



Titanium Elastic Nailing in Pediatric Femoral Shaft Fracture: A Study of 40 cases at NITOR, Bangladesh

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Abstract

Background: The Titanium Elastic Nail is mostly used in children to treat diaphyseal and metaphyseal fractures. The age of the patient, as well as the nature and location of the fracture, determine if the TEN is necessary. In some situations of femoral diaphyseal fractures, it is a successful and realistic therapeutic choice. The TEN allows for elastically stable intramedullary nailing. In terms of patient and parent happiness, as well as shorter confinement to bed and hospital stay, open reduction can produce a significantly better outcome than traction and spica cast or any other treatment. The aim of the study was to observe Titanium Elastic Nailing for treatment of femoral shaft fractures. **Material & Methods:** This observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Bangladesh. The study duration was 2 years and 8 months, from April 2019 to December 2021. The study was conducted with a total of 40 cases of femoral shaft fracture in pediatric patients who were admitted to the study hospital. **Results:** Male prevalence was observed in the present study, with 3.44:1 male: female ratio. Mean±SD age of the participants was 8.8 ± 1.6 years, and sports injuries were the most common cause of fractures. 72.5% of the participants were aged between 5-10 years, and the age range of the participants was 5-13 years. 50% of the participants had fractures at the middle region of the femur, while 45% had fractures at the proximal region. Mean±SD hospital stay duration was 14.5 ± 2.4 days, with 62.58% having hospital stay between 7-14 days. Majority of the participants of the present study faced no complications, while 20% had <1.0 cm of leg length inequality, 2.5% had 1-2 cm leg length inequality, 2.5% faced infection, 5% faced entry site irritation and 1 patient had soft tissue irritation by prominent nail. At 12-month follow up, 75% had excellent outcomes while 20% had satisfactory outcomes. **Conclusions:** The titanium elastic nailing is an effective and viable treatment option in selected cases of femoral shaft fractures in the 5-13 years' age group. Even if it is done by open reduction it gives much better result than traction & Spica cast or any other methods, in respect to patient & parent's satisfaction & shorter confinement to bed & hospital stay.



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INTRODUCTION

The most common significant pediatric injuries treated by orthopedic surgeons are femoral shaft fractures. The femoral shaft is the long, straight section of the femur. A femoral shaft fracture occurs when a break occurs anywhere along this length of bone. The femoral shaft extends from below the hip to the knee, when the bone begins to expand.^[1] Femoral shaft fractures are serious injuries that are regularly encountered in numerous wounded people and are generally connected with a high impact trauma mechanism. Femoral shaft fractures are fairly common, with 37.1 instances per 100,000 occurring each year.^[2] The majority of these fractures occur in those under the age of 20, and the risk of occurrence rises again in the elderly.^[3] Femoral shaft fractures affect about 19.15 per 100,000 children under the age of 18.^[4] Casting or traction followed by casting has been the standard of care for most pediatric femur fractures. Factors such as the patient's age, the mode of injury, the fracture pattern, and the location all have a part in therapy selection. Femur fractures in children under the age of six months are commonly treated with a Pavlik harness or spica cast. Multiple studies have demonstrated that spica casting (with or without pre-casting traction) produces satisfactory outcomes in children aged 6 months to 5 years.^[5,6] Pediatric orthopedists, on the other hand, have increasingly recognized the benefits of fixation

and rapid mobilization over the last two decades.^[7] The orthopaedist faces unique obstacles while treating a broken femur in a toddler or adolescent. In addition to the smaller size, open physes and immature vascular patterns must be taken into account. While the ability to heal and reconstruct quickly during growth is beneficial, the possibility of interfering with that progress poses unique risks. Treatment selection is influenced by psychological and social factors.^[8] Conservative and non-surgical methods such as skin traction, traction followed by spica, and early spica cast are common for pediatric femoral shaft fractures, while surgical methods such as sub muscular bridge plating, flexible intramedullary fixation, rigid intramedullary fixation, and external fixation methods are popular for various reasons. For juvenile femur fractures, an ideal fixation device would function as a load-sharing "internal splint," sustaining reduction for a few weeks until callus develops. More essential, insertion should not jeopardize the physes or the femoral head's blood supply. According to several recent research, elastic intramedullary nailing fits the criteria for this perfect technology.^[9,10,11,12] Because of fast healing and spontaneous angulation correction, most femoral shaft fractures in children under the age of five may be treated conservatively. Non-operative treatment of such fractures after six years of age, on the other hand, may result in loss of reduction,

