



Journal Homepage: www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/22010

DOI URL: <http://dx.doi.org/10.21474/IJAR01/22010>



RESEARCH ARTICLE

FUNCTIONAL OUTCOME OF TITANIUM ELASTIC NAILING FOR PEDIATRIC FEMORAL SHAFT FRACTURE

Akshay P¹, Vinod Kumar K² and Nagakumar J S³

1. Senior Resident, Dept. of Orthopaedics (Sri Devraj Urs Medical College).
2. Associate Professor, Dept. of Orthopaedics (Sri Devraj Urs Medical College).
3. HOD, Dept. of Orthopaedics (Sri Devraj Urs Medical College).

Manuscript Info

Manuscript History

Received: 15 August 2025

Final Accepted: 17 September 2025

Published: October 2025

Key words:-

TENS, Pediatric femur, Functional outcome, Flynn's criteria

Abstract

Injuries to the femoral shaft are prevalent in children which are most commonly caused by automobile accidents, sports injuries, and physical assault. The present study focuses on managing limb shaft fractures in 6 and 16 yrs children by Titanium elastic nailing. This is a retrospective study of thirty patients aged 6 to 16 who had displaced diaphyseal femur fractures repaired with elastic titanium nails and were closely observed clinically and radiologically for at least 6 months to a year. This research leads to the conclusion that the standard surgical treatment for femoral diaphyseal fractures in children between the ages of 4 and 16 is fracture reduction and internal fixation with elastic titanium nails. This procedure is minimally invasive, takes less time, and does not harm the child's cartilage, ensuring a relatively stable attachment also allows for early mobilization, which facilitates early bone consolidation.

"© 2025 by the Author(s). Published by IJAR under CC BY 4.0. Unrestricted use allowed with credit to the author."

Introduction:-

Femur shaft fractures are a common injury in children, accounting for around 1.6% of all wounds in children. [1] The most prevalent causes of injury are engine vehicle accidents, game injuries, genuine attacks, or other unusual reasons. [2] Physical realignment with proper hip and knee joint function is the goal of treatment for femoral shaft fractures. Treatment ranges from strict nonsurgical techniques (such as hip Spica) to cautious adjustments (using adaptable intramedullary nailing, unbending trochanteric section nailing, outside fixation, or plating and screws). [3]

Femoral shaft fractures in children under the age of four are usually treated conservatively because the majority of them heal rapidly and spontaneously, correcting the angulation and for patients over the age of sixteen, intramedullary nailing is the suggested therapeutic option. [4] However, in a group of children aged 4 to 16, intramedullary nailing is not feasible due to skeletal adolescence, and moderate treatment may result in loss of reduction, discrepancy in appendage length, deformities, malunion, and other psychosocial confusion; older children also do not tolerate the application of casts for an extended period of time. [5] So in this age group of pediatric Titanium flexible nailing framework gaining popularity owing to similar steady versatile devotion, near easy and little obtrusive system without hurting the development capacity of developing children. [6]

Therefore, it is of interest to report on the outcome of the children with shaft of femur fractures treated with TENS (titanium flexible nailing framework). This study is a retrospective analysis of children aged 4 to 16 who had femur shaft fractures treated by TENS nailing and considers the poor level of evidence in the literature and the widespread use of titanium flexible nails. Additionally, we have to focus on the relationship and consequences of femoral shaft following TENS treatment.

Aim and the Objectives:-

This study's major goal was to assess the clinical and functional results of closed reduction and internal fixation (CRIF) for femur shaft fractures in children aged 4 to 14 using a titanium elastic nail.

Materials and the Method:-

This is a Retrospective time based cohort study conducted at the Department of Orthopedics, RL Jalappa Hospital aged 4-16yrs diagnosed with closed shaft of femur fracture treated with TENS nailing dating from February 2018 to September 2021 as per the dept OT entry registry. Fractures meeting the following inclusion and exclusion criteria were considered for the study

Inclusion-Criteria:-

1. The age range of 4 to 16 years
2. Male and female children's
3. Fractures of the Diaphyseal
4. A closed fracture
5. Children who received at least six months of follow-up care.

Exclusion Criteria:-

1. Metaphyseal fracture
2. Pathological fracture
3. Fracture with other associated injuries

When each patient was deemed fit for surgery, the procedures were carried out as soon as feasible. Flynn's formula for nail diameter calculation was used to determine each nail's diameter. The formula of Flynn et al[7]. The width of the isthmus, or narrowest point of the medullary canal, on an AP or lateral view, multiplied by 0.4 mm is the equivalent of the TENS nail diameter.

