



Functional Outcome Of Operative Management Of Fracture Shaft Of Femur In Children Aged Between 5 To 16 Years Using Intramedullary Fixation With Titanium Elastic Nailing System

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Abstract

Background: In the past few years fixation with flexible intramedullary nails have become popular technique, for stabilizing femoral fracture in school aged children. TENS fixation system is a simple, effective and minimally invasive technique. It gives stable fixation with rapid healing and prompt return of child to normal activity.

Aim of study: To analyse the efficacy of TITANIUM ELASTIC NAILING SYSTEM (TENS) in the treatment of fracture shaft of femur in children aged between 5 to 16 years.

Materials and Methods: In this randomized retrospective study, 20 patients of 5-16 years of age with diaphyseal femur fractures. Clinical and radiological parameters will be studied and functional evaluation will be done at 6 months and 1 year.

Results: As per the TENS EVALUATION SCORE GIVEN BY FLYNN et al, 9 patients (45%) had excellent results, 8 patients (40%) had successful result and 3 patients (15%) had poor results with no cases of delayed union and non-union

Keywords: Femur fractures; Intramedullary fixation; Pediatric; TENS Nail

Introduction

Femoral shaft fractures account for 1.6% of all PAEDIATRIC INJURIES. In children 5 years or younger, early closed reduction and application of spica cast is an ideal treatment for most diaphyseal fracture. In skeletally mature adolescents, use of antegrade solid intramedullary nail has become standard treatment. But, the best treatment for children between five to sixteen years of age is still debated. Compared with younger children, patients in this intermediate age group have high risk of

shortening and malunion when conservative measures used.

Children managed with traction and spica cast as a treatment modality has to undergo various adverse physical, social, psychological and financial consequences, of prolonged immobilization. Various other modalities include external fixation, plates and screws, use of solid antegrade intramedullary nail are available. However, the risk of certain complications, particularly pintract infection and refractures after external fixation or osteonecrosis with solid nails.

In the past few years fixation with flexible intramedullary nails have become popular technique, for stabilizing femoral fracture in school aged children. TENS fixation system is a simple, effective and minimally invasive technique. It gives stable fixation with rapid healing and prompt return of child to normal activity. This study was intended to assess the functional outcome following treatment of fracture shaft of femur by flexible intra medullary nail or elastic stable intramedullary technique.

Materials And Methods

Trial Design:

This prospective study was conducted at a tertiary high volume trauma care centre in Navi-Mumbai, Maharashtra, India between May 2018 and December 2020.

A total no. of 31 patients presented to the hospital with diaphyseal femur fractures out of which 23 patients fit the inclusion criteria and were enrolled for the study.

Inclusion and Exclusion criteria:

All children and adolescents in age group of 5-15 years of age with closed diaphyseal femur fractures were included in the study. Associated fractures of ipsilateral limb, Fractures involving distal 1/3 of femoral shaft and open fractures were excluded from the study. Parents of few children did not consent for surgical procedure and were excluded.

Surgical Technique:

Two retrograde TENs were used in all femoral fractures. A traction table was used for all the patients. Intra-operatively fracture was reduced under x-ray image intensifier. A 1-2-cm longitudinal skin incision was made over the medial and lateral surface of the distal femur, starting 2 cm proximal to the distal femoral epiphyseal plate and entry was made in the femur with the help of bone awl. A proper sized nails (not less than 40% of the narrowest diameter of the diaphysis) were used. To achieve good three point contact the TENs are pre-bent over the length of the bone three times the diameter of the medullary canal. Nail was introduced with a T-handle by rotation movements of the wrist. Under image intensifier control, the nail was driven with rotatory movement or with a hammer to the fracture site which was aligned to anatomical or near anatomical position and

the nail was advanced to the proximal fragment. At the same time the second nail was advanced to enter the proximal fragment from the other entry point and in the meantime any traction was released to avoid any distraction (Fig. 2). Fracture reduction was checked under image intensifier, end of the nail were buried and wound closed.

Post-operative protocol:

Post operatively patients were kept in supine position and Thomas splint was used for immobilisation. Thomas splint was kept for 2 weeks for rotational stability of fracture as elastic nails. Immobiliser was removed after 2 weeks as the fracture gets sticky and thus TENS alone can provide sufficient stability at this point. Antibiotic prophylaxis was given for 3 days. Knee mobilization started after removing the splint. Patients were kept non weight bearing till 4 wks and partial weight bearing was started from 4 wks. Complete weight bearing was allowed after bony union.

Follow up and outcome analysis:

Regular follow up of the patients was done at 2,4,6 months and 1 year postoperatively.

Results were evaluated using Flynn's scoring criteria (Table 1) & radiological union was assessed by Anthony et al scale for grading callus formation (Table 2).

Results

All patients were followed until fracture union occurred. Results were analysed both clinically and radiologically.

Majority of the patients i.e. 8 (40%) were in the age group of 9-12 years. The youngest patient being 5 years and the oldest being 16 years and the mean age of study was 10.15 years with 5 patients in 5-8 year age group and 7 in 12-15 year age group. Out of these 18 were male and 2 were females. Most common mode of injury was Road traffic accident (11 patients i.e. 55%) followed by fall while playing (7;35%) and fall from height (2;10%). Transverse fracture (14 patients;70%) was the most common pattern encountered and middle 1/3 of shaft (12 patients;60%) being the most common location. Average time interval between trauma and surgery was 3 days. 6 patients had limb length discrepancy. Out of them 4 had less than 5 mm limb length

discrepancy 2 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 2 patients in our study and it was controlled by antibiotics.