malunion, intolerance, and plaster difficulties. Because angular deformity cannot be corrected by growing at the end of skeletal maturity, precise reduction is required. In addition, children may require lengthy bed rest during non-operative therapies, which might isolate them from their typical surroundings and lead to social problems. In light of these considerations, Titanium Elastic Nailing (TEN) has the benefit of being a load-sharing device that is also flexible enough to enable bending, allowing patients some movement. It also eliminates the necessity for physis crossing during insertion. TENs also have an aesthetic benefit over other surgical techniques since they need less incisions and are simple to remove. In this study, Titanium Elastic Nailing was seen in 40 instances of juvenile femoral shaft fractures.

OBJECTIVES

General objective:

To evaluate the role and efficacy of Titanium Elastic Nail in femoral shaft fractures in the 5-13 years age group.

MATERIAL AND METHODS

This observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Bangladesh. The study duration was 2 years and 8 months, from April 2019 to December 2021. The study was conducted with a total of 40 cases of femoral shaft fracture in pediatric patients who were admitted to the study hospital. Informed written consent was obtained from each participants, and ethical approval was obtained from the ethical review committee of the study hospital. Data was

collected regarding patients age, gender, fracture location, fracture type, cause of fracture, post-operative complications, duration of hospital stay and patient satisfaction in a pre-prepared questionnaire. For the TENs treatment method, following preoperative preparations were followed. Determination of the nail diameter was done using Flynn et al.'s formula on the x-ray of the fracture.^[7] Nail diameters were identical to avoid varus or valgus malpositioning. The fractured bone was exposed with opposing longitudinal medial and lateral incisions 2.5–3.5 cm above the level of physis and the soft tissues were spread in the same direction with help of blunt tip scissors. Two weeks of immobilization was mandatory for all patients to avoid entry site irritation. Knee immobilization was removed on the 14th post-operative day. 12-months follow up was conducted for each participant.

Inclusion criteria:

- Age between 5-15 years
- Femoral Fracture (both open and closed)
- Patients whose guardians had given consent to participate in the study.

Exclusion criteria:

- Age >15 years
- Complex femoral fractures
- Itraarticular Fractures
- Overweight patients (50-60 kg)
- Exclude those affected with other chronic diseases etc.

RESULTS

Male prevalence was observed in the present study, with 3.44:1 male: female ratio. Mean±SD



age of the participants was 8.8 ± 1.6 years, and sports injuries were the most common cause of fractures. 72.5% of the participants were aged between 5-10 years, and the age range of the participants was 5-13 years. 50% of the participants had fractures at the middle region of the femur, while 45% had fractures at the proximal region. Mean \pm SD hospital stay duration was 14.5 ± 2.4 days, with 62.58%

having hospital stay between 7-14 days. Majority of the participants of the present study faced no complications, while 20% had <1.0 cm of leg length inequality, 2.5% had 1-2 cm leg length inequality, 2.5% faced infection, 5% faced entry site irritation and 1 patient had soft tissue irritation by prominent nail. At 12-month follow up, 75% had excellent outcomes while 20% had satisfactory outcomes.

Table 1: Gender Distribution of the participants (n=40)

Gender	Frequency	Percentage
Male	31	77.5%
Female	9	22.5%

Among the participants, majority (77.5%) were male, and 22.5% were female. The male: female ratio was 3.44:1.

Table 2: Age distribution of the participants (n=40)

Age in years	Frequency	Percentage
5-10	29	72.5%
11-15	11	27.5%
Age Range	5-13	
Mean \pm SD	8.8 ± 1.6	

Among the participants, majority (72.5%) of the participants were aged between 5-10 years, while the remaining 27.5% were between the age range of 11-15 years. The mean age of the participants was 8.8 years, and the age of the participants ranged from 5-13 years

Table 3: Cause of injury distribution of the participants (n=40)

Cause of Injury	Frequency	Percentage
Sports	16	40.0%
RTA	12	30.0%
Fall	8	20.0%
Minor Trauma	4	10.0%

40% of the participants had sports related injuries as their cause of fracture, while 3% had road traffic accidents. 20% of the participants had fractures from falling from various heights, and 10% of the cases had fractures due to minor traumas.

