International Journal of Orthopaedics Sciences

**ISSN:** 2395-1958
IJOS 2018; 4(4): 499-503

www.orthopaper.com
Received: 15-08-2018
Accepted: 17-09-2018

**Dr. Tarkik K Amin**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Dr. Vipul R Makwana**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Dr. Dhaval R Modi**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Dr. Arpit V Joshi**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Dr. Mrudul M Prajapati**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Dr. Muzammil M Kazi**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Dr. Nishant V Bhavsar**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

**Correspondence**
**Dr. Tarkik K Amin**
Department of Orthopaedics, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

# Titanium elastic nailing in shaft femur fracture in paediatric patients

**Dr. Tarkik K Amin, Dr. Vipul R Makwana, Dr. Dhaval R Modi, Dr. Arpit V Joshi, Dr. Mrudul M Prajapati, Dr. Muzammil M Kazi and Dr. Nishant V Bhavsar**

**DOI:** https://doi.org/10.22271/ortho.2018.v4.i4f.54

**Abstract**
**Background:** Paediatric shaft femoral fracture can be treated either conservatively or by internal fixation. Complications inherited with cast management and advantages of the intramedullary nailing in long bone fracture, resulted in increased use of this technique for paediatric shaft femur fracture. We conducted a retrospective study of the patients treated with close intramedullary nailing by using titanium elastic nail in shaft femur fracture for paediatric patients.
**Materials & Methods:** During 2013 and 2016, we have conducted a retrospective study of 40 diaphyseal fractures of femur using closed titanium elastic nail (TEN), in paediatric patients(24 male and 16 female). Patients' evaluation was done using Flynn criteria, resumption of school and associated complications.
**Results:** With minimum follow-up period of 6 months, 92.5% of the patients had shown radiological union by 4 to 6 weeks with resumption of school by 8 weeks. According to Flynn criteria, excellent results were achieved in 31 (77.5%) patients, good result in 8 (20%) and poor result was present in 1(2.5%) case.
**Conclusions:** Titanium elastic nailing in paediatric patients with shaft femur fracture is a safe, simple and reproducible technique with minimum complications, leading to early return to preinjury level with minimum morbidity.

**Keywords:** Titanium elastic nail, paediatric patient, shaft femur fracture, Flynn criteria

## Introduction
Disadvantageous children with fracture have in their part the great advantage of remodelling of bones [1]. Because of remodelling, till recently conservative treatment remains the main modality of management for different fractures in children including shaft femur fracture especially in preschool aged children [2]; conservative methods of paediatric shaft femur fracture include application of spica cast or traction. Despite the effectiveness of the conservative treatment, there are also number of complications associated with conservative methods along with added advantages like reduced healing time, resumption of weight bearing and better long term functional outcome of intramedullary nailing. [3-5].
There is no doubt regarding treatment of shaft femur fracture in children up to one year in which conservative method works best [2]. In patients more than 6 years conservative method usually does not work and surgery with nailing is indicated in them. Confusion regarding treatment remains in age group of one year to 6 years. Though children in this age group can adapt well with the spica, there are complications like loss of reduction, malunion with deformity and skin problem related with spica and also the issue related with personal hygiene [6]. With availability of titanium as an elastic and biocompatible material, internal stabilization of the fracture with TEN has simplified the management of paediatric shaft femur fracture in all age groups with decrease in complications related to conservative management. Recently major focus has been given to the internal fixation and early mobilization with early returning to the function which for the children would be to join the school. By doing the internal fixation, one can have some surety regarding the length, rotation and alignment of fracture fragment which would have great impact on the outcome. Keeping all these thing, we have done a retrograde study of results of TEN in paediatric shaft femur fracture.

**Materials and Methods**

We have retrospectively studied 40 cases of paediatric shaft femur fracture during the period of 2013 to 2017 treated with TENs. The inclusion criteria for this study was all close and open grade (OG)-I and II fracture of shaft of femur in patient with 2 to 14 years of age. Patients with metadiaphyseal fracture, OG-III fracture, pathological fracture, patients with less than 2 years and more than 14 years of age were excluded from the study.

