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Research Article

Functional and Radiological Outcomes of Pediatric Femoral Shaft Fractures Treated with Titanium Elastic Nailing System

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Abstract: **Introduction** Femoral shaft fractures are among the most common long bone fractures in pediatric patients, constituting approximately 1.6% of all pediatric fractures. These fractures result from high-energy trauma, such as road traffic accidents (RTAs) and falls from height, making them a significant concern in pediatric orthopedic trauma. The management of femoral shaft fractures varies according to patient age, fracture pattern, and associated injuries, necessitating a tailored approach for optimal outcomes. **Materials and Methods** A prospective study was conducted over a period of 1 year in the Department of Orthopedics, Shadan Institute of Medical Sciences, Teaching Hospital & Research Centre. Patients aged 5–16 years diagnosed with closed femoral shaft fractures and treated with TENS were included. This study evaluates the functional outcome of femoral shaft fractures in pediatric patients treated with TENS, focusing on healing time, complications, weight-bearing status, and overall functional recovery. A prospective study was conducted on pediatric patients aged 5–16 years with closed femoral shaft fractures treated using TENS. **Results** The most common fracture type in this dataset is transverse (25 cases), followed by oblique (15 cases) and comminuted (10 cases). This distribution suggests that the majority of fractures in this dataset are relatively stable (transverse and oblique), with a smaller proportion being more complex (comminuted). The fracture heals on average in 8.2 weeks, but full functional recovery (full weight-bearing) takes longer, at 10 weeks. Patients can begin partial weight-bearing at 6 weeks, which is an important milestone in the rehabilitation process. The most common complication in this dataset is nail prominence (6%), followed by limb length discrepancy (4%) and infection (2%). The majority of patients (40 out of 50, or 80%) achieved an excellent outcome. A smaller proportion (8 out of 50, or 16%) had a satisfactory outcome. Only a few patients (2 out of 50, or 4%) had a poor outcome.

Keywords: Femoral shaft fracture, Pediatric, Titanium Elastic Nailing System, Functional outcome, Bone healing,.

INTRODUCTION

Femoral shaft fractures are among the most common long bone fractures in pediatric patients, constituting approximately 1.6% of all pediatric fractures. [1] These fractures result from high-energy trauma, such as road traffic accidents (RTAs) and falls from height, making them a significant concern in pediatric orthopedic trauma. [2] The management of femoral shaft fractures varies according to patient age, fracture pattern, and associated injuries, necessitating a tailored approach for optimal outcomes. [3]Traditionally, non-operative management, including spica casting and traction, was the mainstay of treatment for pediatric femoral fractures, especially in younger children. [4] However, with advancements in surgical techniques and an increased emphasis on early mobilization, operative interventions have gained preference, particularly in older children and adolescents. [5] Among the various surgical options, intramedullary fixation using the Titanium Elastic Nailing System (TENS) has emerged as a gold standard due to its minimally invasive nature, biomechanical stability, and early functional recovery.[6]

TENS provides adequate stabilization through elastic fixation, which allows for micro-motion at the fracture site, stimulating callus formation while maintaining axial and rotational stability. [7] Compared to rigid fixation methods like plating or external fixation, TENS minimizes soft tissue disruption, preserves the periosteal blood supply, and reduces the risk of physeal damage. [8] The elasticity of titanium nails facilitates bone healing while preventing stress shielding and secondary fractures.[9]Several studies have demonstrated superior outcomes with TENS compared to conventional methods, with patients experiencing faster healing times, early weight-bearing, and minimal postoperative complications. [10] However, potential challenges such as nail prominence, irritation at the entry site, malalignment, and rare cases of delayed union have been reported. [12] Proper patient selection, meticulous surgical technique, and post-operative rehabilitation protocols play a crucial role in ensuring the best possible functional outcomes. [12]This study aims to assess the functional outcomes of pediatric femoral shaft fractures treated with TENS, with a focus on healing time, weight-bearing progression, complications, and overall recovery based on Flynn's criteria. The findings will contribute to existing literature and aid in optimizing management strategies for pediatric femoral fractures.

