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PAEDIATRIC FEMORAL SHAFT FRACTURES MANAGED WITH TENS

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ABSTRACT

The study included fifty children (36 males, 14 females) aged 6-16 years with recent femoral shaft fractures (48 closed, 2 open), which were fixed with titanium elastic nails. Post operatively partial weight bearing was started at around four weeks and full weight bearing by eight weeks. Mean duration of follow up was 64 weeks. The results were evaluated as per Flynn's scoring criteria. Radiological union was achieved in a mean time of 6.62 weeks. Full weight bearing was possible in a mean time of 8.8 weeks. Mean duration of hospital stay was 9.8 days. The final results were excellent in 44 patients (88%), successful in six (12%) and poor in none of the patients. Limb length discrepancy up to 1 cm was found in five cases and six patients developed bursitis at the entry point. Titanium elastic nailing is a safe, minimally invasive, cost effective implant for the treatment of femoral shaft fractures in age group 6-16 years old children, which allows early rehabilitation and provides excellent functional and cosmetic results.

KEYWORDS : Callus; Femur; Paediatric; TENS

Femoral shaft fractures are one of the most common pediatric injuries representing around 2% of all fractures in the pediatric age group (Loder et al., 2006). The management options depends upon the age, type of injury, associated injuries, the location, type of the fracture and the socioeconomic status of the patient. To a great extent, the treatment options vary according to the surgeon's preference (Beaty and Kasser, 2005). Most of the femoral shaft fractures in children younger than six years of age can be managed with the traditional conservative methods due to high potential of healing. (Buckley, 1997 and Gwyn et al., 2004). However, above six years of age, non operative management of such fractures may have complications such as loss of reduction, malalignment, malunion, plaster associated problems, intolerance and school absenteeism. These demerits lead to increasing trend towards operative procedures that permit rapid mobilization in children over six years of age (Canale and Tolo, 1995, Narayanan et al., 2004 and Metaizeau, 2004). The management of the femoral shaft fracture in children of this age still a topic of debate (Lee et al., 2007). Various operative methods for femoral shaft fractures in children include external fixation, compression plating, rigid or flexible intramedullary nailing (Aronson and Turksy; 1992, Krettek et al., 1991, Hansen, 1992, Ligier et al.,1988 and Heinrich et al., 1998). Titanium Elastic Nailing, also known as Elastic Stable Intramedullary Nailing, has become the choice of surgical procedure in pediatric femoral shaft fractures because of the various advantages such as early union due to repeated micromotion at the fracture site, less chance of physeal damage, early mobilization, early weight bearing, small scar and better patient compliance (Flynn et al., 2003; Bhaskar, 2005 and Sanders et al., 2001).

The aim of our study was to evaluate the outcome of TENS nailing in cases of femoral shaft fractures in 6-16 years age group children.

MATERIALS AND METHODS

The study group consisted 50 children (36 males, 14 females) in the age between 6-16 years with fresh femoral shaft fractures that which were fixed with Titanium Elastic Nail (TEN), between 2012-2015. No control group was used. The mean age was 9.75 years and the right side was more commonly involved than the left. The predominant mode of injury was due to road traffic accident (n = 29, 58%) followed by fall from height (n = 21, 42%). Pre-operative evaluation included full length radiograph of the involved thigh including knee and hip joint (both anteroposterior (AP) and lateral views) (Figure 1). The locations of fracture in this study group were as follows: six fractures were in proximal third, 36 in middle third and eight in distal third of femur. Subtrochanteric and supracondylar femur fractures were excluded from the study. All of the fractures were closed except two cases which were grade I

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Figure 1: Pre Operative Radiograph Showing Femoral Shaft Transverse Fracture

Figure 2: Post Operative Radiograph Showing Fixation Of Femur Fracture With Tens Nails And Fracture Patella With K Wires And Tension Band Wiring. Also Showing Protruding Nail Ends Causing Bursitis At Entry Point Site

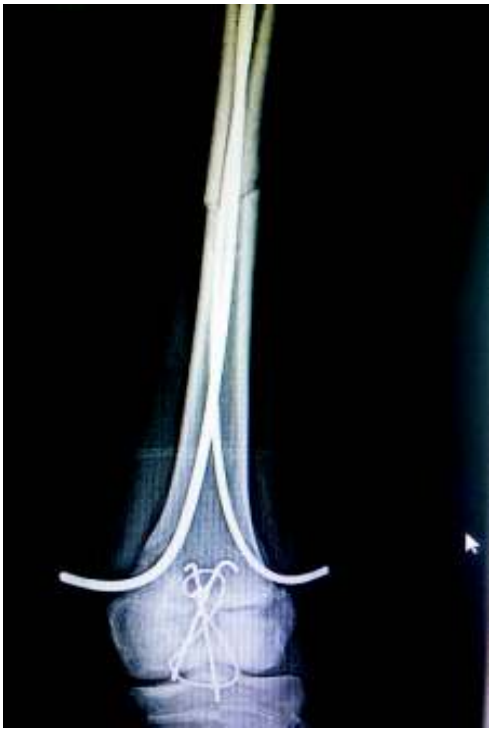

Figure 3 : Post Operative Radiograph at 5 Weeks Follow Up

Figure 4 : Post Operative Radiographafter Removal of Nails at 24 Weeks. Sound Radiological Union Can be Very Well Appreciated

