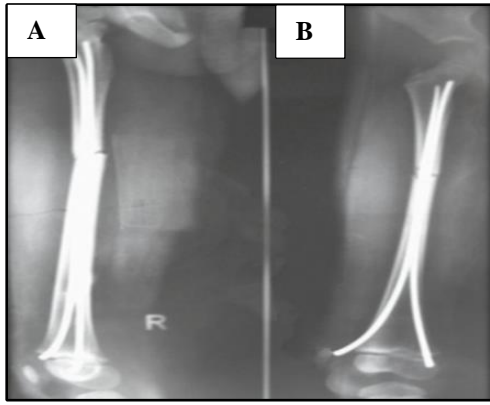
**Figure 5: Knee bending (Case 1).**



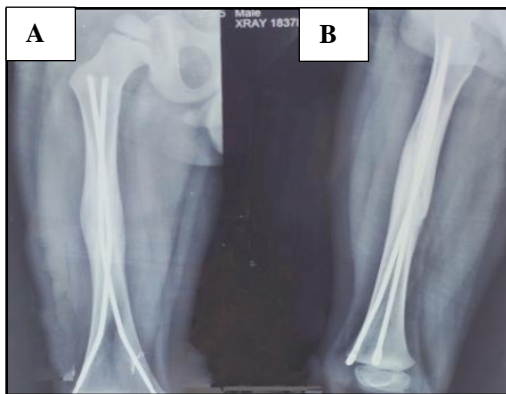
**Figure 6: Squatting(Case 1).**



**Figure 7: Pre-op X-ray (Case 2).**



**Figure 8: Post-op X-ray (Case 2).**



**Figure 9: Follow-up X-ray.**



**Figure 10: Squatting (Case 2).**

## DISCUSSION

It is controversial how to handle femoral shaft fractures in adolescents, especially those who are aged between 5 and 15 years. However, there is a growing acceptance of surgical treatment. The operating surgeon must be aware of the unique benefits and risks associated with each of the surgical techniques discussed.

The goal of the current study was to evaluate the effectiveness of flexible nailing with TENS for treating femoral shaft fractures in paediatric patients.

The surgical treatment of paediatric fractures with subsequent early mobilization and hospital discharge has grown in popularity as a result of rising healthcare expenses.

Several prominent medical centers in the United States and Europe have reported on series of femoral fractures in children and adolescents, demonstrating the relative safety and efficacy of femoral fracture fixation with flexible intramedullary nails.

All the 40 patients having diaphyseal femur fracture were fixed with intramedullary TENS nail and followed up on a periodic interval until fracture union occurred. The follow-up period ranged from 4 weeks to 6 months and results were analyzed both clinically and radiologically. The results were evaluated according to the Flynn's scoring system.

Our study comprised of 28 cases (70%) with transverse fractures, 10 cases (25%) with oblique fractures and 2 cases (5%) with spiral fractures. The mean age was 10.75 years of which 32 patients (80%) were male and 8 patients (20%) were female. The injured limb in most of the cases (70%) was right sided in our study. The average period for bone union was 10.1 weeks in our study as most of the cases i.e. 22 cases (55%) united by 10 weeks and average hospital stay was 10.5 days.

In our study complications like limb length discrepancy (<2 cms) was seen in 8 cases (20%), infection in 2 cases (5%), nail protrusion in 4 cases (10%) and malalignment in 6 cases (15%).

The functional outcome evaluated using Flynn's scoring system was excellent in 24 cases (60%), satisfactory in 14 cases (35%) and poor in 2 cases (5%). In comparison with other studies, the functional outcome was excellent in 80.82% of the cases in the study conducted by Ramprakash et al, the outcome was excellent in 71.4% of the cases, in the study conducted by Roop et al and it was excellent in 65% of the cases in the study conducted by Moroz et al.<sup>10-12</sup>

The limitations of the study were absence of any control group and no comparison from the other treatment options available. No cases lost to follow up, builds the strength of our study.

## CONCLUSION

Our results and expertise lead us to the conclusion that flexible intramedullary nailing using TENS is a superb method for treating diaphyseal femur fractures in children. It is easier to introduce a flexible intramedullary nail like TENS because it offers stable fixation. Flexible

intramedullary nailing promotes rapid union by protecting the fracture haematoma and exposing just a minimal amount of soft tissue. By enabling early independent ambulation, it significantly shortens the hospital stay and removes the need for prolonged bed rest and decreases the patients' dependence and morbidity.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Hathiwale MI, Mundewadi VM, Ahmed MN. Prospective study of surgical management of femoral shaft fractures in children using tens nail. Int J Res Orthop 2024;10:69-74.