

Outcome of TENS in Management of Pediatric Femoral Diaphyseal Fracture

Dayanand Manjunath*, Deepak S.**, Ramalingiah***, Narasimha Murthy****, Lokesh*****, Ramachandra*****

Abstract

Introduction: Femoral shaft fractures account for 1.6% of all paediatric bony injuries. Angulation, malrotation and shortening are not always corrected effectively by conservative methods. Fixation of femur fractures in children & adolescents by flexible intramedullary nailing is becoming widely accepted because of the lower chance of iatrogenic infection and prohibitive cost of in hospital traction and spica cast care. **Method:** A prospective study of 90 cases of fracture shaft femur was done in BMCRI from 2009 to 2011 Children and adolescents between the age group of 5-15 years with femoral shaft fractures excluding subtrochanteric and supracondylar fractures were included. All patients underwent titanium elastic nailing fixation for the femur fracture. Clinical parameters like pain, comfort to the patients, early mobilization, operative technique, radiological evaluation for union, stages of weight bearing till complete recovery and any associated complications were studied. Patients were followed up for a period of 6 months at 4,8,12 and 24 weeks after surgery. **Result:** The outcome was excellent in 70 cases, satisfactory in 20 cases and there were no cases of poor outcome. No cases got infected, 2 cases had valgus malunion and 15 cases had limb lengthening. **Conclusion:** Flexible intramedullary nail leads to rapid fracture union by preservation of fracture hematoma and limited soft tissue exposure. It also helps in preventing damage to the physis, is fairly a simple, reliable technique with a shorter learning curve with negligible complications.

Keywords: Paediatrics; TENS; Femoral diaphyseal fractures.

Introduction

Femoral shaft fractures account for 1.6% of all paediatric bony injuries. Though most of the fractures can be effectively managed conservatively, unstable and displaced fractures need fixation to provide good results. The two major drawbacks with various types of traction and plaster cast immobilization are prolonged bed rest leading to separation of the child from routine activities and the expenditure incurred on the treatment during the stay in the hospital and parental non

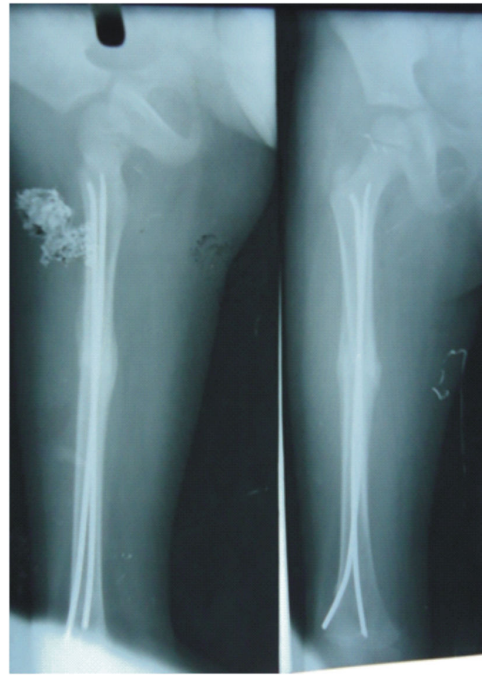
acceptance. Angulation, malrotation and shortening are not always corrected effectively by conservative methods.[1]

Conservative methods are preferred for children less than 5 yrs.[2] The management of pediatric femoral shaft fractures gradually has evolved towards operative approach in the past decade. For children that occupy the middle age group between 6-14 years, there are a wide variety of surgical and nonsurgical treatment options available as early spica casting, traction followed by casting, external fixation, plate fixation, reamed intramedullary rods and flexible intramedullary nails with no clear consensus as to the preferred treatment.[3] A systematic review of the literature provides little evidence to support one method of treatment over another.[4] Plating of femoral shaft fracture offers rigid fixation but it requires a larger exposure with the potential for increased blood loss and scarring. It is a load bearing device and refracture is a risk and it can cause growth

Author Affiliation: *Senior Resident, **Associate Professor, ***Professor, ****Jr. Resident, *****Sr. Resident, *****Asstt. Professor, Department of Orthopedics, Bangalore Medical College and Research Institute, Bangalore, Karnataka, India.

Reprint request: Dayanand Manjunath, 304, Elegant Westwood Apts, 11th Cross, 11th Main, Malleswaram, Bangalore, Karnataka, India.

E-mail: drdaynand.m@gmail.com

Figure 1: Preop Radiograph (Case 1)**Figure 3: Follow Up (Case 1)**

fractures, yet these have poor elasticity, rotational stability and require multiple nails to achieve fracture stability.

Elastic internal fixation in the form of flexible intramedullary nailing provides a healthy environment for fracture healing with some motion leading to increased callus

disturbance also. Antegrade nailing techniques have shown a risk of proximal femoral deformities and avascular necrosis of the femoral head.

