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Elastic Stable Intramedullary Nailing and Fixation with Titanium Elastic Nail in Displaced Femoral Shaft Fractures in Children

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ABSTRACT

Introduction: Femoral shaft fracture is an incapacitating injury in children. The treatment has traditionally been age related, influenced by the type of injury, associated injuries and the location and type of fracture. The aim of fracture treatment is not only anatomical realignment, but also restoration of muscle and joint function as close as possible to the normal. **Objective:** To evaluate the elastic stable intramedullary nailing and fixation with titanium elastic nail in displaced femoral shaft fractures in children. **Material and Methods:** A Retrospective Study conducted at Dept. of Ortho-Surgery, Patuakhali Medical College Hospital, Patuakhali, Bangladesh from January 2022 to June 2022. Forty six peadriticpatientsfemoral shaft fractures were included. **Results:** Total 46 children (36 males, 10 females) having age between 6-14 years with fresh femoral shaft fractures which were fixed with Titanium Elastic Nail. All patients achieved complete healing at a mean of 9.1 (Range 810) weeks. 41 fractures were reduced by closed means but 5 needed open reduction. 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. The mean time of the union was 7.9 (range 79) 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. No major complication was recorded. Most common minor complication was entry site skin irritation recorded in 6 patients. 87% had excellent result and 13% had satisfactory. **Conclusion:** It is concluded that Elastic Intramedullary Nailing of Femur Shaft Fractures in Children have excellent outcome with minimal complications. Elastic stable intramedullary nailing is the method of choice for the femoral shaft fractures in paediatric patients, because it is minimally invasive and shows very good functional and cosmetic result. It allows early ambulation and shorter hospital stay and higher parent satisfaction. It also provides flexural, translational and rotational stability as well.

Keywords: *Elastic stable intramedullary nailing (ESIN), Titanium elastic nail (TEN), Femoral shaft fracture, Rotational Stability.*

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INTRODUCTION

Femoral shaft fracture is an incapacitating injury in children [1,2]. The treatment has traditionally been age related, influenced by the type of injury, associated injuries and the location and type of fracture. The aim of fracture treatment is not only anatomical realignment, but also restoration of muscle and joint function as close as possible to the normal. Psychological recovery is accelerated by early resumption of functional activity, which encourages healing of fracture, maintenance of normal circulation, preservation of tone of the muscles and restoration of the movements of the joints. The aim there fore is early mobilization by early use of the injured part without movement at the fracture site. 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]. However above six years of age, nonoperative 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 [5,6,7]. Because of rapid healing and s pontaneous correction of angulations most of femoral shaft fractures in children younger than six years of age can be treated co nservatively. Above six years of age all such fractures when treated non -operatively could have loss of reduction, malunion, intolerance and complication associated with plaster. Only a limited number of studies have focused on the combined use of ESIN and EF. Ertürk et al [8] and Atef and El Tantawy [9] reported the combined use of ESIN and EF in the management of open unstable tibial fractures in adults and adolescents. However, no studies have reported the results of

such a fixation system in children aged 5 to 11 years with unstable femur fractures. Due to these reasons it was preferred to treat femur shaft fractures in children with elastic intramedullary nails. The aim of this study was to present our experiences regarding the outcome of femur shaft fractures treated with elastic intramedullary nail fixation.

Material and Methods

A Retrospective Study conducted at Dept. of Ortho-Surgery, Patuakhali Medical College Hospital, Patuakhali, Bangladesh from January 2022 to June 2022. Forty Six peadriticpatientsfemoral shaft fractures were included. 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 =26, 56.6%) followed by fall from height (n =20, 43.4%). 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: 4 fractures were in proximal third, 36 in middle third and 6 in distal third of femur. Sub trochanteric and supracondylar femur fractures were excluded from the study. All data analysed windows SPSS version 21.

Inclusion Criteria:

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

Exclusion Criteria:

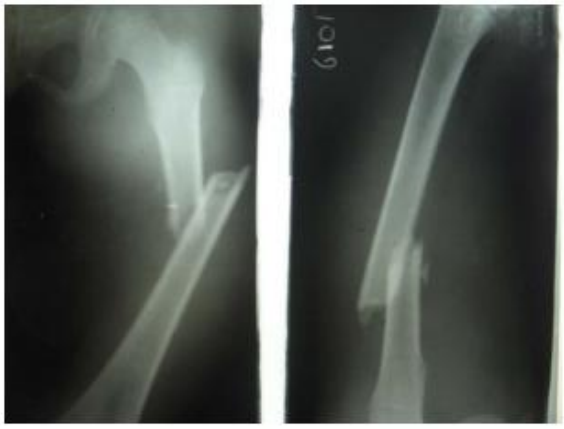
- Children 14 yrs of age.
- Metaphyseal fractures.
- Undisplaced fractures.
- Open fractures.
- Pathological fractures.