Average age of the patient in this study was 6 years. Out of 40 patients, there were 24(60%) boys and 16(40%) girls, of which 21(52.5%) were of right side, 17(42.5%) patients were of left side and 2(5%) patients had bilateral fractures. Thirty eight (38) patients had unilateral fracture and 2 patients had bilateral fracture. Motor vehicle collision was responsible for fracture in 11(27.5%) patients while fall while playing was the cause in 22(55%) patients and fall from height was responsible in 7(17.5%) cases. On classification of the fractures, 7(17.5%) fractures were transverse, 9(22.5%) oblique, 19(47.57%) spiral and 5(12.5%) had butterfly fragment. Depending upon anatomic location of fractures, 12(30%) fractures had involved proximal 1/3$^{rd}$ of shaft femur, 19(47.5%) fractures were in middle 1/3$^{rd}$ and 9(22.5%) fractures were in distal third. Out of 40 patients, 36(90%) were closed, 3(7.5%) were OG-I and 1(2.5%) patient had OG-II fracture. In all patients two TENs were used, one nail from medial side and another from lateral side. TENs are available with diameter from 2mm to 4mm and universal length of 440 mm; different colour coding is available depending upon the diameter of nails (Fig 1).

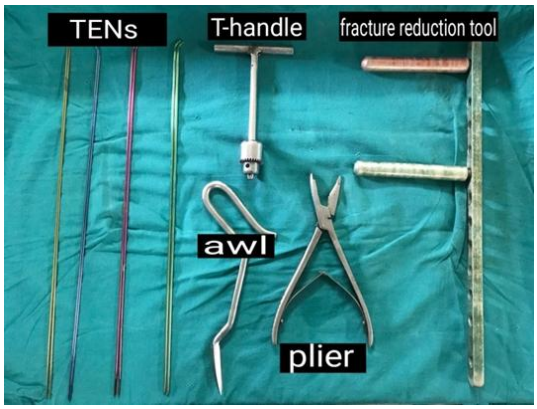


**Fig 1:** Titanium elastic nail (TEN) along with instrument for its use

Diagnosis of the patient was done by proper history and radiological examination (Fig 2).

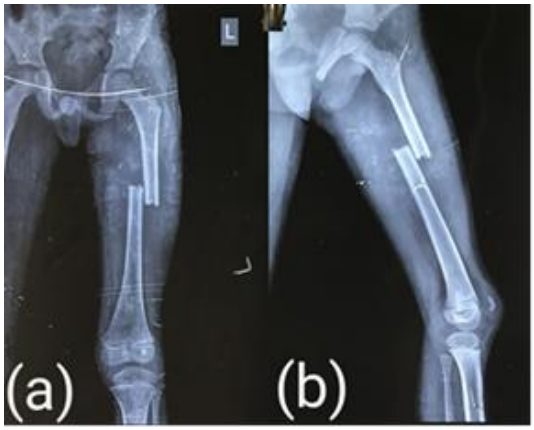


**Fig 2:** Preoperative radiograph: (a) Antero-posterior view and (b) Lateral view

All patients were assessed in detail to rule out any other injury. After proper preoperative laboratory investigation and anaesthetic assessment, patients were taken for surgery. All the surgeries were done under general anaesthesia on simple radiolucent table with C-arm assistance. The surgery was done in supine position with a single bolster under knee joint. A mark for incision is made by keeping the tip of an artery forceps over suprapatellar region on medial side and lateral side one following other under c-arm guidance (Fig 3).

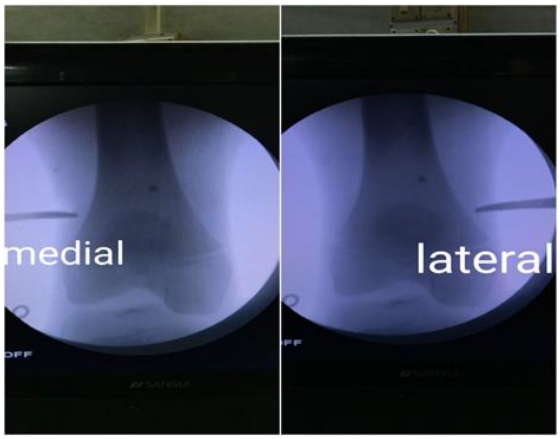


**Fig 3:** Use of artery forceps under C-arm guidance to determine the site of skin incision and TEN entry on both (a)medial and (b)lateral side of distal femur

