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Original Research Article

Short Term Clinical, Functional and Radiological of Fixation of Paediatric Femoral Shaft Fracture by Titanium Elastic Nail in Paediatric Patients

Md. Ashker Ibne Shams[1*], Sanjay Mondal[2], G. M. Jahangir Hossain[3]

[1]Junior Consultant (Ortho Surgery), National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh
[2]Junior Consultant (Ortho Surgery), DGHS, Dhaka, Bangladesh
[3]Associate Professor (Ortho Surgery), National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh

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Abstract: ***Introduction:*** Femoral shaft fracture is the most common major paediatric orthopaedic. For generations traction and casting was the standard treatment for all femoral shaft fractures in children. Elastic stable intramedullary nailing is one for treating these fractures and has a reliable methodology. Over the past two decades the advantages of fixation and rapid mobilisation have been increasingly recognised. ***Objective:*** To evaluate the short term clinical, functional and radiological outcome of intramedullary fixation of displaced femoral shaft fractures in skeletally immature children using titanium elastic nails. ***Methods:*** A prospective study was conducted in the Department of Ortho Surgery, National Institute of traumatology and orthopedic rehabilitation (NITOR), Dhaka, Bangladesh from July to December 2020. 52 femoral shaft fractures in child aged 6-14 years were fixed with titanium intramedullary elastic nail in the department of Orthopaedics, NITOR, Bangladesh. Two nails of proper and equal diameter were used for fracture fixation. No external splint was used after surgery. Outcomes assessed on the basis of Flynn *et al.*, scoring criterion. ***Results:*** The results of the 52 included in our study. All patients achieved complete healing at a mean of 9.1 (Range 8- 10) weeks. 44 fractures were reduced by closed means but 8 needed open reduction. No major complication was recorded. Most common minor complication was entry site skin irritation recorded in 8 patients. 84.61% had excellent result and 15.38% had satisfactory. ***Conclusion:*** The treatment of paediatric shaft femur fracture has been drastically changed over the last two decades to internal fixation by elastically stable intra- medullary nail (ESIN). It allows early ambulation and shorter hospital stay and higher parent satisfaction. It also provides flexural, translational and rotational stability as well.

Keywords: Femoral Shaft Fracture, Hip Spica, Elastically Stable Intra-Medullary Nail, Titanium Elastic Nails.

INTRODUCTION

Femoral shaft fractures are amongst one of the commonest major injuries occurring in the diaphysis of long bones in school going children presenting to us in the emergency rooms of our hospital [1]. The etiology has mainly been attributed to high velocity injuries, like road traffic accidents and fall from height [2]. Management of femoral diaphyseal fractures in the age group of 6-14 years is highly controversial. Femoral shaft fractures in the paediatric patients have traditionally been treated non- operatively with either early spica cast or a period of traction followed by application of hip spica cast until the time of fracture union. 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 [3, 4]. Though the treatment in toddlers and adults is standard protocol in form of spica casting and medullary interlocking nailing respectively, the management in school age children has always presented a challenge and dilemma situation as to what can be the better option. 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 [5-7]. The presence of a growing proximal and distal physes has presented a challenge in treating these injuries and hence the use of elastic intramedullary nails has gained popularity worldwide [8]. Titanium Elastic Nailing, also known as Elastic Stable Intramedullary

***Corresponding Author:** Md. Ashker Ibne Shams
Junior Consultant (Ortho Surgery), National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh

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 [9]. Rods were left too long and caused painful bursae and limited knee flexion. All 10 patients had the nail removed 2-5 months after surgery [10]. To evaluate the short term clinical, functional and radiological outcome of intramedullary fixation of displaced femoral shaft fractures in skeletally immature children using titanium elastic nails.

MATERIALS AND METHODS

A prospective study was conducted in the Department of Ortho Surgery, National Institute of traumatology and orthopedic rehabilitation (NITOR), Dhaka, Bangladesh from July to December 2020.The study group consisted 52 children (34 males, 16 females) having age between 6-14 years with fresh femoral shaft fractures which were fixed with Titanium Elastic Nail (TEN) in the department of Orthopaedics, NITOR, Bangladesh. No control group was used.

Inclusion Criteria

- Age group between 6-14years.
- Displaced fracture, with or without comminution.
- Multiple fractures.
- Closed fractures.

Exclusion Criteria

- Children 14 yrs of age.
- Metaphyseal fractures.
- Undisplaced fractures.
- Open fractures.
- Pathological fractures.