Table 1 : Flynn et al's Scoring Criteria for TENS

	Excellent	Satisfactory	Poor
Pain	None	None	Present
Malalignment	$<5^0$	$5\text{-}10^0$	$>10^0$
Limb Length Discrepancy	<1 cm	1-2cm	>2cm
Complication	None	Minor	Major and/or lasting morbidity
No. patients (n=50)	n=44	n=6	n=0

open (Gustilo- Anderson). 30 fractures were transverse, six were short oblique, four were spiral and ten were minimally comminuted (Winquist 1). One patient had associated patella fracture which was fixed with k wires and tension band (Figure 2). Majority of the patients underwent surgery within six days of their injury. The surgery was performed under general anesthesia with the patient in supine position with the help of image intensifier. Two Titanium Elastic Nails of identical diameter were used and the diameter of the individual nail was selected as per Flynn et al's formula (Flynn et al., 2003) (Diameter of nail = Width of the narrowest point of the medullary canal on Anteroposterior and Lateral view × 0.4 mm) and intraoperative assessment. The diameter of the nail was chosen so that each nail occupies at least one-third to 40% of the medullary cavity. The nails were inserted in retrograde fashion with medial and lateral incisions 2-3 cm above the physis. The nails were prebent sufficiently so that apex of the bowed nails rested at the same level on the fracture site to ensure a good equal recoil force. Open reduction was required in four cases due to soft tissue interposition. The nails were advanced proximally so that both were divergent and the tips got anchored minimum 1 cm distal to the physis. Postoperatively patient's limb was elevated on a pillow. Patients were mobilized without weight bearing on the eighth to tenth day postoperatively. Partial weight bearing was started at around four weeks and full weight bearing by eight weeks depending on the fracture anatomy, quality of reduction, callus response and associated injuries. All patients were followed up radiologically as well as clinically every 3 weeks for first 12 weeks, then once every 3 months (Figure 2, 3 & 4)). Parameters studied were clinical and radiological features of union, mal-alignment, range of motion of the affected side knee, limb length discrepancy and any other complications found during the study.

RESULTS

The results were evaluated using Flynn et al scoring criteria for TENS (Table: 1) (Flynn et al., 2001). Nails were removed at about eight months to one year post surgery when the fracture line was no longer visible radiologically (Figure 4).

The mean duration of surgery was 33 minutes (range, 25- 45 mins). The size of nail varied from 2- 4 mm. The mean duration of hospital stay was 7 days (5-16 days). Apart from the adequacy of fixation, the hospital stay also depended upon the associated injuries. All the 50 patients were available for evaluation after a mean duration of follow up for 64 weeks. The mean time of the union was 6.62 weeks (range, 6 - 8.2 weeks). Full weight bearing was possible in a mean time of 7.9 weeks (7.1 - 10.8 weeks). All the patients achieved full range of motion by 9 weeks with an average of 8.6 weeks. The results were excellent in 44 patients (88%), satisfactory in six (12%) and poor in none of the patients as per the scoring criteria for TENS by Flynn et al (Flynn et al., 2001). None of the patients developed any angular deformity of greater than five degrees. Limb length discrepancy of less than 1 cm was found in five cases, which was clinically insignificant. Six patients developed bursitis at the entry point due to friction caused by cut ends of the nail (Table 2) (Figure 2). Two patients developed superficial infection due to bursitis which resolved within seven days of oral course of antibiotics. None of the cases developed any deep infection, joint penetration of nail, nail bending/implant failure, iatrogenic fracture, nonunion or

Table 2 : Complications in the Study

Complications	No. of cases (n=50)
Entry site irritation/ bursitis	6
Superficial infection	2
Deep infection	0
Limb length discrepancy (upto 1cm)	5

any neurovascular complications. The nails were removed after an average of 30 weeks (range, 24-54 weeks). No complications were associated with the nail removal procedure and no re-fractures were observed after nail removal till the last follow up.

