

A Prospective Study of Fracture Femur Shaft in Children Between 5-16 Years Treated by Titanium Elastic Nailing System (TENS)

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Abstract:- Incidence of femur fractures in children accounts for 1.6%. They occur as a result of fall from height while playing and are mostly in the diaphyseal region. Treatment protocol for children younger than five years is spica cast and for skeletally mature adolescents is an antegrade intramedullary nail. But, for children between 5 to 16 years, the best treatment is still controversial. They present with a higher complication rate of shortening and malunion.

In this study, 20 children aged between 5-16 years with diaphyseal femur shaft fractures were treated with Titanium Elastic Nailing System (TENS) at Government general hospital, Kurnool from a period of September 2020 to September 2022. Majority of the patients in the study, i.e. 8 (40%) were in the age group of 5-8 years. Average time of union was about 8.2 weeks. Results were excellent in 9(45%), successful in 8(40%) and poor in 3(15%) patients

TITANIUM ELASTIC NAILING SYSTEM (TENS) is an ideal method for treating femur shaft fractures in children aged between 5-16 years which gives elastic mobility required for rapid union and stability.

I. INTRODUCTION

Incidence of femur fractures in children accounts for 1.6%. They occur as a result of fall from height while playing and are mostly in the diaphyseal region.

Treatment protocol for children younger than five years is spica cast and for skeletally mature adolescents is an antegrade intramedullary nail. But, for children between 5 to 16 years, the

best treatment is still controversial. They present with a higher complication rate of shortening and malunion.

Dameron and Thompson outlined seven principles of pediatric femoral shaft fracture care:

- The simplest form of satisfactory treatment is the best.
- The initial treatment should be permanent whenever possible.
- The perfect anatomical reduction is not essential for perfect function.
- Restoration of alignment is more important than the position of fragments with respect to one another.
- More potential growth equals more probable restoration of normal architecture because of remodelling.
- Overtreatment is usually worse than under treatment.
- Injured limb should be kept in Thomas splint with skin traction before definitive therapy is begun.

Conservative management with traction and spica cast have a disadvantage of physical, social, psychological and financial stress. Other modes of treatment include Ex-Fix, plating and intramedullary nailing, and they carry the risk of pin tract infection, refractures and osteonecrosis with solid nails.

TENS fixation was introduced by Nancy group in 1979 and has gained popularity in the recent past. They act as load sharing devices and are flexible enough to allow bending. It gives stable fixation with rapid healing and early return of the child to regular activity. It is a simple, effective and minimally invasive technique with minimal complications.

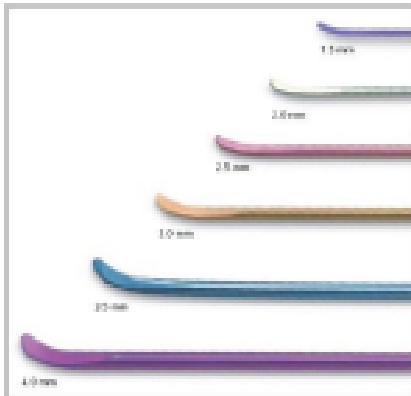


Fig 1: TENS NAILS

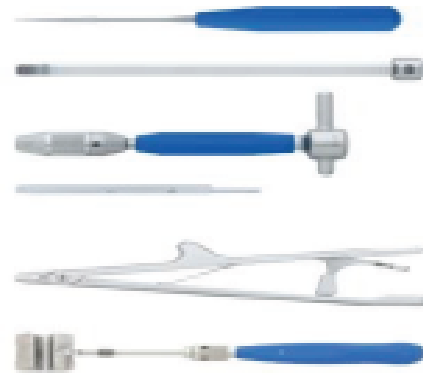


Fig 2: INSTRUMENT SET

AIM OF THE STUDY

To analyze the role of Titanium Elastic Nailing System (TENS) in children aged 5-16 years with femur shaft fracture.

II. MATERIALS AND METHODS

In this study, 20 children aged between 5-16 years with diaphyseal femur shaft fractures were treated with Titanium Elastic Nailing System (TENS) at Government general hospital, Kurnool from a period of September 2020 to September 2022.

➤ Inclusion Criteria

Children and adolescent patients from 5 to 16 year with diaphyseal femur fracture.

➤ Exclusion Criteria

- Patients less than five years of age and more than 16 years of age.
- Patients unfit for surgery.
- Comminuted and segmental fractures.
- A fracture involving the distal 1/3rd of the femoral shaft.
- Gustilo Anderson grade III and IV compound fractures.

As the patient was brought to casualty initial ATLS protocol was followed and was investigated with plain X-ray of the femur, both AP and the lateral view, including both hip and knee joints, were taken. The limb was rested in a Thomas splint.