Skin incision of approximately 1cm in size was made over both medial and lateral side of supracondylar region of femur under c-arm guidance, which were made approximately 2.5 cm proximal to the distal femoral physes. Entry in the bone was taken with an awl under C-arm control which is also located approximately 2.5 cm above the physes. A proper sized nail was contoured according to the location of the fracture and nail was introduced till fracture. Reduction of the fracture is achieved under C-arm guidance and once fracture is reduced in both AP and Lateral plane, nail is advanced across the fracture site and progressed in proximal fragment till proper length of the nail is achieved in proximal fragment. Same procedure is repeated from other side and 2$^{nd}$ nail is introduced. Nails were cut in a way that approximately 1 cm of nail will remain outside the bone which will help in easy removal of nail (Fig 4).


**Fig 4:** Immediate (a) Antero-posterior and (b) Lateral radiographs of the same patient shown in Fig1

After discharge, patients were followed up weekly till suture removal, that is approximately done by two weeks; then on monthly interval till fracture union is achieved and then every 3 months till completion of 1 year. During each follow-up visit, clinical and radiological evaluations were carried out.

**Results**

Study of the results were done retrospectively with detailed evaluation of cases along with personal interview, clinical examination and radiological evaluation at the time of follow-ups. The study was conducted by dividing patients in two age groups. Those belonging to 2-6 years of age-group were 17 (42.5%) and patients between 7-14 years were 23 (57.5%) in numbers. Average duration between injury and surgery was 24 hours in 36 cases while in 4 patients, the surgery was done within 48 hours of injury. Patients below 12 years of age were given general anaesthesia while spinal anaesthesia was given in patients with age more than 12 years. Mean surgery time was 60 minutes. In all patients two nails were used for fracture stabilization. Four (10%) patients were discharged from the hospital on first postoperative day while 34 (85%) patients were discharged on 2nd postoperative day. The remaining 2 patients were transferred to paediatric department for the management of fever and they were discharged from the hospital by 5th-7th day of surgery. Suture removal was done in each and every patient on 15th postoperative day and after that the regular follow-ups were done at 1 month, 2 month, 3 month and 6 month postoperatively. During each follow-up visit, patients were interviewed personally along with proper clinical examination and radiological evaluation. Radiological union was started appearing 4-6 weeks (Fig 5) and clinical union was seen around 6-8 weeks.


**Fig 5:** One month post-operative radiograph, both (a) Antero-posterior and (b) Lateral view

Partial weight bearing was started by 4 weeks and full weight bearing was started by 8 weeks. Thirty seven (92.5%) patients started going to their school by 2 months of surgery while remaining 3 patients joined their schooling at 3 months from the surgery. In all patients, the hip and knee range of movement was full (fig 6).


**Fig 6:** Final follow up at one year: (a) and (b) represent radiograph with complete union with nails in situ. (c) & (d) showing clinical images.

Two (5%) patients had superficial suture site infection which was resolved by regular dressing only. Six (15%) patients had entry site irritation and nail backing out was present in 3 (7.5%) patients which did not hamper their activity of daily living. Shortening was present in three (7.5%) patients. Two patients had shortening of 1 cm while one patient had shortening of 1.5 cm. Varus malalignment was present in one patient which had a butterfly fragment preoperatively. The final result was evaluated by Flynn criteria [7]. In our study, according to Flynn criteria [Table 1], excellent results were achieved in 31 (77.5%) patients, good result in 8 (20%) patients and poor result was present in 1(2.5%) case.

**Table 1:** Flynn criteria and result of this study according to it

| | Excellent | Satisfactory | Poor |
|---|---|---|---|
| Length discrepancy | <1cm | <2cm | >2cm |
| Malalignment | 5degree | 10degree | >10degree |
| Pain | No | No | Yes |
| Complications | None | Minor and Solved | Major and Residual |
| Results (n=40) | 31(77.5%) | 8(20%) | 1(2.5%) |

