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Original Research Article

Functional Outcome of Femur Shaft Fracture in Pediatric Age Group Treated with Titanium Elastic Nailing System

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Abstract: *Pediatric femoral shaft fractures are commonly managed surgically when conservative treatment is unsuitable. Titanium elastic nailing provides stable fixation, early mobilization, and preservation of fracture biology.* ***Objective:*** *To determine the early functional outcome of femur shaft fracture in pediatric age group treated with titanium elastic nailing system.* ***Methods:*** *This study was conducted on a sample of 60 patients aged 5 to 16 years, of either gender, with radiologically confirmed femoral shaft fractures in the Orthopedic Surgery Department, MTI, Khyber Teaching Hospital, Peshawar,. Those with metabolic bone disorders, polytrauma, and comminuted fractures were excluded. All patients underwent titanium elastic nailing under C-arm fluoroscopy using two pre-bent nails inserted retrograde through medial and lateral incisions. Early functional outcome was assessed at 8th week of treatment using Flynn's scoring system. Data were analyzed using SPSS 25. Frequencies and percentages were calculated for functional outcome. Chi-square and Fisher's exact tests were used for stratification; p-values ≤ 0.05 were considered significant.* ***Results:*** *The mean age of the 60 patients in the current study was 9.42±3.22 years. Male patients were 40 (66.7%), and female patients were 20 (33.3%). A transverse fracture pattern was observed in 34 (56.7%) cases. Excellent functional outcome was achieved in 40 (66.7%) cases, satisfactory in 16 (26.7%) cases, and poor in 4 (6.7%) cases. Complications were nail protrusion in 5 (8.3%) cases and infection in 3 (5.0%) cases.* ***Conclusion:*** *The early functional outcome of the titanium elastic nailing system in the pediatric age group with shaft of femur fractures was excellent in 66.7% of patients, satisfactory in 26.7% of patients, and poor in only 6.7% of patients.*

Keywords: Titanium elastic nailing, femoral shaft fracture, paediatric, Flynn's criteria, functional outcome, Peshawar

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Introduction

Pediatric femoral shaft fractures constitute prevalent injuries that orthopedic surgeons routinely handle. Fractures typically occur in early childhood, coinciding with the transition from weak woven bone to stronger lamellar bone, or during adolescence, a period when individuals are more susceptible to. (1) Researchers have identified a bimodal distribution, where the first peak generally appears between the ages of 1 and 3 years and is frequently connected to low-energy incidents, and a subsequent peak throughout early adolescence, typically associated with high-energy trauma. This latter period represents the predominant occurrence of femoral shaft fractures within this demographic. The causes of these fractures differ by age; however, falls from heights and road traffic accidents are the most common contributors. (2)

Pediatric femoral fractures represent 1.6% of the total fractures occurring in children. The distribution of femoral fracture rates exhibits a bimodal pattern, with a male-to-female ratio of 2:6:1. In young children, a second peak follows the initial peak in late adolescence. (3) Elastic intramedullary nailing, commonly referred to as a titanium elastic nail (TENS), serves as an alternative method for addressing specific long bone fractures in children. Titanium nails are preferred over plaster casts, as well as stainless-steel nails for children over the age of six (4, 5)

Multiple treatment options exist for femoral shaft fractures in adolescents. TENS is now the standard treatment for femoral fractures in children due to several factors, such as its minimally invasive surgical approach, elimination of casting, promotion of early mobilization and discharge, and increasing cost-effectiveness considerations. (6) Operative treatment presents numerous advantages compared to non-operative approaches, such as improved fracture reduction, enhanced stability of fixation, quicker mobilization, reduced hospital stays, minimal disruption to social life, as well as a swifter return to educational settings. (6,7) A study found the functional outcomes, i.e., excellent 52%, satisfactory 40%, and poor 8%, of TENS in the pediatric age group with shaft of femur fractures. (7) Due to the scarcity of literature on this subject locally, the goal of this study is to determine the functional outcome of femur shaft fracture in pediatric age group treated with titanium elastic nailing system at our health facility. Assessing the functional outcomes of TENS in this patient population will help our clinicians enhance surgical techniques, inform clinical decisions, and improve treatment strategies for pediatric femoral fractures, aiming to achieve a balance between rapid recovery and enduring skeletal well-being.

