



## Original Article

# Evaluation of Pediatric Femur Shaft Fractures Treated with a Titanium Elastic Nailing System (TENS): A Tertiary Level Hospital in Bangladesh

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### Abstract

**Background:** Pediatric femur shaft fractures are common in children, especially in developing countries, and are associated with significant morbidity and mortality. Titanium Elastic Nail System (TENS) has now become the preferred stabilization method in pediatric long bone fractures, particularly femoral shaft fractures.

**Objective:** This study was to evaluate the Titanium Elastic Nailing System (TENS) for intramedullary fixation of pediatric femoral shaft fractures.

**Materials and Methods:** The study conducted multicentered based non-randomized prospective study was performed in the Department of Orthopaedic Surgery, Rajshahi Medical College Hospital, Rajshahi, Bangladesh, from January 2021 to December 2022. There was a total of n=40 pediatric patients (5-16 years old; 31 males, 9 girls) who had retrograde TENS fixation for femoral diaphyseal fractures. Gustilo and Anderson's classification criteria were used to classify fractures into Grades I through III.

**Results:** TENS was a safe and effective treatment option for pediatric femur shaft fractures, with all patients achieving fracture healing without major complications. The mean duration of follow-up was 21 months (range 3-39 months). After an average of 9 weeks, the radiographic union was confirmed for all fractures with grade 3 callus development, and by 9.5 weeks, patients may recover full weight bearing. Flynn's criteria evidenced an excellent outcome in 33 patients (82.5 %) and a good outcome in 7 patients (17.5 %). Six patients had limb lengthening, four had varus mal-alignment, and three had rotational. In 4 cases, closed reduction failed, and 2 required nail corkscrewing.

**Conclusion:** The study TENS is a reliable treatment option for pediatric femur shaft fractures in a resource-limited setting like Bangladesh. It is a minimally invasive technique that allows early mobilization and reduces the risk of complications associated with traditional treatment methods.

**Key words:** Paediatric femoral fractures, TENS.

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### Introduction

Orthopaedic surgeons see a lot of children every year for fracture of femoral shaft they account for

1.2% of all childhood fractures.<sup>1</sup> Traditional care for fractures are related injuries has taken into

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account the patient's age in addition to the fracture site and injury severity.

Most children who suffer a femoral shaft fracture can benefit from conservative treatment, including immobilization in a spica cast, either immediately or after a period of traction.<sup>2</sup>

When conservative treatment fails to achieve or maintain an adequate reduction of the fracture, when the fracture is open, when the patient has suffered a head injury, or when there are numerous injuries, surgical stabilization may be required. Operative stabilization of juvenile femoral shaft fractures can be achieved by various means, including but not limited to external fixation, compression plating, and stiff intramedullary nailing.<sup>3</sup> Complications and issues such as pin tract infections, these methods were associated with growth slowdown, avascular necrosis of the proximal femoral epiphysis, refracture after implant removal, and loss of reduction.<sup>4</sup>

There is a prevailing opinion on how to care for children under the age of 5 and those above the age of 16. There is no general consensus on the best treatment choice for kids aged 5 to 16, as there are many different surgical and nonsurgical approaches that may be used.<sup>5,6</sup> In general, there is consensus on how to care for children under the age of 5 and those above the age of 16. There is no standardized recognized effective treatment choice for children aged 5 to 16 years old, and there is a vast range of surgical and nonsurgical treatments to choose among.

Many studies have supported the Elastic nails shown in several trials to be safe and effective for treating femoral fractures in children. This current retrospective study aims to assess the efficacy of TENS fixation in treating femoral shaft fractures in children aged 5 to 16 years.

### **Aims and objective**

The objective of this study is to evaluate the effectiveness of TENS with a minimally invasive technique that enables early mobilization and reduces the risk of complications associated with traditional methods of treatment. The specific objectives are:

- To assess the safety and efficacy of TENS in treating pediatric femur shaft fractures.
- To determine the rate of fracture healing and complications associated with TENS treatment.
- To evaluate the duration of follow-up required for successful TENS treatment.
- To assess the functional outcomes of patients treated with TENS using Flynn's criteria.
- To identify any factors that may affect the effectiveness of TENS treatment, such as patient age, fracture severity, and fracture location.
- To compare the effectiveness of TENS treatment with traditional treatment methods for pediatric femoral shaft fractures.