**Discussion**

Paediatric shaft femur fracture constitutes around 4% of skeletal lesion in children [8]. These fractures are treated either conservatively with application of hip spica, skeletal traction or operatively [9-12]. Children are fortunate to have the capacity of remodelling following fracture [1]. This biological process had led to the use of conservative treatment of paediatric shaft femur fracture with hip spica or skeletal traction. Patients with hip spica and his/her family bears a lot of psychosocial as well as financial problems [13-14]. There are certain complications which are inherent with spica treatment which include chances of loss of reduction, plaster sore, skin irritation, personal hygiene of child and difficulty in travelling as well as mobilization, loosening of cast etc. Also in country like India with hot and humid atmosphere, hip spica causes a lot of discomfort to the child. Parents have to keep a constant watch regarding the management of the cast and they have to look after the child so that he/she does not insert any foreign material in spica which may cause skin irritation or ulceration. Same is true regarding insect invasion in to spica. A study by Catena *et al*. states that in children aged from early infancy to age of 6 years with shaft femur fractures can be treated with cast with positive long-term outcome, but the thing which

should be noted is the suffering of children and their parents during the casting period as well as early rehabilitation [15]. With a wide acceptance and success of intramedullary nailing in adult shaft femur fracture, the idea of using intramedullary nailing has been put forward by multiple orthopaedic surgeons. For children with more than 6 years of age intra medullary nailing with TEN was our treatment of choice. In patients with age group of 2-6 years, we routinely explain the parents for either conservative versus operative intervention with TENs. In all 17 patients between 2 to 6 years of age, the parents elected surgical intervention. Spica *et al*. had shown that the patients between 6-16 years of age treated with TENs (22 patients) resulted in excellent results in 59% and successful in 27.2% of patients [16]. In our study, result was excellent in 77.5% of cases, satisfactory in 20% and poor in 2.5%. In our series, all fractures united within 8 weeks of surgery with TENs while in study by Singh R. *et al*. shown union at 4 months post fixation with shorter union time in patients with less than 10 years of age [17]. Houshion *et al.* reported that in their series, union was seen by 5-9weeks. In our series, 95% of patients were discharged within 48 hrs of surgery which shows a significant reduction in the hospital stay [18], which in turn reduces expense of the treatment. Singh R. *et al.* had shown that in their study hospitalization time was 12-30 days. Heendon *et al.* showed that hospital stay with non-surgical group averaged 28days and in surgical group on averaged
17 days [19]. Partial weight bearing was started at 4-6 weeks and full weight bearing was started at 8 weeks by which time patients have started going to their schools, which was compared with study by Singh R. *et al.* (partial weight bearing: 4.56 weeks, full weight bearing: 8.3 weeks respectively) as well as to other literatures. Only one patient with comminuted fracture had varus malalignment (5 degree) which was not significant clinically. From just one patient, any conclusion cannot be drawn, though the thin nails were seemed to be responsible for varus malunion which should be treated by thicker nail, a period of traction or a brace. Shortening was seen in 3 patients but these were not clinically significant and also the patient didn't complaint about the same. Entry sight irritation was present in 6 (15%) patients, which seems to be the most common complication in our series followed by shortening (3 patients), backing out of nail (3 patients) and suture site infection (2 patients). In study by Singh R. *et al.* also entry sight irritation was main complication (14.2%). The cause of entry site irritation was seemed to be too long nail that were kept outside bone which should be prevented by properly measuring the nail under C-arm while doing final impaction. Nail backed out was seen in three patients. All of these 3 patients were having spiral fracture. Similar to comminuted fracture, thicker nails with bent at the apex of the fracture should be used with or without a short period of traction. Suture site infection was resolved by routine dressing only and did not required any specific antibiotic or active intervention. In our series, removal of the nail was done between 12 to 18 months of surgery following which no period of immobilization or non-weight bearing walking was advised. According to Flynn criteria, 31(77.5%) patients had excellent outcome, 8(20%) had satisfactory and 1(2.5%) had poor outcome. Various cohort studies and systematic reviews have shown excellent result with flexible nailing for children and few studies have extended its indication to preschool children also [20-24].

To conclude, shaft femur fracture in age group of 2-16 years, can be treated with TENs with good outcome and without significant complication. TENs resulted in early return to the pre-injury level activity with resumption of school, decreased hospital stay, lesser financial burden on family without the complications inherited with conservative management.