Methodology

This prospective observational study was conducted from 23-02-2025 to 23-05-2025 in the Orthopedic Surgery Department, MTI, Khyber Teaching Hospital, Peshawar, after obtaining ethical approval from the hospital. Sample size was calculated using the WHO sample size calculator, with the following assumptions: a functional outcome (Poor 8%) of TENS in the pediatric age group with a shaft of femur fracture. (7) Absolute precision 6.9%, and confidence level 95%, the sample size was 60. Non-probability consecutive sampling was used.

Patients aged 5 to 16 years, of either gender, presenting with a shaft fracture of the femur were included in the study. A shaft of femur fracture was diagnosed on X-ray imaging, with visible fracture line, angulation, and shortening of the femur, in patients with signs such as pain (VAS > 3), inability to move, and deformity. Patients with metabolic bone illness, polytrauma, and comminuted fractures were excluded.

After obtaining written informed consent from the parents or guardians of the patients, baseline demographics, including BMI, age, gender,

financial status, and place of residence, were recorded. Patients with confirmed shaft of femur fractures on X-rays were treated with TENS; i.e., adequate aseptic precautions were implemented in the operating room. Surgeries were conducted utilizing C-arm fluoroscopy. For each case, two titanium elastic nails were utilized. The nails underwent pre-bending before insertion. The insertion was performed in a retrograde manner. A skin incision measuring 2 cm was made on both the medial and lateral aspects of the lower thigh, aligned with the upper pole of the patella. A 4.5 mm bone awl was utilized to create an entry approximately 2–3 cm proximal to the physis, with the angle directed through the canal. Titanium elastic nails of the predetermined size were inserted and carefully hammered throughout the fracture site, rotating them as needed to engage in a divergent manner within the proximal physis for the femur. Precautions were taken to ensure the nails remained clear of the physis proximally and distally. About 2 cm of nail was retained at the entry site and trimmed to facilitate extraction at a later time. The nail tips remained unbent. The ends were positioned to lie flush with bone to prevent skin irritation. Early functional outcome were assessed using Flynn's scoring system, with a total score range of 0 to 30 at 8th week of treatment.

This assessment was conducted under the supervision of a consultant with at least 5 years of post-fellowship experience. A pre-designed, structured pro forma was used to document the details of each patient. The researcher collected all the data by himself.

IBM SPSS v.25 software was used to analyze the data. Frequencies and percentages were calculated for categorical variables, including gender, functional outcome, fracture pattern, side involved, complications, financial status, and place of living. Mean + SD were determined for numerical variables such as age and BMI. Functional outcomes were stratified by age, gender, BMI, fracture pattern, side involved, complications, financial status, and place of living to identify effect modifiers. Post-stratification chi-square or Fisher's exact test was applied at the 5% significance level. Results were presented in tables.

Results

The mean age of 60 children was 9.42±3.22 years. The mean body mass index was 19.39±2.98 kg/m². Regarding gender distribution, 40 (66.7%) patients were male and 20 (33.3%) were female (Table 1).

The right side was involved in 36 (60.0%) cases and the left side in 24 (40.0%) cases. The most common fracture pattern observed in this study was transverse in 34 (56.7%) cases. Oblique fractures in 19 (31.7%) cases, while spiral fractures in 7 (11.7%) cases.

The early functional outcome in the present study was excellent in 40 (66.7%) patients. A satisfactory outcome was observed in 16 (26.7%) patients, and a poor outcome in 4 (6.7%) patients. Regarding complications, 52 (86.7%) patients had none. Nail protrusion was observed in 5 (8.3%) patients and superficial infection in 3 (5.0%) patients (Table 2).

Complications had a significant association with functional outcomes ($p < 0.001$) (Table 3)

Table 1: Demographics

Demographics		n	%
Gender	Male	40	66.7%
	Female	20	33.3%
Place of living	Urban	27	45.0%
	Rural	33	55.0%
Financial status	Lower class	24	40.0%
	Middle class	28	46.7%
	Upper class	8	13.3%

Table 2: Functional outcome

Functional outcome & postoperative complications		n	%
Functional outcome	Excellent	40	66.7%
	Satisfactory	16	26.7%
	Poor	4	6.7%
Complications	Nail protrusion	5	8.3%
	Infection	3	5.0%
	No complication	52	86.7%

Table 3: Stratification of functional outcome with demographics and clinical variables