To offer advice on TENS' proposal for treating pediatric femur shaft fractures in Bangladesh, a country with low resources.

### **Materials and Methods**

**Study Design:** This study is a non-randomized prospective study conducted in the Department of Orthopaedic Surgery at Rajshahi Medical College Hospital, Bangladesh, from January 2021 to December 2022.

**Participants:** The study included 40 pediatric patients aged between 5 to 16 years who had retrograde TENS fixing for femoral diaphyseal fractures. Among the 40 patients, there were 31 males and 9 females. Fractures were classified using Gustilo and Anderson's Grades I through III classification criteria.

**Intervention:** The intervention used in this study was TENS for intramedullary fixation of pediatric femoral shaft fractures. The TENS procedure involved the retrograde insertion of a titanium nail with elastic properties into the medullary canal of the femur, with fixation achieved through distal and proximal interlocking screws.

**Data Collection and Analysis:** Data were collected prospectively through clinical examination, radiographic imaging, and patient-reported outcomes. Descriptive statistics were used to analyze the data, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. The t-test was used to compare means between groups, and the Chi-square test assessed

differences in categorical variables. Statistical analysis was performed using SPSS version 26.0

**Ethical Considerations:** The study was approved by the hospital authority with Review Board, and informed consent was obtained from all patients or their guardians before enrollment in the study. Patient confidentiality was ensured throughout the study.

## Results

The average duration of follow-up was 21 months, with a range of 3 to 39 months. The mean interval between injury and definitive surgery was 3.8 days, and the mean duration of surgery was 20 to 45 minutes. The hospital stay ranged from 5 to 12 days, with a mean of 8.1 days.

Of the 40 cases, 31 were managed with closed reduction, while 4 required open reduction due to soft tissue interposition at the fracture site. Compound fractures were treated with debridement and primary fixation. No postoperative immobilization was used in 82.5% of cases, while hip spica was applied in 17.5% of cases. Clinical and radiological criteria assessed the union of the fracture. All fractures in this series united with grade 3 callus formation in a duration ranging between 8 and 10 weeks, with an average of 9 weeks.

Functional outcome was evaluated using the Flynn scoring system, with excellent results noted in 82.5% of patients and satisfactory results in 17.5% of patients. No patient had a poor result. The results were excellent in all 18 patients of Winquist and Hansen Grade-I. Three patients of Winquist and Hansen (Grade II and III) and one of Gustilo and Anderson (Grade II) showed satisfactory results.

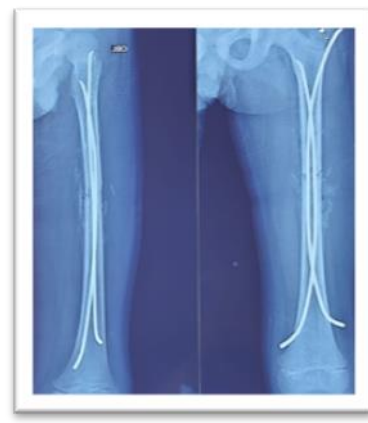
### Clinical Case No. 21



a) Eight year old boy with proximal fracture femur



b) Immediate post-op X-ray shows good fracture reduction with nail insitu.