Table 4: Distribution of the participants by fracture location(n=40)

Location of fracture	Frequency	Percentage
Proximal	18	45.0%
Middle	20	50.0%
Distal	2	5.0%

For half of the cases, the fracture originated at the middle area of the femur, and 45% had fractures at the proximal region, while the remaining 5% had fractures at distal region.

Table 5: Distribution of the participants by hospital stay duration (n=40)

Hospital Stay	Frequency	Percentage
7-14 days	25	62.5%
15-21 days	12	30.0%
>21 days	3	7.5%
Mean±SD	14.5 ± 2.4	

62.5% of the participants had hospital stay of 7-14 days, while 30% had hospital stay of 14-21 days. Only 7.5% of the participants had to stay at the hospital for over 21 days. The average hospital stay duration was 14.5 ± 2.4 days

Table 6: Post-operative complications among the participants

Post-operative complications	Frequency	Percentage
Infection	1	2.5%
<1.0 cm leg length inequality	8	20.0%
1.0-2.0 cm leg length inequality	1	2.5%
Soft tissue irritation by prominent nail	1	2.5%
Entry Site irritation	2	5.0%
No Complications	27	67.5%

Majority of the participants of the present study faced no complications, while 20% had <1.0 cm of leg length inequality, 2.5% had 1-2 cm leg length inequality, 2.5% faced infection, 5% faced entry site irritation and 1 patient had soft tissue irritation by prominent nail.

Table 7: Outcome at 12-months follow-up among the participants (n=40)

Outcome	Frequency	Percentage
Excellent	30	75.0%
Satisfactory	9	22.50%
Poor	1	2.50%

At the follow-up at 12-months, 75% of the participants had reported excellent patient satisfaction, 22.5% reported satisfactory levels of satisfaction, while 1 patient had poor satisfaction levels.



DISCUSSION

Femoral shaft fracture is an extremely common type of fracture during the developing age. Various measures can be taken to treat a fractured femoral shaft, and depending on the severity of the fracture, the necessary process can be conservative or surgical in nature. The present study was conducted with a total of 40 pediatric femoral fracture cases who were treated following the Titanium Elastic Nailing TEN method. Among the participants, majority were male, and 22.5% were female. The Male: Female ratio was 3.44:1. Pediatric femoral fractures are more common among boys compared to girls, due to the high amount of outdoor activities done by boys. The high incidence of male participants in our study was supported by various other studies.^[13,14] 72.5% of the participants were between the age of 5-10 years, and the mean age was 8.8 years. The high incidence of fractures at this age group could be caused by children becoming more interested in various outdoor sports and activities around this age. This was supported by observing the cause of the incidents, where 40% had been injured from sports related incidents, 30% from road traffic accidents, 20% from falls and the remaining 10% had fractures from trivial injuries. These causes were also similar to the findings of other studies regarding pediatric fracture, though the incidence distribution was different in some cases.^[15,16,17] Half of the participants had fractures in the middle regions, 45% had fractures in the proximal regions, and the remaining 2 had distal fractures. 62.5% of the present study participants had hospital stay of 7-14 days, and 30% of the participants had hospital stay duration of 15-21 days. Only 3

participants had hospital stay of >3 weeks, and the mean hospital stay duration was 14.5 days. This was higher than other studies regarding TENS fixation of femoral shaft fractures, where patients had to stay at the hospital for shorter durations.^[2] This discrepancy can be explained by the fact that our study was conducted during the global COVID pandemic, and hospital admission and discharge processes became complicated in all departments. For post-operative complications, 67.4% reported no complications, 1 patient had infection due to open fractures and 8 patients had leg length inequality of <1 cm, which was common in this type of surgery. 1 patient had leg length inequality of 1.0-2.0 cm, 1 complained regarding soft tissue irritation due to prominent nail, and 2 complained about entry site irritation from TENs. Patients were managed at the hospital for their duration of stay, and full weight bearing was permitted at 8.5 weeks on average. At a 12-month follow-up, the results were excellent for 75% of cases, satisfactory for 22.5% of cases, and poor for 2.5% of cases. The poor outcome came from the singular infection cases among the participants. These results were measured by following the scoring criteria for TEN used by Flynn et al.^[2]

Limitations of The Study

The study was conducted in a single hospital with a very small sample size. So, the results may not represent the whole community.