		Functional outcome						P value
		Excellent		Satisfactory		Poor		
		n	%	n	%	n	%	
Age distribution (Years)	5 to 10	25	62.5%	11	68.8%	3	75.0%	0.825
	11 to 16	15	37.5%	5	31.3%	1	25.0%	
BMI (Kg/m^2)	13 to 16	10	25.0%	7	43.8%	0	0.0%	0.159
	> 16	30	75.0%	9	56.3%	4	100.0%	
Gender	Male	29	72.5%	9	56.3%	2	50.0%	0.388
	Female	11	27.5%	7	43.8%	2	50.0%	
Place of living	Urban	18	45.0%	8	50.0%	1	25.0%	0.668
	Rural	22	55.0%	8	50.0%	3	75.0%	
Financial status	Lower class	17	42.5%	6	37.5%	1	25.0%	0.835
	Middle class	19	47.5%	7	43.8%	2	50.0%	
	Upper class	4	10.0%	3	18.8%	1	25.0%	
Side involved	Right	22	55.0%	12	75.0%	2	50.0%	0.353
	Left	18	45.0%	4	25.0%	2	50.0%	
Fracture pattern	Spiral	4	10.0%	1	6.3%	2	50.0%	0.106

	Oblique	11	27.5%	7	43.8%	1	25.0%	
	Transverse	25	62.5%	8	50.0%	1	25.0%	
Complications	Nail protrusion	0	0.0%	3	18.8%	2	50.0%	< 0.001
	Infection	0	0.0%	2	12.5%	1	25.0%	
	No complication	40	100.0%	11	68.8%	1	25.0%	

Discussion

The present study was conducted to evaluate the functional outcome of the titanium elastic nailing system in pediatric patients with femoral shaft fractures. The study enrolled 60 children aged 5 to 16 years.

The mean age of patients in the present study was 9.42±3.22 years. Male patients accounted for the majority (66.7%) of the sample. This male predominance aligns well with Ahmed et al., who documented 65% male patients in their study. (8) Similarly, Dilimon et al. reported 71.4% male frequency in their study of 35 children. (9) Killada et al. found an even higher male proportion of 83%. (10) The consistent observation across different geographical regions suggests that boys are inherently more exposed to trauma during childhood years.

Regarding fracture profile, the transverse pattern was the most frequently observed fracture (56.7%). Oblique fractures 31.7% and spiral 11.7%. These figures align with the work of Chiranjeevi et al., who reported transverse fractures in 56.7% of their 30 patients (11). Wahid et al. also found transverse fractures to be predominant, constituting 69.57% of their cases. (12) The mechanical forces applied to the femur during falls and road traffic accidents likely explain this pattern of distribution.

According to Flynn's criteria, the functional outcome in the present study was excellent in 66.7% of patients. A satisfactory outcome was observed in 26.7%, while a poor outcome was observed in only 6.7%. These figures are in agreement with existing studies. Ahmed et al. reported an excellent outcome in 51.7% of their 60 patients (8). Dilimon et al. documented an excellent rate of 74.3%. (9) Killada et al. found excellent results in 67% of their cases. (10) Akbar et al. reported 65.6% excellent outcomes in children under eight years of age. (13) Uddin et al. reported the highest excellent rate of 76.7% in their study. (14)

Complications observed in this study were nail protrusion in 8.3% and superficial infection in 5.0%. The majority of patients (86.7%) had no complications encountered. These figures are comparable to those reported by Dilimon et al., who found nail site infection in 8.6% of their cases. (9) Killada et al. reported pain at the nail insertion site in 23% of patients, though no deep infections occurred. (10) Wahid et al. documented nail protrusion in 8.7% and infection in 8.7% in their study. The low complication rate in the present study supports the safety profile of titanium elastic nailing in appropriately selected children. (12)

Stratification analysis revealed that complications were highly significantly associated with functional outcome ($p < 0.001$). All patients who achieved excellent outcomes were complication-free. Conversely, among those with nail protrusion or infection, none attained excellent results. This finding underscores the critical importance of meticulous surgical technique and vigilant postoperative care.

Conclusion

In conclusion, the functional outcome of femur shaft fracture in pediatric age group treated with titanium elastic nailing system was excellent in 66.7% of patients, satisfactory in 26.7% of patients, and poor in only 6.7% of patients. The safety profile of the procedure was acceptable, with 8.3% of cases of nail protrusion and 5% of cases of infection.

Declarations

Data Availability Statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-KTHP-0238/24)

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Conflict of interest

The authors declared the absence of a conflict of interest.

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