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

No cases of delayed union and non-union were reported in our series.

Two cases of varus malalignment of 10 and 12° respectively were observed in our series. No cases of valgus, Anteroposterior or rotational malalignment was observed.

All patient had full range of motion of hip joint, 3 patient who had a nail protrusion had little bit knee stiffness and it also soon recovered with physiotherapy.

We analysed our final results with TENS EVALUATION SCORE GIVEN BY FLYNN *et al* (Table 1) and also compared our results to other studies. As per the evaluation criteria 9 patients (45%) had excellent results, 8 patients (40%) had successful result and 3 patients (15%) had poor results.

Discussion

It has been commonly accepted that surgical intervention is indicated in paediatric femoral shaft fracture in age group of 5-16 are generally open fracture, poly trauma, concomitant head injuries and neurovascular wounding. However there are number of publications, suggesting that surgery can also be considered for isolated femoral fractures.

Due to achievements such as earlier return to function, less joint stiffness, lesser wound complication, Malunion, Non union, reduction in duration of hospitalization and cost makes intramedullary nailing one of the best methods of choice in children too.

In children, intervention using elastic nails are technically easier than the use of rigid nails. Using ender nails is little bit difficult because it is very hard and canal diameter is a restrictor factor in ender nail.

The studies have shown that the intramedullary fixation with TENS can be performed successfully in age group of 5-16 years. The mean age in our series was 10.15 years.

Some authors reported that they were using elastic nails in compound fracture upto to Grade 3. We have used for 2 cases of compound G II injuries in our series.

It appears that most of the femoral fractures we treated were transverse. However, LIGIER *ET AL* have demonstrated that it can be successfully used in oblique and spiral fractures.

FLYNN *et al* & LIGIER *et al* reported mean hospitalization was about 5-10 days in this method. In our series mean hospitalization was 10.1 days.

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 5mm and 1 cm. It didn't give any problem for the patients.

Another complication in a pediatric femoral shaft fracture in angulatory malunion. Herdon *et al* reported 7 of his 24 patients treated with spica casting developed malunion but none of him 21 patients who were treated by elastic nail developed malunion. Gaplin *et al* had 2 patients out of 35 developed malunion by this technique and they had excellent improvement in angulation deformity in the final follow up. We had 2 cases of malunion especially varus malunion 10 degrees and 12 degrees and which did not give any functional difficulty for patients.

We analysed rotational deformities by clinically measuring the foot progression angle and looking for intoeing or outtoeing when the child stands. We never had rotatory malunion as seen by clinical methods.

Other complications in our series in the protrusion of nail in 3 cases causing skin irritation and knee stiffness. Luhmann *et al*. indicated that the technical problem can be minimized if the part of the nail which in left outside the femur in smaller than 2.5cm.

Flynn *et al* found very few complication in a multicenter study with 58 cases on whom they performed TENS. First callus tissue emerged in four weeks on the average. In this study the nail was

routinely removed in the 6th month. While early removal was required in five cases due to soft tissue irritation. But it has reported that it did not affect stability. We have removed nail between 6 to 9 month in our series. Following surgery in Flynn series 2 children had 15° of rotational asymmetry and 6 patients had limb length discrepancy of 1-2 cm. 2 patients had deep tissue infection.

Studies with ender nails for pediatric femoral shaft fracture by Kareglu et al and Ozturkmen et al found increased incidence of varus - valgus angulation when compared with elastic nails.

Bar et al compared ESIN with external fixation for paediatric femoral shaft fractures and concluded that increase in number of complications is associated with external fixation technique.

Many studies recommended allowing walking using crutches after the pain subsided. But Flynn et al suggested that it is ideal to allow partial weight bearing, when there is development of callus and full weight bearing only after clinical and radiographically complete union has occurred.

Kiely biomechanically compared the application by two nails in 'C' shape and two nails one in S shape and another in 'C' shape and concluded that there was basically no difference between there 2 groups.

Several case reports of avascular necrosis of femoral head were observed while using antegrade rigid interlocked nails for children and these complication were not reported in elastic nailing technique.

Conclusion

Twenty patients with 20 diaphyseal fractures of femur were treated with Titanium Elastic Nailing System (TENS) between May 2018 to December 2020 at MGM Hospital, Kamothe, Navi Mumbai.

Children and adolescents aged between 5 to 16 years were included in this study with the average age being 10.15 years and 90% of them were boys.

Early return to school is possible in this technique when compared with conservative methods.

Based on our experience and results, we conclude that intramedullary fixation with TENS is an ideal method for treatment of pediatric femoral shaft fractures. It gives elastic mobility promoting rapid union at fractures site and stability which is ideal for

early mobilization. It gives lower complication rate, good outcome when compared with other methods of treatment.

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Tables

Table 1.: FLYNN SCORING SYSTEM

	Excellent	Successful	Poor
Limb length Discrepancy	< 1.0cm	< 2cm	> 2cm
Sequence Disorder	5°	10°	>10°
Pain	Absent	Absent	Present
Complication	Absent	Mild	Major Complication or increased Morbidity

Table 2: ANTHONY ET AL GRADING FOR CALLUS FORMATION

Grade 0	No identifiable fracture healing
Grade 1	Primary bone healing with little or no new bone formation
Grade 2	Periosteal new bone formation on two sides of femur
Grade 3	Periosteal new bone formation on three or four sides of femur



Figure 1: Spiral diaphyseal femur fracture operated by TENS Nail in a 9-year-old female child; Image showing preoperative, immediate postoperative and 3-month follow-up x-rays