Surgery Procedure: Under fluoroscopic guidance, patients were operated on using traction tables. Reduction tried using C arm guidance and following appropriate reduction of fracture location. A small skin incision was performed on the medial and lateral side of the distal thigh, approximately 2 cm in front of the distal epiphyseal plate, under C-arm guidance. The previously reduced fracture site was then crossed by one titanium elastic nail (TENS), then by another nail. Up until the fracture site, TENS of the proper size (usually 2-3.5mm) with curve ends were injected simultaneously from the medial and lateral sides. The nails were proceeded so that the lateral nail was placed just below the trochanter physics and the medial side nail was inserted into the femur neck just below the physics. After the nails were properly trimmed and positioned, their ends were curved so that they would never protrude above the distal epiphysis plate on television. They were also not to be overly sharp so as to avoid irritating the skin. Ultimately, the introduction website was shut down. The total patients that were operated were 30. The radiological and the clinical data were obtained from the dept. registry and from moksha software rented by our hospital. Patients was followed at 6 and 12week. The final followup and outcome for above collected data and observations was done as per Flynn's criteria (Table 1). [4]

Table 1	Excellent	Successful	Poor
Limb length discrepancy	< 1.0cm	< 2cm	> 2cm
Sequence Disorder	5 ⁰	10 ⁰	>10 ⁰
Pain	Absent	Absent	Present
Complication	Absent	Mild	Major Complication or increased Morbidity

Results:-

The average age of the children's was 11.3 years, and they ranged in age from 7 to 15. Patients are divided two to one in favour of men (20:10). More right femur injuries occurred than left, with a transverse fracture pattern accounting for 60% of cases. The average length of stay in the hospital ranged from 5 to 7 days. The bulk of the patients had injuries from motor vehicle collisions; 24 patients (80%) had fallen while playing, and 1 patient had been physically assaulted. There were no cases of bilateral and segmental fractures observed. Of all the patients, twenty-five had a midshaft fracture, three had proximal femur fractures, and two had distal femur fractures. The left side was observed in 11 cases (36.6%) and the right side in 63.3% of the cases (19). There was a one-to-four-day interval, on average, between the injury and operation. Three had spiral fractures, eight had oblique fractures, and nineteen had transverse fractures in our study.

At all patients, partial weight bearing began after three weeks, and complete weight bearing began following radiographic confirmation of union in a maximum of ten weeks. At a usual 3 weeks, a follow-up radiograph revealed a spanning callus with no less than three cortices. The patients that make up the majority of the group (25) accomplished association by about a month and a half (6 weeks) with normal opportunity to association being following 10 weeks. Flynn's criteria were used to evaluate the results, which were deemed outstanding in 28 (93.33 percent) instances and adequate in 02 (6.66 percent) cases. There was not a single patient who had a negative outcome. Excellent results were obtained in 18 (60%) cases of transverse fractures, 11 (36.66%) cases of oblique fractures, and 1 case (3.34%) of spiral fractures. Soft tissue irritation occurred in 2(6%) of the instances, while other problems, such as limb length disparity in 3(10%) of the cases, are not substantial and fall into the excellent group according to Flynn criteria. Eight cases showed an angulation of ten degrees.

Complications: The patient experienced a nail outgrowth at the fourth month following fracture union, which was surgically removed. There is never a deep infection, angular or rotational deformity, limb length discrepancy, discomfort, limping, or abnormal gait in the patient.

Discussion:-

For children and young adolescents with diaphyseal femur fractures, skeletal traction combined with the use of a Plaster of Paris (POP) cast has been the recommended course of treatment up until this point. Nonetheless, a variety of strategies have been tried by orthopedics to avoid delayed immobilization and provide better nursing care. Further investigations have further increased our understanding of the psychological and financial effects of Spica- cast immobility on children and their families. [8, 9] The most successful results in recent years have been obtained with flexible intramedullary nailing. Since the titanium flexible nail is a load-sharing internal device/splint that doesn't abuse or destroy physical structures, allows for annual joint mobilization, and maintains alignment in place, it seems to be preferable over other cautious strategies, especially in the pediatric age. Our study's average age is 8.5 years old. In Flynn JM et al.'s study, the average age was 10.2 years. [10] Twenty boys (66.6%) and ten girls (33.3%) make up the sex incidence in our study. This is comparable to a study by Bhasker et al. that examined 60 patients in total and discovered that 36.6% of them were girls and 63.4% of them were boys. [11]

In our study group, motor vehicle accidents (RTAs) account for the majority of injuries (totaling 80.8% [20] patients). In Flynn et al.'s comparison analysis, we found that 58.1% of cases were RTAs, while the remaining 8% involved falls from a height or physical assault. [10] According to our research, there may be more road traffic accidents (RTAs) as a result of inexperienced drivers, bad road conditions, a lack of street lighting, or a recent increase in the number of vehicles in emerging nations. The average union time in our study is nine weeks, while the average union times in Saikia et al.'s study and Bhasker et al.'s study were eight and twelve weeks, respectively. [1] In our research, we began complete weight bearing by the tenth week on average, but Saikia et al. permitted weight bearing by the eighth week on average. [12]

Only 2(6%) of the patients in our study experienced mild pain, particularly at the site of entrance from nail protrusion from the distal femur. This pain was relieved with enough time and medication, as reported by Flynn et al. [4], who also reported excruciating pain at the site of insertion in about 16.2% of instances with nail addition. None of our patients experienced limb lengthening or deep infection, in contrast to Flynn et al.'s 10 cases of mild angulation and Khazzam et al.'s detailed excess of multiple (2–3) cm in 3 patients, which is comparable to our study's total of 8 (26%) occurrences of angulation. [13] In our study, the end result was adequate in 2 cases (6%), and excellent in 28 cases (93.3%). Saikia et al. likewise reported outstanding outcome in 79%, satisfactory in 17.2%, and

poor in 3.6% cases in their investigations. Flynn et al. had excellent outcome in 85% cases, satisfactory in 5% cases, and poor in 10% cases. [13, 10]