Although a number of intramedullary devices like rush nail or ender's nail are available for treatment of paediatric long bone

Figure 2: Postpo Radiograph (Case 1)**Figure 4: Preop Radiograph (Case 2)**

Figure 5: Post Op Radiograph (Case 2)

formation. This method avoids physical damage, minimally invasive with relatively reduced hospital stay and high acceptance by parents. Fixation of femur fractures in children & adolescents by Titanium flexible intramedullary nailing is becoming widely accepted because of the lower chance of iatrogenic infection and prohibitive cost of in hospital traction and spica cast care.[5] Hence we conducted a study to find out the outcome of TENS in children of 6-14 years with diaphyseal femoral fractures.

Materials and Method

A prospective study of 90 cases of fracture shaft femur was done in BMCRI from 2009 to 2011. Children and adolescents between the age group of 6-14 years with Fresh closed displaced/undisplaced, comminuted and segmental diaphyseal fractures were included

Open fractures, pathological fractures, subtrochanteric and supracondylar fractures were excluded. All patients underwent closed reduction and titanium elastic nailing fixation for the femur fracture under IITV control. Clinical parameters like pain, comfort to the

patients, early mobilization were assessed and Radiological evaluation for union, stages of weight bearing till complete recovery and any associated complications were studied.

Patients were followed up for a period of 6 months at 4,8,12 and 24 weeks after surgery. The final outcome was based on Flynn's criteria.[5]

Result

In our study 60% of patients were between 5-8 years, with the average age being 8.4 years. 56% of the patients were boys and 44% were girls. RTA was the most common mode of injury accounting for 73% of cases. Transverse fractures accounted for 17% cases, oblique fractures 50% and spiral fractures 33%. Fractures involving the middle 1/3rd accounted for 63%, upper 1/3rd 30% and lower 1/3rd in 7% cases. All the patients were prepared and operated as early as possible once the general condition was stable and the patient was fit for surgery. The Average duration of surgery is 68 minutes (range 45 to 90 min). Average duration of stay in hospital was 9.1 days (range 3 to 12 days). Union was

Figure 6: Follow Up (Case 2)

achieved in <3 months in all the patients with average time to union being 8.3 weeks (range 7 to 12 weeks). Unsupported full weight bearing walking was started in < 3 months in all the patients. All patients had full range of hip and knee motion by 12 weeks in the present study. 7 patients had developed pain at site of nail insertion during follow up evaluation due to skin irritation, all of which resolved after nail removal.

4 patient had shortening of femur (0.5 cm) and 3 patient had lengthening of femur (average 0.8 cm). No patient in our study had major limb length discrepancy (i.e. $> \pm 2$ cm). Nail back out was not seen in any of the cases. One patient had valgus malunion and one had varus malunion.

The outcome was excellent in 70 cases, satisfactory in 20 cases and there were no cases of poor outcome according to Flynn's criteria⁵.

Discussion

The advantages of TEN in pediatric fractures are that these nails are not very expensive, they are available in different diameters, and they do not disturb the blood supply of the femoral epiphysis, with proper bending they provide a three-point fixation, no plaster is required, and removal of the nails can be done very easily.

A prospective comparison of TENS fixation and spica casting for the treatment of femoral shaft fractures in children found that children treated with flexible nails achieved recovery milestones significantly faster than those treated with traction and spica casting alone. Hospital charges for the two methods were similar, and the complication rate after flexible nailing (21%) was lower than after traction and spica casting (34%).[10]

Moreover, conservative treatment results in prolonged hospitalization causing more burden on the hospital and financial losses to the family with parents attending their children in the hospital. Recent studies have also increased awareness of the psychosocial

and economic effects of spica casting on children and their families.[5,10,11]

Mazda *et al* treated 34 femoral shaft fractures with TENS. They observed that elastic properties of titanium provide a very good stability and it is a safe surgical treatment for immature femoral shaft fractures.[13]

In our study union was achieved in <3 months in all 30 (100%) cases. Average time to union was 8.4 weeks. Oh *et al* observed that all 31 fractures in his series healed within 12 weeks (mean 10.5 weeks) without delayed union.[14] Buechsenchuetz *et al* reported that in 42 patients treated with ESIN all fractures healed at a mean of 88 days from injury.[10] Houshian *et al* reported median union time of 7 (5-9) weeks.[15]

In the present study, unsupported full weight bearing walking was started in <12 weeks for 30 (100%) of the patients. The average time of full weight bearing was 8.3 weeks. These are comparable to as reported in the literature.[5,13,14] In patients with comminuted fractures, head injuries and with associated injuries affecting the mobility of patients with crutches partial weight bearing was delayed. Oh *et al* used Ender nails and observed weight bearing without assistive devices at an average of 9.7 weeks (6-16 weeks).[14] Flynn *et al* and Mazda *et al* observed walking without assistive devices at an average of 8.5 weeks and 9.5 weeks respectively in patients using TENs.[5,13] Houshian *et al* reported partial weight bearing as early as 3 weeks and full weight bearing after 6-8 weeks.[15] Early mobilization have all the benefits like shorter hospital stay; economical; less school days loss; psychological advantages; and less joint stiffness and muscle atrophy.