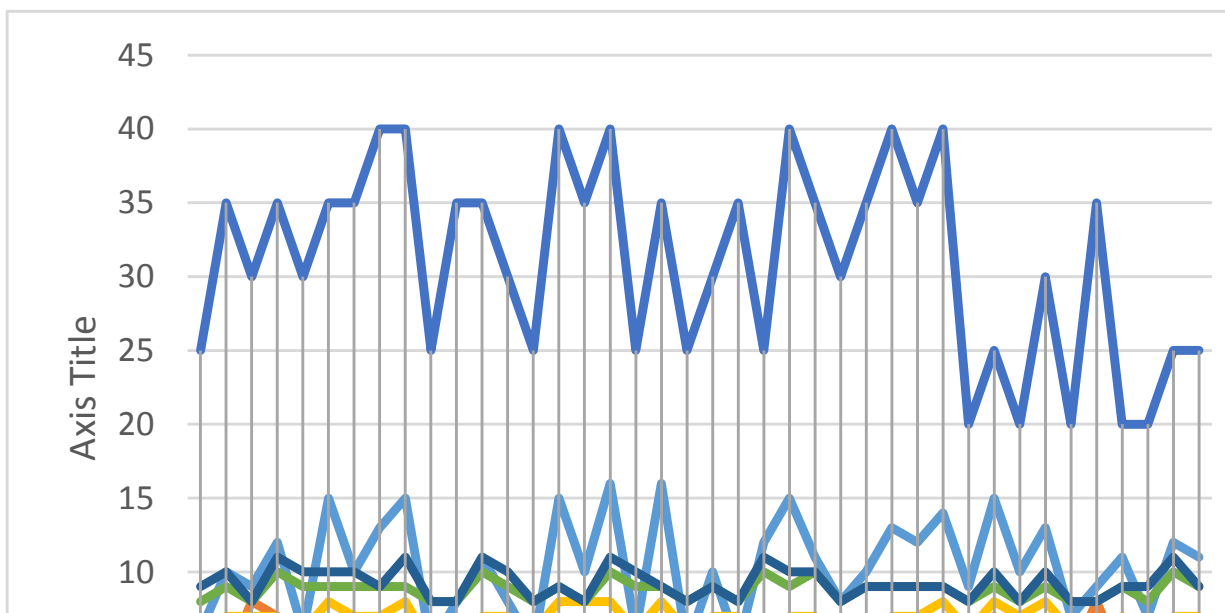
c) Eight weeks follow-up X-ray shows fracture united by callus formation.

No cases of mortality or neuro-vascular impairment were documented. Soft tissue interposition at the fracture site necessitated open reduction in 4 cases and corkscrewing of one nail over another in 2 cases

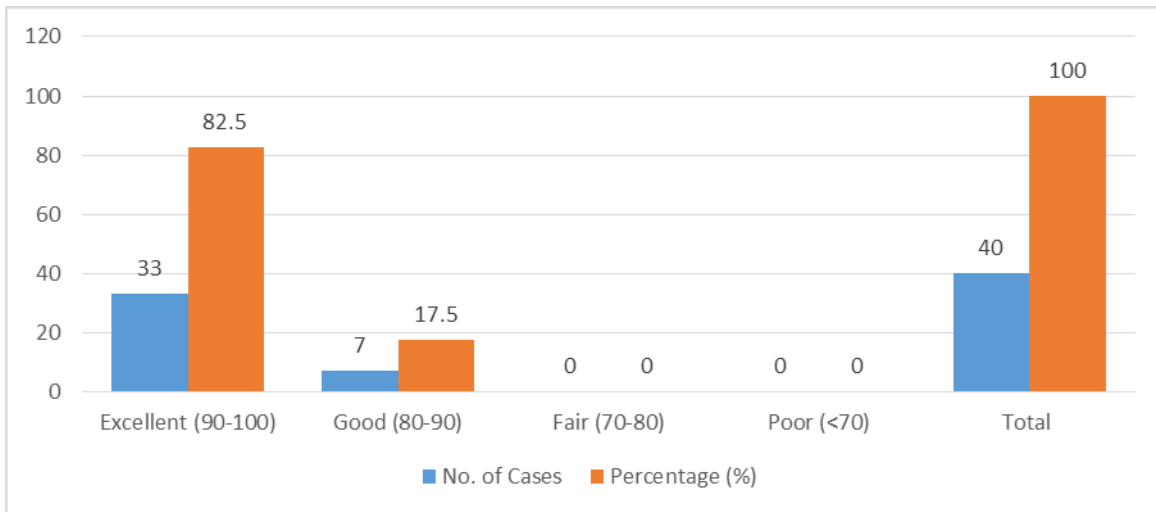
due to per-operative technical problems encountered during close reduction. In six instances, researchers found an asymmetrical growth pattern in limb length. Three out of the six instances exhibited extension of more than 1.5 cm, while the other three were each less than 1 cm. In two of the four cases, the varus angle was  $5^\circ$ , while in the other two, it was  $10^\circ$ . In 37 out of 40 cases, the foot progression angle was perfectly symmetrical, indicating perfect rotational alignment. One patient experienced a  $5^\circ$  out-toeing malalignment, while two patients experienced a  $10^\circ$  malalignment. In this cohort, there was not a single instance of implant failure or refracture.

Two patients had a nail entry site infection that required a bandage and oral medications to resolve. Nail irritation at the entrance site led to ulceration in one case. In this study, seven people reported skin discomfort at the entrance portal owing to a protruding nail. Nails that protrude into the skin can be irritating, limiting motion at the knees. Nail protrusion at the knee restricted extension, making weight-bearing difficult.