**References**


1. Kaye E, Wilkins. Principles of fracture remodelling in children. *Injury* Int. J. Care Injured. 2005; 36:3-11.
2. Jauquier N, Doerfler M, Haecker FM, Hasler C, Zambelli PY, Lutz N. Immediate hip spica is as effective as, but more efficient than, flexible intramedullary nailing for femoral shaft fractures in pre-school children. J Child Orthop. 2010; 4:461-5.
3. Bopst L, Reinberg O, Lutz N. Femur fracture in preschool children: Experience with flexible intramedullary nailing in 72 children. J Pediatr Orthop 2007; 27:299-303.
4. Lascombes P, Haumont T, Journeau P. Use and abuse of flexible intramedullary nailing in children and adolescents. J Pediatr Orthop. 2006; 26:827-34.
5. Saseendar S, Menon J, Patro DK. Treatment of femoral fractures in children: Is titanium elastic nailing an improvement over hip spica casting? J Child Orthop 2010; 4:245-51.
6. Hedlung R, Lidgren U. The incidence of femoral shaft fractures in children and adolescents. J Pediatr Orthop 1986; 6:47-50.
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; 21:4-8.
8. Rockwood and Wilkins' textbook of Fractures in Children, eighth edition, 987.
9. Rush JK, Kelly DM, Sawyer JR, Beaty JH, Warner WC Jr. Treatment of pediatric femur fractures with the Pavlik harness: Multiyear clinical and radiographic outcomes. J Pediatr Orthop. 2013; 33:614-7.
10. Podeszwa DA, Mooney JF. 3 rd, Cramer KE, Mendelow MJ. Comparison of Pavlik harness application and immediate spica casting for femur fractures in infants. J Pediatr Orthop. 2004; 24:460-2.
11. Vanlaningham CJ, Schaller TM, Wise C. Skeletal versus skin traction before definitive management of pediatric femur fractures: A comparison of patient narcotic requirements. J Pediatr Orthop. 2009; 29:609-11.
12. D'Ollonne T, Rubio A, Leroux J, Lusakisimo S, Hayek T, Griffet J. Early reduction versus skin traction in the orthopaedic treatment of femoral shaft fractures in children under 6 years old. J Child Orthop. 2009; 3:209-15.
13. Buechsenschuetz KE, Mehlman CT, Shaw KJ, *et al*. Femoral shaft fractures in children: Traction and casting versus Elastic stable intramedullary nailing. J Trauma. 2002; 53(5):914-21.
14. Hedin H, Bergquist L, Larssen S. A cost analysis of three method of treating femoral shaft fractures in children. Acta Orthop Scand. 2004; 75:241-48.
15. Catena N, Senes FM, Riganti S, Boero S. Diaphyseal femoral fractures below the age of six years: Results of plaster application and long term followup. Indian J Orthop. 2014; 48:30-4.
16. KC Saikia, SK Bhuyan, TD Bhattacharya, SP saikia. Titanium elastic nailing in femoral diaphysial fracture of children in 6 to 16 years of age, Indian J Orthop. 2007; 41(4):381-385.

17. Singh R, Sharma SC, Magu NK, Singla A. Titanium elastic nailing in pediatric femoral diaphyseal fractures. Indian J Orthop. 2006; 40:29-34.
18. Houshian S, Gothgen CB, Padersen NW, *et al*. Femoral shaft fractures in children. Elastic stable intramedullary nailing in 31 cases. Acta Orthop Scand. 2004; 75(3):249-51.
19. Herndon WA, Mahnken RF, Yngve DA, *et al*. Management of femoral shaft fractures in the adolescent. J Pediatr Orthop. 1989; 9:29-32.
20. Ruhullah M, Singh HR, Shah S, Shrestha D. Hip spica versus Rush pins for management of femoral diaphyseal fractures in children. Indian J Orthop. 2014; 48:488-94.
21. Kirby RM, Winquist RA, Hansen ST Jr. Femoral shaft fractures in adolescents: A comparison between traction plus cast treatment and closed intramedullary nailing. J Pediatr Orthop. 1981; 1:193-7.
22. Mann DC, Weddington J, Davenport K. Closed ender nailing of femoral shaft fractures in adolescents. J Pediatr Orthop. 1986; 6:651-5.
23. Ligier JN, Metaizeau JP, Prevot J, Lascombes P. Elastic stable intramedullary nailing of femoral shaft fractures in children. J Bone Joint Surg Br. 1988; 70:74-7.
24. Nascimento FP, Santili C, Akkari M, Waisberg G, Reis Braga SD, de Barros Fucs PM. Short hospitalization period with elastic stable intramedullary nails in the treatment of femoral shaft fractures in school children. J Child Orthop. 2010; 4:53-60.