The average duration of stay in the hospital in our study was 9.1 days. The mean hospital stay was 12 days in Kalenderer O *et al* study.[24] Average hospitalization time was 11.4 days in the study conducted by Mann *et al*. [25] Gross RH, *et al* conducted a study on cast brace management of the femoral shaft fractures in children and

young adults. The average length of hospitalization in their study was 18.7 days.[25]

Compared to the above studies conducted on conservative methods and cast bracing, the average duration of hospital stay was less in our study i.e. 9.1 days. The reduced hospital stay in our series is because of proper selection of patients, stable fixation and less incidence of complications. Flynn *et al* reported that compared with children treated with traction and cast, those treated with TENs had shorter hospitalization, walked with support sooner, walked independently sooner, and returned to school earlier. These differences were significant ($p < 0.0001$).[12]

One patient had valgus malunion and one had varus malunion. This was due to improper bending of the nail and failed to achieve three point fixation principle. It is recommended that the apex of the curvature should be at the level of the fracture and nails diameter be related to correspond to between one third and 40% of the narrowest medullary space diameter¹⁹. These malalignments may require correction followed by additional plaster stabilization, replacement of the nails or additional stabilization by traction or external fixator till callus forms. A cautious approach is required for unstable fracture pattern and obese children.

In our series 4 patients had shortening of femur (0.5 cm) and 3 patient had lengthening of femur. Cramer KE, *et al* noted average limb lengthening of 7 mm (range 1-19mm) in their study. Clinically significant limb discrepancy ($> 2\text{cm}$) did not occur in any patient in their study.[26]

Skin irritation was the most common problem encountered in the series. 7 patients had developed pain at site of nail insertion during follow up evaluation due to skin irritation, all of which resolved after nail removal. This was seen due to cutting of nail after bending of nail at insertion site in the initial part of the study later in the study The nails ends were cut straight rather than bending them to avoid symptoms at the insertion site. For many years, outward

bending of the nail to facilitate retrieval was recommended, but this can cause anything from irritation to skin necrosis and infection and therefore should be avoided.[19] These cases also had restriction of knee motion. Ligier *et al* observed 13 cases of skin ulceration or local inflammatory reaction due to nail protrusion out of 123 cases. In All these cases nail was removed earlier than others and no skin ulceration was seen.

No cases of infection were seen in the present series. Similar results, regarding infection were observed by Herndon *et al*. [16]

Nails were removed under anaesthesia after 6 months to one year of the fracture fixation, without any complication during or after the procedure. Theoretically it is possible to remove nails 3 months after surgery and in literature nails have been removed as early as 6 weeks.[15] There are always chances of refracture with early removals and delayed nail removal may be the factor responsible for no refracture in the present series.

The outcome was excellent in 70 cases, satisfactory in 20 cases and there were no cases of poor outcome according to Flynn's criteria. J.M.Flynn *et al* treated 234 femoral shaft fractures and the outcome was excellent in 150(65%) cases, satisfactory in 57 (25%) cases and poor in 23(10%) of cases.¹⁵ K.C. Saikia *et al* in their study of 22 children with femoral shaft fractures 13 (59%) excellent, in 6 (27.2%) satisfactory and 3(13.6%) poor results.[11]

Conclusion

Based on our experience and results, we conclude that Titanium Elastic Nailing System is an ideal method for treatment of pediatric femoral fractures. It gives elastic mobility promoting rapid union at fracture site and stability which is ideal for early mobilization with lower complication rate, good outcome when compared with other methods of treatment. It is a simple, easy, rapid, reliable and effective method for management of pediatric femoral fractures between the age

of 5 to 15 years, with shorter operative time, lesser blood loss, lesser radiation exposure, shorter hospital stay, and reasonable time to bone healing. Because of early weight bearing, rapid healing and minimal disturbance of bone growth, TENS may be considered to be a physiological method of treatment. Use of TENS for definitive stabilization of femoral shaft fractures in children is a reliable, minimally invasive, and physeal protective treatment method.

Our study confers all the advantages which the previous studies have shown at various institutes and is fairly a simple, reliable technique with a shorter learning curve imparting lot of advantages over other intramedullary technique or other methods followed for management of pediatric diaphyseal femur fractures.

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Phone: 91-11-22754205, 45796900, Fax: 91-11-22754205

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