➤ Operative Technique

Nails are available in diameters of 1.5, 2, 2.5, 3, 3.5 and 4mm with 440 mm in length with colour coding for easy identification.

Nail size = 40% of the diameter of bone and two nails are used.

Patient in the supine position with a bolster under the knee and C-arm on the opposite side, small nicks are given over the skin medially and laterally just proximal to the physis. Entry into the bone is made with an awl at the level of the flare of femoral condyles for it to bind against it.

Nails are prebent to an angle of approximately 30° with apex at the fracture site and covering a distance of 3 times the diameter of the bone. Nails are inserted one after the other from the medial and lateral side till the fracture site. Fracture is held in reduction using F tool, and both the nails are passed across the fracture site simultaneously. Nails are passed up to the proximal metaphyseal area or into the neck without crossing the physis. Nails are cut 1-2cm outside the cortex and buried inside soft tissue, and the skin is closed.

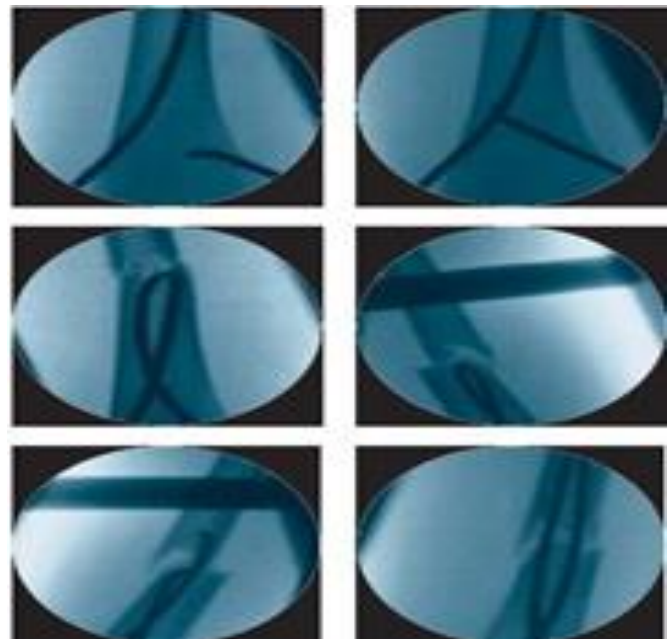


Fig 3: Intraop Images

III. RESULTS

All the patients were followed regularly till union and were analyzed clinically and radiologically.

The results were evaluated according to the TENS SCORING SYSTEM used by FLYNN et al.

Table 1: The Scoring Criteria for TENS.

RESULTS VARIABLES at 24 weeks	Excellent	Satisfactory	Poor
Limb length discrepancy	<1.0 cm	1.0-2.0 cm	>2 cm
Angulation/Malalignment	5 degrees	10 degrees	>10 degrees
Pain	Absent	Absent	present
Complications	None	Minor and resolved	Major and lasting morbidity

Majority of the patients in the study, i.e. 8 (40%) were in the age group of 5-8 years. The youngest patient was five years, and the oldest was 15 years, with the mean age of 10.15 years. Majority of patients were males, and 2 were females. The right femur was involved in 55% of the cases. The average time interval between trauma and surgery was 3.95 days. Two patients had a superficial infection and stayed for more than 12 days in the hospital. The average duration of hospital stay in our series was 10.1 days.

Time of union is defined as the period between surgery and full weight bearing without external support and a radiographically healed fracture. Average time of union was about 8.2 weeks.

All patients had full range of motion of the hip joint, three patient who had a nail protrusion and had little knee stiffness and soon recovered with physiotherapy.

Following complications were seen in our study.

Table 2: Complication

Complications	No. of cases	Percentage
Limb length discrepancy		
<5 mm	4	20
>5 mm	2	10
Infection	2	10
Delayed union/non union	0	0
Nail protrusion	3	15
Malalignment	2	10

Six patients had limb length discrepancy. Out of them, four had less than 5 mm, and two had nearly 1cm limb length discrepancy. No patient in our series had significant limb length discrepancy (i.e. > - 2 to+ 2cm). Superficial infection was seen in two patients and was controlled by antibiotics. No cases of delayed union and non-union were seen in our series. Two cases of varus malalignment of 10° and 12° were observed in our series. No cases of valgus, anteroposterior or rotational malalignment were observed.

We analysed our final results with TENS EVALUATION SCORE given by FLYNN et al.

Results were excellent in 9(45%), successful in 8(40%) and poor in 3(15%) patients.

Table 3: Results

Results	No. of cases
Excellent	9
Satisfactory	8
Poor	3

IV. DISCUSSION

It has been accepted that surgical intervention is must in paediatric femur fractures for a better anatomical alignment, early union and early mobilization, thus reducing the morbidity and mortality. It reduces the incidence of complications like joint stiffness, wound complications, malunion and nonunion.