After an average of 6.5 months (range, 5-8), all patients had returned to their pre-injury activity levels. Removal of the nails occurred between the ages of 12 and 32 weeks on average. There were no postoperative refractures or other complications from the removal of the nail.



**Figure 1:** Patient Summary



**Figure 2:** Outcome results of TENS treatment.

## Discussion

The management of femoral shaft fractures in children has evolved over the years due to the need to avoid the negative effects of prolonged immobilization, reduce the loss of school days, and provide better nursing care. Conservative treatment was preferred in the past, but recent studies have increased awareness of the psychological and economic effects of spica casting on children and their families. The use of titanium elastic nails (TENS) has become a popular alternative for treating femur fractures in children.

Studies have reported positive outcomes with the use of TENS in the treatment of femoral shaft fractures in children, with low rates of complications. However, some complications associated with TENS include pain/irritation at the insertion site, radiographic malunion, refracture, transient neurologic deficit, and superficial wound infection. Most complications are minor and preventable, and TENS is still considered a safe and effective treatment option for femoral shaft fractures in children. The best indications for TENS are transverse, short oblique, and short spiral fractures with minimum comminution in the 5-12 years age group. Complications can be minimized by advancing the nail ends till they lie against the supracondylar flare of the femur.<sup>7</sup>

Ligier and colleagues were the first to report the beneficial use of titanium elastic nails (TENS) for the treatment of children's femur fractures, and they were the first to report its success.<sup>8</sup> Only one instance of deep wound infection and thirteen occurrences of skin ulceration or local inflammatory reaction owing to nail protrusion were detected in their five-year analysis of 118 children (123 fractures) aged five to sixteen. No patients reported impairments in mobility or gait throughout the 1-year follow-up period.

Flynn and colleagues reported results of TENS treatment for 49 fractures in The ages of the 48 children reported vary from 6 - 16, with a mean of 10.2 years.<sup>9</sup> They didn't find any cases of angulation, malalignment, or LLD more than 1 cm, but they did find 8 cases of nail bending, 1 refracture owing to early (6.5-week) nail removal, and 1 case of nail bending after a fall (corrected by closed reduction, which led to delayed union, which was treated with external fixation).

Narayanan *et al.* analyzed their titanium elastic stable intramedullary nailing: first five years of experience to report complications and propose preventative measures.<sup>10</sup> In 78 kids with femoral fractures, TENS was employed as a treatment option. Eight cases of radiographic malunion, two cases of refracture, two cases of transient neurological impairment, and one case of superficial wound infection. (2) were among the

complications reported (2). Ten of the patients needed further surgery before they could fuse. Mismatched nail diameters (odds ratio = 19.4) and comminution of more than 25% (odds ratio = 5.5) were highly linked with malunion and/or loss of reduction requiring re-operation. A significant correlation was found between terminal nail deformities and insertion site pain. Minor issues occur often and are often avoidable.

They found that TENS was most effective for kids aged 5-12 who had transverse, short oblique, or short spiral fractures with minimal comminution. There was no comparison to alternative treatments, and we did not use a control group. No implant failure or refracture was seen following nail removal, and our findings are consistent with the universal union. To reduce the risk of entry site discomfort and pain, the nail should be advanced until they lay against the supracondylar flare of the femur. In our research, seven patients had entry-site discomfort tied to a very long or conspicuous nail end (>2 cm). In most cases, this necessitates removing the nail, although this should wait until the fracture has healed completely. Leg length disparity, often lengthening, and malalignment of fracture are two additional rare consequences.

### Conclusion

Overall, TENS has shown to be a safe and effective method for treating pediatric femoral fractures, with minimal complications and quick healing time. However, as with any surgical procedure, proper technique and monitoring are crucial to avoid potential complications. TENS may be considered a viable alternative to traditional treatments such as casting and traction, especially in cases where prolonged immobilization may negatively affect the patient's physical and psychological well-being. Ultimately, the treatment choice should be individualized and based on the patient's age, fracture characteristics, and overall health status.

### LIMITATIONS

This study has several limitations, including its non-randomized design and the relatively small

sample size. The study was conducted at a single center, which may limit the generalizability of the findings.

**Conflict of interest:** None declared

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