CONCLUSIONS

The titanium elastic nailing is an effective and viable treatment option in selected cases of femoral shaft fractures in the 5-13 years' age

group. Even if it is done by open reduction, it gives much better result than traction & Spica cast or any other methods, in respect to patient

& parent's satisfaction & shorter confinement to bed & hospital stay.

REFERENCES

1. Flynn JM, Schwend RM. Management of pediatric femoral shaft fractures. *J Am Acad Orthop Surg.* 2004;12(5):347-59. doi: 10.5435/00124635-200409000-00009.
2. Liao GZQ, Lin HY, Wang Y, Nistala KRY, Cheong CK, Hui JHP. Pediatric Femoral Shaft Fracture: An Age-Based Treatment Algorithm. *Indian J Orthop.* 2020;55(1):55-67. doi:10.1007/s43465-020-00281-6
3. Hedlund R, Lindgren U. Epidemiology of diaphyseal femoral fracture. *Acta Orthop Scand.* 1986;57(5):423-7. doi: 10.3109/17453678609014762.
4. Hinton RY, Lincoln A, Crockett MM, Sponseller P, Smith G. Fractures of the femoral shaft in children. Incidence, mechanisms, and sociodemographic risk factors. *J Bone Joint Surg Am.* 1999;81(4):500-9. doi: 10.2106/00004623-199904000-00007.
5. Rasool MN, Govender S, Naidoo KS. Treatment of femoral shaft fractures in children by early spica casting. *S Afr Med J.* 1989;76(3):96-9.
6. Burton VW, Fordyce AJ. Immobilization of femoral shaft fractures in children aged 2-10 years. *Injury.* 1972;4(1):47-53.
7. Flynn JM, Hresko T, Reynolds RA, Blasier RD, Davidson R, Kasser J. Titanium elastic nails for pediatric femur fractures: a multicenter study of early results with analysis of complications. *J Pediatr Orthop.* 2001;21(1):4-8. doi: 10.1097/00004694-200101000-00003.
8. Anglen JO, Choi L. Treatment options in pediatric femoral shaft fractures. *Journal of orthopaedic trauma.* 2005;19(10):724-33.
9. Bar-On E, Sagiv S, Porat S. External fixation or flexible intramedullary nailing for femoral shaft fractures in children: a prospective, randomised study. *The Journal of Bone and Joint Surgery. British volume.* 1997;79(6):975-8.
10. Flynn JM. Current treatment options for pediatric femur fractures. *Univ PA Orthop J.* 1998;11:27-35.
11. Gregory P, Sullivan JA, Herndon WA. Adolescent femoral shaft fractures: rigid versus flexible nails. *Orthopedics.* 1995;18(7):645-9.
12. Heinrich SD, Drvaric DM, Darr K, MacEwen GD. The operative stabilization of pediatric diaphyseal femur fractures with flexible intramedullary nails: a prospective analysis. *Journal of pediatric orthopedics.* 1994;14(4):501-7.
13. Hinton RY, Lincoln A, Crockett MM, Sponseller P, Smith G. Fractures of the femoral shaft in children. Incidence, mechanisms, and sociodemographic risk factors. *JBS.* 1999;81(4):500-7.
14. Heideken Jv, Svensson T, Blomqvist P, Haglund-Åkerlind Y, Janarv PM. Incidence and trends in femur shaft fractures in Swedish children between 1987 and 2005. *J Pediatr Orthop.* 2011;31(5):512-9. doi: 10.1097/BPO.0b013e31821f9027.
15. Flynn JM, Schwend RM. Management of pediatric femoral shaft fractures. *J Am Acad Orthop Surg.* 2004;12(5):347-59. doi: 10.5435/00124635-200409000-00009.
16. Hedlund R, Lindgren U. The incidence of femoral shaft fractures in children and adolescents. *J Pediatr Orthop.* 1986;6(1):47-50. doi: 10.1097/01241398-198601000-00010.
17. Schwend RM, Werth C, Johnston A. Femur shaft fractures in toddlers and young children: rarely from child abuse. *J Pediatr Orthop.* 2000;20(4):475-81.

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