MATERIALS AND METHODS

A prospective study was conducted over a period of 1 year in the Department of Orthopedics, Shadan Institute of Medical Sciences, Teaching Hospital & Research Centre. Patients aged 5–16 years diagnosed with closed femoral shaft fractures and treated with TENS were included.

Inclusion Criteria:

Pediatric patients aged 5–16 years

Closed femoral shaft fractures

Patients treated with TENS

Patients with a follow-up period of at least six months

Exclusion Criteria:

Open fractures

Pathological fractures

Polytrauma patients with head injury requiring intensive care

Patients with metabolic bone disease

Surgical Technique: Under general or spinal anesthesia, two titanium elastic nails were inserted through the lateral and medial entry points at the distal femur. Fracture reduction was achieved under fluoroscopic guidance, and nails were advanced to stabilize the fracture. Postoperatively, partial weight-bearing was initiated after four to six weeks, depending on radiological signs of healing.

Outcome Assessment: Functional outcome was assessed based on:

Time to radiological union

Flynn's criteria for outcome assessment

Complications such as limb length discrepancy, infection, nail irritation, or re-fracture

.

RESULTS

Table 1: Demographic Data

Parameter	Value
Total Patients	50
Mean Age	10.5 ± 3 years
Male:Female	30:20
Mechanism of Injury	Fall (60%), RTA (40%)

Table 2: Fracture Characteristics

Type of Fracture	Number
Transverse	25
Oblique	15
Comminuted	10

The most common fracture type in this dataset is **transverse** (25 cases), followed by **oblique** (15 cases) and **comminuted** (10 cases). This distribution suggests that the majority of fractures in this dataset are relatively stable (transverse and oblique), with a smaller proportion being more complex (comminuted).

Table 3: Healing and Weight-Bearing Progression

Parameter	Value
Average Healing Time	8.2 weeks
Full Weight-Bearing	10 weeks
Partial Weight-Bearing	6 weeks

The fracture heals on average in **8.2 weeks**, but full functional recovery (full weight-bearing) takes longer, at **10 weeks**. Patients can begin **partial weight-bearing** at **6 weeks**, which is an important milestone in the rehabilitation process.

Table 4: Complications

Complication	Incidence (%)
Nail Prominence	6%
Limb Length Discrepancy (>1cm)	4%
Infection	2%

The most common complication in this dataset is **nail prominence** (6%), followed by **limb length discrepancy** (4%) and **infection** (2%).

Table 5: Functional Outcome by Flynn's Criteria

Outcome	Excellent	Satisfactory	Poor
Number of Patients	40	8	2

The majority of patients (40 out of 50, or 80%) achieved an excellent outcome. A smaller proportion (8 out of 50, or 16%) had a satisfactory outcome. Only a few patients (2 out of 50, or 4%) had a poor outcome.

DISCUSSION

The results of this study reinforce the efficacy of TENS in pediatric femoral shaft fractures, showing a high rate of union within an average of 8.2 weeks. The ability to initiate early weight-bearing is one of the primary advantages of this technique, reducing complications associated with prolonged immobilization.In this study, the most common fracture type in this dataset is transverse (25 cases), followed by oblique (15 cases) and comminuted (10 cases). This distribution suggests that the majority of fractures in this dataset are relatively stable (transverse and oblique), with a smaller proportion being more complex (comminuted).In current study the most common complication in this dataset is nail prominence (6%), followed by limb length discrepancy (4%) and infection (2%). Our study found a complication rate comparable to existing literature, with minor issues such as nail prominence (6%) and limb length discrepancy (4%). [13] These are manageable with proper surgical technique and follow-up. [15] A review of previous studies suggests that patients treated with TENS experience better functional recovery compared to traction or plating.[16]TENS is particularly advantageous in skeletally immature patients as it provides stable fixation without disrupting the growth plate. [17] Furthermore, the results of Flynn's criteria demonstrate excellent to satisfactory outcomes in 96% of cases, highlighting the reliability of this technique. [18]

CONCLUSION

TENS is an effective treatment modality for pediatric femoral shaft fractures, ensuring rapid union, early ambulation, and minimal complications. It remains a preferred choice for children aged 5–16 years due to its minimally invasive nature and functional benefits

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