Operative Technique:

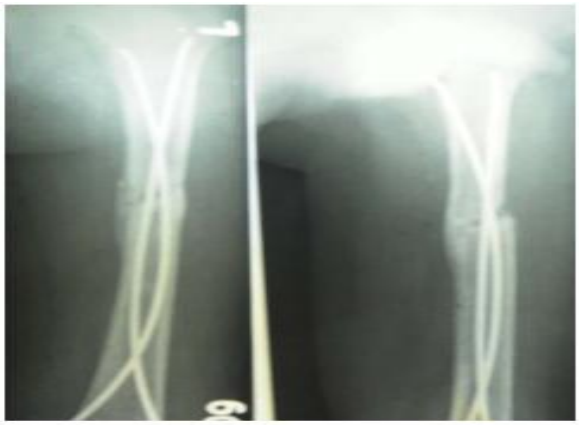
The surgeries were performed under general anesthesia with the patients in supine position with the help of image intensifier. Two Titanium Elastic Nails of identical diameter were used and the diameter of the individual nail was selected as per Flynn et al.'s formula16 (Diameter of nail = Width of the narrowest point of the medullary canal on anteroposterior and lateral view×0.4mm). 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. Insertion of the later nail was done in a similar fashion but from the opposite side of the bone. 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. All nails were then knocked home, leaving sufficient nail exposed at the site of insertion to enable subsequent removal. Open reduction was required in five 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 physics.

Post-Operative Rehabilitation:

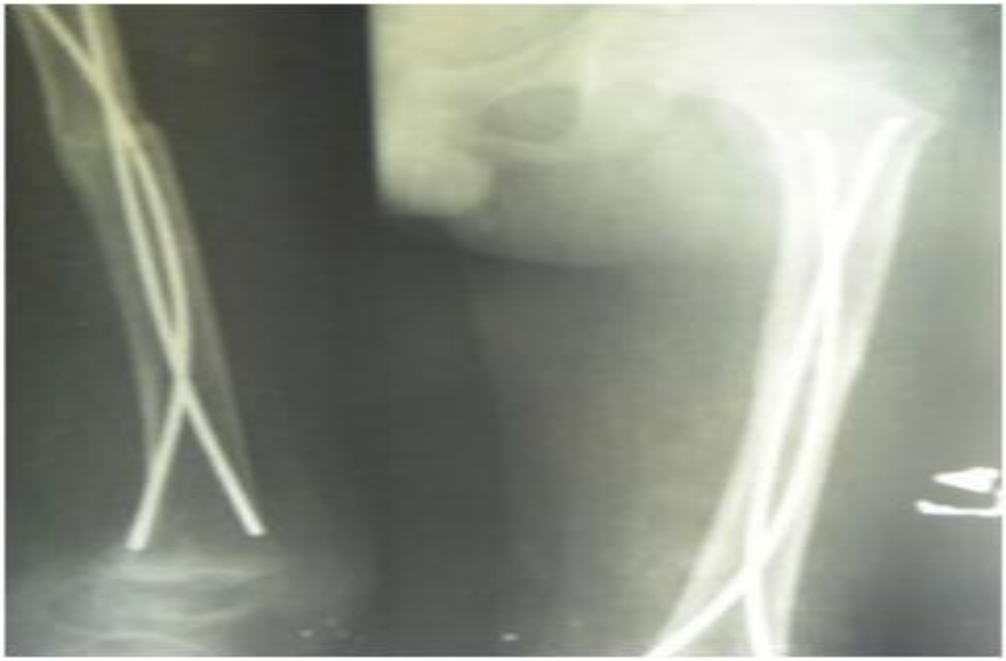
No external splints were used. Postoperatively patient's limb was elevated on a pillow. Patients were mobilized without weight bearing on the eighth to tenth day postoperatively. Partial weight bearing was started at around four weeks and full weight bearing by eight weeks depending on the fracture anatomy, quality of reduction, callus response and associated injuries. All patients were followed up radiologically as well as clinically every 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.



Pic-1



Pic-2



Pic-3

RESULTS

Total 46 children (36 males, 10 females) having age between 6-14 years with fresh femoral shaft fractures which were fixed with Titanium Elastic Nail (TEN) (Fig-1). All patients achieved complete healing at a mean of 9.1 (Range 810) weeks. 41 fractures were reduced by closed means but 5 needed open reduction. The results were evaluated using Flynn et al., 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. The mean time of the union was 7.9 (range 79) 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. No major complication was recorded. Most common minor complication was entry site skin irritation recorded in 6 patients. 87% had excellent result and 13% had satisfactory. None of the patients developed any angular deformity of greater than five degrees. Limb length discrepancy of less than 2 cm was found in 5 cases, which was clinically insignificant. Six 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 (Fig-2). This 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.