Conclusions:-

In view of our study, our decision is that close reduction and internal fixation with titanium elastic nailing is standard strategy for treatment in femoral shaft fractures in youngsters' between 4-16 years old group as it is a negligibly intrusive, less tedious method with no harm to development plate in developing kid's which gives relatively stable fixation. It additionally permits early mobilization which helps in early bony union and better outcome and absent physcal and cartilage injuries.

References:-

1. Saikia KC et al Titanium elastic nailing in femoral diaphyseal fractures of children in 6-16 years of age. Indian J Orthop. 2007 41(4):381-5. [PMID: 21139795] <https://pubmed.ncbi.nlm.nih.gov/21139795/>, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989518/>
2. Viljanto J et al Indications and results of operative treatment of femoral shaft fractures in children. Acta Chir Scand. 1975 141(5):366-9. [PMID: 1179927] <https://pubmed.ncbi.nlm.nih.gov/1179927/>
3. Denisiuk M&Afsari A. Femoral Shaft Fractures. [Updated 2023 Jan 2]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK556057/>
4. Flynn JM, et al 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. [PMID: 11176345]. <https://pubmed.ncbi.nlm.nih.gov/11176345/>
5. Bhasker A. Mumbai treatment of long bone fractures in childrens by titanium elastic nailing. Ind J Orthop. 2005; 39(3):166-8. <https://www.researchgate.net/publication/26489220>
6. Khuntia S, Swaroop S, Patro BP, Sahu S. Paediatric Long Bone Fractures Managed with Elastic Intramedullary Nails: A Retrospective Study of 30 Patients. Cureus. 2020 Apr 27;12(4):e7847. doi: 10.7759/cureus.7847. [PMID: 32483498] <https://pubmed.ncbi.nlm.nih.gov/32483498/>
7. Ansari MA Q. A study of titanium elastic nailing in the surgical management of fracture shaft of femur in children. Ind J Ortho Surg 2021;7(3):227-232. <https://www.ijos.co.in/html-article/14623>
8. Reeves RB, Ballard RI, Hughes JL. Internal fixation versus traction and casting of adolescent femoral shaft fractures. J Paediatr Orthop 1990 10(5):592-5. [PMID: 2394812] <https://pubmed.ncbi.nlm.nih.gov/2394812/>.
9. Hughes BF, Sponseller PD, Thompson JD. Paediatric femur fractures: effect of Spica cast treatment on family and community. J Paediatr Orthop 1995 15(4):457-60. [PMID: 7560034] <https://pubmed.ncbi.nlm.nih.gov/7560034/>
10. Flynn JM, Luedtke LM, Ganly TJ, Dawson J, Davidson R, Dormans JP, et al. Comparison of Titanium Elastic Nails with Traction and a Spica Cast to Treat Femoral Fractures in Children. J Bone Joint Surg Am. 2004 86(4):770-8. [PMID: 15069142] <https://pubmed.ncbi.nlm.nih.gov/15069142/>
11. Govindasamy R, Gnanasundaram R, Kasirajan S, Ibrahim S, Melepuram JJ. Elastic Stable Intramedullary Nailing of Femoral Shaft Fracture-Experience in 48 Children. Arch Bone Jt Surg. 2018 Jan;6(1):39-46. [PMID: 29430494] <https://pubmed.ncbi.nlm.nih.gov/29430494/>
12. Donati F, Mazzitelli G, Lillo M, Menghi A, Conti C, Valassina A, Marzetti E, Maccauro G. Titanium elastic nailing in diaphyseal femoral fractures of children below six years of age. World J Orthop. 2017 Feb 18;8(2):156-162. doi: 10.5312/wjo.v8.i2.156. [PMID: 28251066] <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5314145/>
13. El-Adl G, Mostafa MF, Khalil MA, Enan A. Titanium elastic nail fixation for paediatric femoral and tibial fractures. Acta Orthop Belg. 2009; 75(4):512-20. [PMID: 19774819] <https://pubmed.ncbi.nlm.nih.gov/19774819/>
14. Bhasker A. Mumbai treatment of long bone fractures in childrens by titanium elastic nailing. Ind J Orthop. 2005; 39(3):166-8.
15. Khazzam M, Tassone C, Liu XC, Lyon R, Freeto B, Schwab J, et al. Use of Flexible Intramedullary Nail Fixation in Treating Femur Fractures in Children. Am J Orthop. 2009; 38(3):49-55.
16. Flynn JM, Luedtke LM, Ganly TJ, Dawson J, Davidson R, Dormans JP, et al. Comparison of Titanium Elastic Nails with Traction and a Spica Cast to Treat Femoral Fractures in Children. J Bone Joint Surg Am. 2004; 86(4):770-8.