In children, using elastic nails is more technically easier than rigid nails. Various studies have shown that the intramedullary fixation with TENS can be performed successfully in the age group of 5-16 years. The most common complication in treating femoral shaft fractures in children is limb length discrepancy. Significant discrepancy is LLD >2cm. We had 4 cases of <5mm LLD and two cases of LLD between 5 mm and 1 cm. It didn't give any problem to the patients.

Angulatory malunion is another complication in a pediatric femoral shaft fracture. Gaplin et al. had two patients out of 35 who developed malunion by using TENS and in the final follow up, and they had excellent improvement in angulation deformity. We had 2 cases of malunion with varus angulation of 10° and 12°, which did not give any functional difficulty to the patients.

We analyzed rotational deformities by looking at in-toeing or out-toeing when the child stands and clinically by measuring the foot progression angle. We never had rotatory malunion as seen by clinical methods.

Other complications were protrusion of nail in 3 cases causing skin irritation and knee stiffness. Luhmann et al. indicated that the technical problem could be minimized if the part of the nail which is left outside the femur is smaller than 2.5cm. Limb length discrepancy is another most common complication in treating femoral shaft fractures in children. The nail was routinely removed between 6 to 9 month in our series, while early removal was required in five cases due to soft tissue irritation. But it has reported that it did not affect the stability.

V. CONCLUSION

We based on our experience and results thus conclude that **TITANIUM ELASTIC NAILING SYSTEM(TENS)** is an ideal method for treating femur shaft fractures in children aged between 5-16 years which gives elastic mobility required for rapid union and stability. It has an advantage of early mobilization, simple and straight forward procedure, lower complication rate with good outcome compared to other methods of treatment.

REFERENCES

- [1]. **Flynn J.M., Hresko T., Reynolds R.A., Blasier R.D., Davidson R., Kasser J.** Titanium elastic nails for paediatric femur fractures: a multi-centre study of early results with analysis of complications. *J PediatrOrthop.* 2001;21:4–8. [PubMed] [Google Scholar]
- [2]. **Buechsenschuetz K.E., Mehlman C.T., Shaw K.J., Crawford A.H., Immerman E.B.** Femoral shaft fractures in children: traction and casting versus elastic stable intramedullary nailing. *J Trauma.* 2002;(53-55):914–921. [PubMed] [Google Scholar]
- [3]. **Metaizeau J.P.** Osteosynthesis in children: techniques and indications (in French) *ChirPédiatr.* 1983;69:495–511. [Google Scholar]
- [4]. **Stans A.A., Morrisy R.T., Renwick S.E.** Femoral shaft fracture treatment in patients age 6 to 16 years. *J PediatrOrthop.* 1999;19(2):222–228. [PubMed] [Google Scholar]
- [5]. **Sanders J.O., Browne R.H., Mooney J.F., Raney E.M., Horn B.D., Anderson D.J., Hennrikus W.L., Robertson W.W.** Treatment of femoral fractures in children by pediatric orthopedists: results of a 1998 survey. *J PediatrOrthop.* 2001;21:436–444. [PubMed] [Google Scholar]
- [6]. **Martinez A.G., Carroll N.C., Sarwark J.F., Dias L.S., Kelikian A.S., Sisson G.A., Jr** Femoral shaft fractures in children treated with an early spica cast. *J PediatrOrthop.* 1991;11:712–716. [PubMed] [Google Scholar]
- [7]. **Evanoff M., Strong M.L., MacIntoch R.** External fixation maintained until fracture consolidation in the skeletally immature. *J PediatrOrthop.* 1993;13:98–101. [PubMed] [Google Scholar]
- [8]. **Miner T., Carroll K.L.** Outcomes of external fixation of pediatric femoral shaft fractures. *J PediatrOrthop.* 2000;20:405–410. [PubMed] [Google Scholar]

- [9]. **Ligier J.N., Métaizeau J.P., Prévot J., Lascombes P.** Elastic stable intramedullary nailing of femoral shaft fractures in children. *J Bone Jt Surg.* 1988;70-B:74–77. [PubMed][Google Scholar]
- [10]. **Gamal E., Mostafa Mohamed F., Khalil Mohamed A., Enan Ahmed.** Titanium elastic nail fixation for paediatric femoral and tibial fractures. *Acta Orthop. Belg.* 2009;75:512–520. [PubMed] [Google Scholar]
- [11]. **Moroz L.A., Launay F., Kocher M.S., Newton P.O., Frick S.L., Sponseller P.D., Flynn J.M.** Titanium elastic nailing of fractures of the femur in children–Predictors of complications and poor outcome. *J Bone Jt Surg [Br]* 2006;88-B:1361–1366. [PubMed] [Google Scholar]