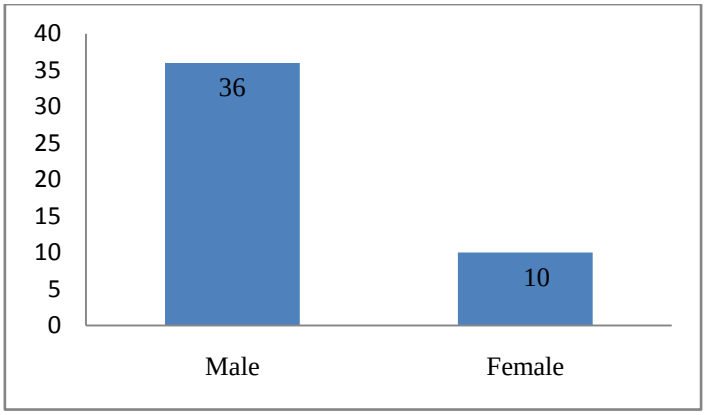


Fig-1: Sex distribution of Patients.

Table-1: Flynn et al., Scoring Criteria for TENS and present study result (N=46)

	Excellent	**Satisfactory**	**Poor**
Pain	**None**	**None**	**Present**
Malalignment	$< 5^0$	$5\text{-}5\text{-}10^0$	$>10^0$
Limb Length Discrepancy	<1 cm	1-2cm	>2cm
Complication	**None**	**Minor**	**Major and/or lasting morbidity**
No. patients (n=46)	n=41	n=5	n=0

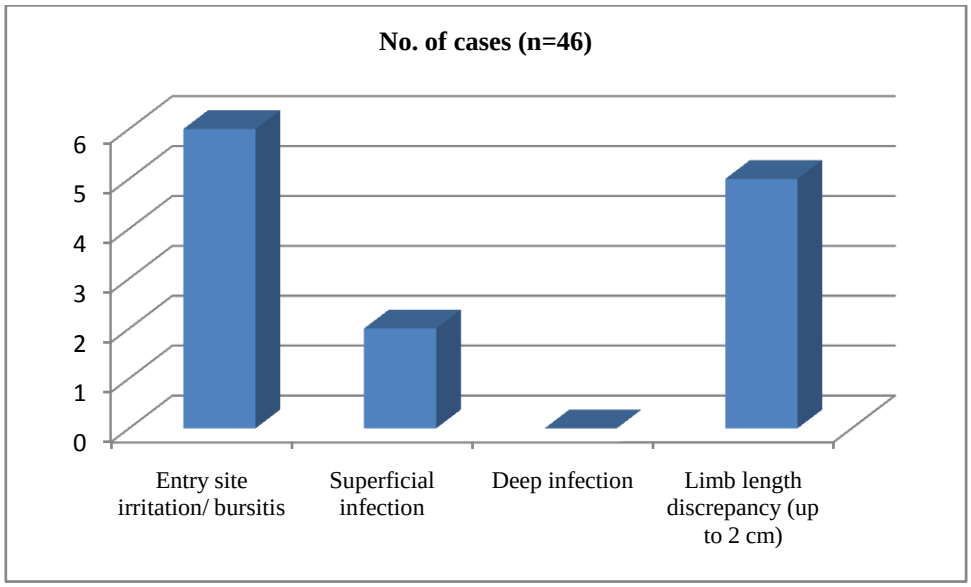


Fig-2: Complications in the Study (N=46)

DISCUSSION

Paediatric femoral shaft fractures had been traditionally treated with non-operative methods with traction and spica cast application [6–8], however over the past two decades operative treatment has been increasingly tried in order to avoid prolonged immobilisation and other complications of earlier methods. Most popular of these operative treatments have been internal fixation with plate [10,11], rigid fixation with intramedullary nail [12], external fixation [13,14] and more recently flexible intramedullary nailing [15].The results were excellent in 40 patients (87%), satisfactory in 6 (13%) and poor in none of the patients as per the scoring criteria for TENS by Flynn et al., [17]. 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 [18-20]. However, to overcome these problems in this age group, the operative approach has been gaining popularity for last two decades [21]. There are multiple options for operative fixation of these fractures such as external fixators, flexible and locked intramedullary nails, and compression plating [22]. 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 [23]. 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 [24, 25]. 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, coxavalga, and avascular necrosis of the femoral head and growth disturbances [26, 27]. 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. 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 [28]. Of his study population none of the patients complained of disability and no gait abnormalities were observed at one year of follow-up. We have conducted a prospective study on 46 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. All the patients achieved full range of motion by 9.6 weeks. The results were analyzed as per the scoring criteria by Flynn et al., [29] which showed excellent results in 41 patients, satisfactory in 5 and none of the patients fell into poor category. The most common complication of Titanium elastic nail is entry site irritation and pain [30]. Other complications included limb length discrepancy, angulation of fracture, refractures and infection. Six 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. This 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. 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. However, the cases are being followed up further for a possible limb length discrepancy that may develop in future.

CONCLUSION

It is concluded that Elastic Intramedullary Nailing of Femur Shaft Fractures in Children have excellent outcome with minimal complications.Titanium elastic nailing seems to be more physiological and effective method of treatment of femoral shaft fractures in children. It is simple, rapid and safe procedure with advantages of early union, early mobilization and early return to function with minimal complications.

Conflict of Interest: None.
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Authors Contributions: All Authors contribution was present study.

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