The mean age was 9.44 (range 6-14) years and the right side was more commonly involved than the left. The predominant mode of injury was due to road traffic accident (n = 32, 61.53%) followed by fall from height (n = 20, 38.46%). Pre-operative evaluation included full length radiograph of the involved thigh including knee and hip joint (both ateroposterior and lateral views) (Pic-1). The locations of fractures in this study group were as follows: 5 fractures were in proximal third, 38 in middle third and 7 in distal third of femur. Subtrochanteric and supracondylar femur fractures were excluded from the study. 40 fractures were transverse, 9 were short oblique, 3 were spiral and of these 8 were minimally comminuted (Winquist-1).

Pic-1

Pic-2

Operative Technique:

The surgeries were performed under general anesthesia with the patients 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 16 (Diameter of nail = Width of the narrowest point of the medullary canal on anteroposterior and

lateral view × 0.4 mm). Its length was selected on the basis of pre-operative radiograph of known magnification, and confirmed on the limb before insertion. 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. Under image intensifier, the cortex was breached with an awl or drill according to individual. TENs of proper diameter and length tapped along the medulla with the tip angled away from the cortex. The temptation to rotate the nail clock or counter clockwise was resisted. The fracture was reduced by manipulation and the nail advanced across the fracture site. All nails were inserted up to the fracture site, starting at the distal fragment in retrograde fashion then the fracture reduced, and the nails tapped across the fracture site in an alternating manner for perhaps 1 to 2 cm into the proximal segment. 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 6 weeks for first 12 weeks, then once every 3 months (Pic-2 & 3). Parameters studied were clinical and radiological features of union, malalignment, range of motion of the knee of the affected side, limb length discrepancy and any other complications found during the study.

RESULTS

The results of the 52 included in our study. The study group consisted 52 children (34 males, 16 females) having age between 6-14 years with fresh femoral shaft fractures which were fixed with Titanium Elastic Nail (TEN) (Fig-2). All patients achieved complete healing at a mean of 9.1 (Range 8- 10) weeks. 31 fractures were reduced by closed means but 10 needed open reduction. No major complication was recorded. Most common minor complication was entry site skin irritation recorded in 8 patients. 84.61% had excellent result and 15.38% had satisfactory. The results were evaluated using Flynn *et al.*,'s scoring criteria for TENS (Table-1). The mean duration of surgery was 38 (range 30- 45) minutes. The size of nail varied from 2- 4 mm. The mean duration of hospital stay was 8.16 (range 7-12) days. Apart from the adequacy of fixation, the hospital stay also depended upon the associated injuries. All the 52 patients were available for evaluation after a mean duration of follow up for 70 weeks. The mean time of the union was 7.9 (range 7- 9) weeks. Full weight bearing was possible in a mean time of 8.6 (range 7-10) weeks. All the patients achieved full range of motion by an average of 9.6 (range 8-11) weeks. None of the patients developed any angular deformity of greater than five degrees. Limb length discrepancy of less than 4 cm was found in 10 cases, which was clinically insignificant (Table-2). Four patients developed bursitis at the entry point due to friction caused by cut ends of the nail and two patients developed superficial infection at the nail entry site (Table-2) which resolved within seven days of oral course of antibiotics. None of the cases developed any deep infection, joint penetration by nail, nail breakage and implant failure, iatrogenic fracture, nonunion or any neurovascular complications. The nails were removed after an average of 47 (range 42-54) weeks. No complication was associated with the nail removal procedure and no refracture was observed after nail removal till the last follow up.

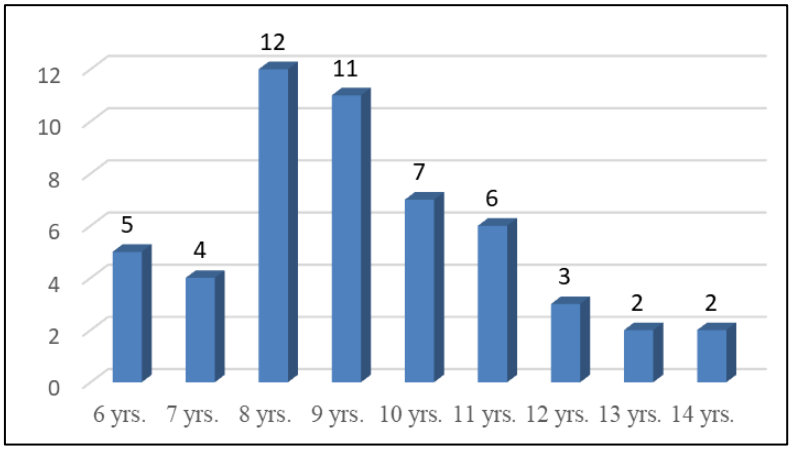

Fig. 1: Distribution of ages of patients (N=52)