DISCUSSION

The management of femoral shaft fractures in pediatric age group especially in 6 years to 16 years age group has been controversial and the choice of treatment still remains a constant challenge to the orthopedic surgeons. The age old conservative method had been the treatment of choice for pediatric femur shaft fracture, but the union was usually achieved at the expense of extended period of immobilization, delayed mobilization, loss of school attendance, intolerance and prolonged hospital stay (Salem et al., 2006, Beaty and Kasser 2001 & Carey and Galpin, 1996). However, to overcome these problems in this age group, the operative approach has been gaining popularity for last two decades (Saikia et al., 2007). There are multiple options for operative fixation of these fractures such as external fixators, compression plating, flexible and locked intramedullary nails, and compression plating (Beaty et al., 2005). The classic algorithm of treatment consists of spica cast in children younger than 6 years, whereas appropriate operative method in children older than 12 years. However, for the age group of 612 years, the preferred treatment is still matter of discussion.

Compression plating is widely used but has the disadvantages of larger soft tissue dissection, a large scar, increased risk of infection, delayed weight bearing and a second major operation for implant removal (Hansen; 1992). External fixation has been associated with problems of pintrack infection and re-fractures through the pin tracks, but has advantage of good stability and early mobilization (Aronson and Turksy, 1992 & Krettek et al., 1991)Rigid intramedullary nailing is ideal for skeletally mature patient, but when introduced in skeletally immature child, it has been associated with problems of physeal damage, coxa valga, avascular necrosis of the femoral head and growth disturbances (Beaty et al., 1994 and Letts et al., 2002).

There is lack of any comparative study regarding the efficacy of Enders Nail, Rush Nail or Titanium Elastic Nail, although all the three have given similar results but the Rush Nail provides poor rotational stability and require multiple nails to achieve a good fixation. Furthermore Enders Nail is not very elastic and flexible enough for pediatric fractures (Ligier et al., 1988 & Heinrich et al., 1998).

Titanium elastic nailing system (TENS) is a flexible intramedullary nail which is a load sharing implant, acts as an internal splint, and maintains length and alignment. It has a unique advantage of providing micro motion at the fracture site due to the elasticity of the fixation, which helps in rapid development of bridging callus, early mobilization and early weight bearing. Further, being a closed procedure there is no disturbance of periosteum or fracture hematoma, thereby less risk of infection and nonunion. It also combines the advantages of titanium such as more strength, light weight, corrosion resistance and MRI compatibility. Ligier et al had highlighted the beneficial use of titanium elastic nails in the treatment of femur fractures in children for the first time (Ligier et al., 1988). They included 123 fractures in age group 5 to 16 years. All the fractures united both clinically and radiologically. The study showed only one case of deep wound infection and 13 cases of skin ulceration or local inflammatory reaction due to nail protrusion. Overall, none of the patients complained of disability and no gait abnormalities were observed at one year of follow-up. Flynn et al studied the outcomes of 49 fractures treated with TENS and found no malalignment, angulation or limb length discrepancy of more than 1 cm but reported 8 cases of nail-tip irritation near the insertion site and had found TENS to be advantageous over hip spica in treatment of femoral shaft fractures in children (Flynn et al., 2004).

An important factor in the management of paediatric femoral shaft fractures is fracture geometry (Flynn et al., 2001). Lascombes et al reported that all femoral diaphyseal fractures except severe Type III open fractures could be fixed with TENS in children above six years of age (Lascombes et al., 2006). Titanium elastic nail is incapable of providing adequate stability in comminuted,

long oblique or spiral fractures and some other alternative apart from TENS should be considered in such cases.

We have conducted a prospective study on 50 patients focusing on the outcomes of fracture shaft femur in age group 6-16 year old children. All the fractures united with the mean duration of 6.62 weeks, which is comparable to the various studies in the literature. The mean time from surgery to full weight bearing was 7.9 weeks. All the patients achieved full range of motion by 9 weeks. The results were analyzed as per the scoring criteria by Flynn et alwhich showed excellent results in 44 patients, satisfactory in six and none of the patients fell into poor category.The most common complication of Titanium elastic nail is entry site irritation and pain (Flynn et al; 2001). Other complications included limb length discrepancy, angulation of fracture, re-fractures and infection. In our study, six patients developed bursitis/entry site irritation due to friction by the cut ends of the nail. Two patients developed superficial infection which resolved with oral antibiotics. This complication was observed in the initial part of the study (Fig: 2), after which we rounded the sharp edges of the nail end. None of the patients developed angular deformity of greater than five degrees. Limb length discrepancy of less than 1 cm was found in five cases, which was clinically insignificant. However, the cases are being followed up further for a possible limb length discrepancy that may develop in future. The mean duration of follow up in our study is 64 weeks and this is the limitation of our study. There was no case lost to follow up as most of the cases were from the nearby village area has been the strength of our study.

CONCLUSION

Titanium elastic nailing seems to be more physiological and effective method of treatment of femoral shaft fractures in 6-16 years old children. It is simple, rapid and safe procedure with advantages of early union, early mobilization and early return to function with minimal complications.

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