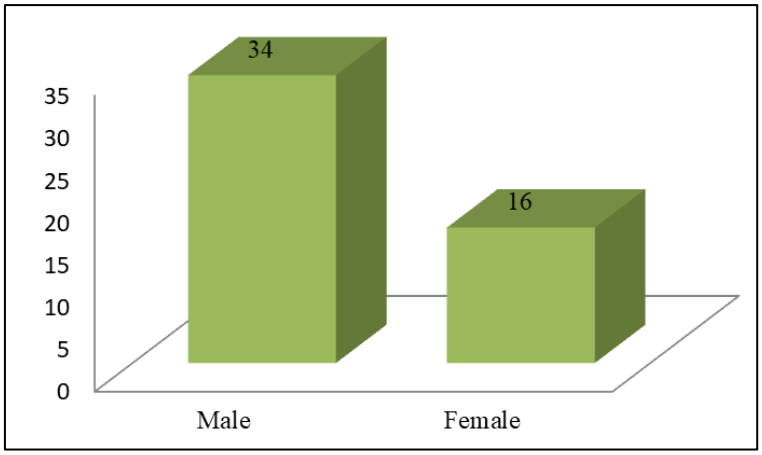

Fig. 2: Distribution of sex (N=52)

Table 1: Flynn *et al.*,'s Scoring Criteria for TENS and present study result (N=52)

	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=52)	n=44	n=8	n=0

Table 2: Complications in the Study (N=22)

Complications	**No. of cases (n=22)**
Entry site irritation/ bursitis	8
Superficial infection	4
Deep infection	0
Limb length discrepancy (up to 2 cm)	10

DISCUSSION

The management for fracture shaft of femur in children has always been controversial and debatable, as till date there is no consensus in the treatment for this fracture in pediatric age group. On considering school going age group (6yrs. to 14 yrs.) there are numerous options available to treat this fracture pattern which we have included in our study. Treatment options range from conservative spica casting to operative i.e elastic intramedullary nailing, dynamic and locking compression plates and use of external fixators. Plaster of paris spica casting in school age children is associated with complications like cast breakage, loss of reduction, malunion, skin complications, prolonged immobilization, quadriceps weakness, loss of education and associated psychological burden. Due to these complications the trend has shifted towards operative stabilization of these fractures. The results were excellent in 44 patients (84.61%), satisfactory in 8 (15.38%) and poor in none of the patients as per the scoring criteria for TENS by Flynn *et al.*, [11]. 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 [12, 13]. However, to overcome these problems in this age group, the operative approach has been gaining popularity for last two decades [14]. There are multiple options for operative fixation of these fractures such as external fixators, flexible and locked intramedullary nails, and compression plating [15]. 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 [16]. External fixation has been associated with problems of pin track infection and refractures through the pin tracks, but has advantage of good stability and early mobilization [17, 18]. 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, and avascular necrosis of the femoral head and growth disturbances [19, 20]. 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. 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 [21]. An

important factor in the management of paediatric femoral shaft fractures is fracture geometry. 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 [22]. We have conducted a prospective study on 36 patients focusing on the outcomes of fracture shaft femur in age group 6-14 year old children. All the fractures united with the mean duration of 7.9 weeks, which is comparable to the various studies in the literature. The mean time from surgery to full weight bearing was 8.6 weeks. Other complications included limb length discrepancy, angulation of fracture, refractures and infection. None of the patients developed angular deformity of greater than five degrees. Limb length discrepancy of less than 2 cm was found in five cases, which was clinically insignificant. Overall experience in our study shows that titanium elastic nailing for paediatric shaft femur fracture is a safe, cost effective procedure resulting in very few short term complications, mostly minor and with a relatively easy learning curve [23, 24].

CONCLUSION

The treatment of paediatric shaft femur fracture has been drastically changed over the last two decades to internal fixation by elastically stable intra-medullary nail (ESIN). Titanium elastic nailing seems to be more physiological and effective method of treatment of femoral shaft fractures in 6-14 years old children. In our study, we encountered only a few complications most of them being minor. It is simple, rapid and safe procedure with advantages of early union, early mobilization and early return to function with minimal complications. Most of the complications were surgical technique related and were seen at the initial phase of the learning curve.

CONFLICT OF INTEREST

None.

DECLARED

None.

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