Original Article

Outcome of Elastic Stable Intramedullary Nailing in Fracture Shaft of Femur in Children of 6-16 years Age

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Abstract

Introduction: *Treatment of fracture shaft of femur is controversial in 6-16 years age group. The objective of this study was to determine the effectiveness and the complication associated with elastic stable intramedullary nailing in fracture shaft of femur in children of 6-16 years age.* ***Materials and methods:*** *This study was conducted on 36 cases of recent (>3 days) fracture shaft of femur in children of 6-16 years age which were treated by stabilization with titanium elastic nail at Eastern Medical College Hospital (EMCH), Mukti Hospital and Trauma center, Cumilla from February 2016 to January 2020. The Inclusion criteria were a) age group of 6-16 years, b) recent fracture of femur shaft, c) transverse, short, oblique, minimally comminuted fractures. The final results were clinically evaluated by using Flynn's criteria and radiologically by Anthony et al.'s criteria.* ***Result:*** *All patients (36) achieved union by 8-12 weeks (mean duration 10.4 weeks). Clinical results were excellent in 32 patients (88.9%), satisfactory in 4 patients (11.1%) and poor in none. Full range of movement was achieved by 8-10 weeks (mean duration 8.39 weeks). Angulation (10°-15°) developed in three patient and limb length discrepancy (1-2 cm) seen only in two patients. Four patients developed bursitis at entry point of the nail and two patients developed superficial infections.* ***Conclusion:*** *Titanium Elastic Nail (TEN) is very much effective in the management of fracture shaft femur in 6-16 years children with early union, early mobilization and minimum complications.*

Key words: Elastic Stable Intramedullary Nail, Fracture Femur, Flynn's criteria, Titanium Elastic Nail

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Introduction

Traumatic injuries of long bones in children and adolescence are the leading cause of morbidity and mortality in Bangladesh[1]. Fracture shaft of the femur constitute 2% of all fractures in children which require hospitalization and causes significant burden on families as well as healthcare system[2,3].

Among the various causes of fracture shaft of femur in children, road traffic accident and fall from height is the top most[4,5]. Fracture shaft of the femur are 2.6 times more common in boys than in girls[6,7]. Treatment of the fracture shaft of the femur depends on age of the patient, type of the fracture, location of fracture and on surgeon preference[8].

In children younger than 6 years of age healing occurs rapidly and angulation corrected spontaneously; that's why young children of 6 years of age or less can be treated conservatively with low cost and good outcome[9,10]. In older children above 6 years of age, conservative treatment results in loss of reduction, angulation, malunion, psychological intolerance in the child as well as the family. Near the end of skeletal maturity angular deformity is not corrected by growth and adequate reduction is mandatory[11]. Antegrade interlocking intramedullary nailing is the standard treatment in skeletally mature adolescents with age more than 16 years. However, the best treatment between 6 and 16 years of age is a matter of debate[12].

There is an increase in tendency towards operations using external fixator, compression plate, intramedullary locking nail and elastic stable intramedullary nail (ESIN) in patient over 6 years age for last 2 decades[13]. Plating provides rigid fixation with some demerits of large exposure, increased blood loss, repeat surgery for implant removal and scarring[14]. Interlocking nailing is preferred in children near skeletal maturity[15]. And external fixators are mainly used in open fracture[16]. ESIN was introduced for femoral fracture by Nancy group in 1979[17].

The biomechanical principal of the Titanium Elastic Nail (TEN) is based on the symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points[18,19]. The ESIN has the benefits of early immediate stability to the involved bone

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segment which permits early mobilization and return to the normal activities of the patients, with very low complication rate[20,21].

This prospective study was conducted on Elastic Stable Intramedullary Nailing using TEN for the treatment of fracture shaft of the femur to assess the result and role of TENS in management of fracture shaft of femur in children with age between 6-16 years.

Materials and Methods

This prospective study was conducted on 36 cases of recent (>3 days) fracture shaft of femur in children of 6-16 years age (mean age 9.28 years) which were treated by stabilization with Titanium elastic nail at Eastern Medical College Hospital, Mukti Hospital and Trauma center, Cumilla from February 2016 to January 2020. Children younger than 6 years and older than 16 years, grade III open fractures, severely comminuted fracture grade IV, pathological fractures, fractures with metabolic bone disease and children with neuromuscular disorders are excluded from study.

Most common mechanism of injury was road traffic accident (n=26, 72.2%) followed by fall from height (n=10, 27.8%). Among these 36 cases, 30 (83.3%) are boys and 6 (16.7%) are girl; 22 (61%) fractures were right sided and 14 (39%) fractures were left sided; 33 (91.6%) fractures were close, 2 (5.6%) fractures were grade I compound and 1 (2.8%) was grade II compound; 24 (66.6%) fractures involve the middle third, 7 (19.4%) fractures involve the distal third and 5 (13.9%) fractures involve proximal third of shaft of femur; 25 (69.5%) fractures were transverse, 8 (22.2%) were short oblique and 3 (8.3%) were minimally comminuted; and associated injuries are seen in 7 cases.

Displaced fractures were immobilized using skin traction up to day of operation. Open fractures were immediately managed by surgical toileting with normal saline, povidone iodine solution followed by immediate I.V. antibiotics. Majority of fractures (n=32, 88.9%) are stabilized (by TENS) within one week. Operation was done under general anaesthesia in supine position with traction in fracture table. The nails were pre-bent sufficiently and prepared for insertion so that apex of the bowed nails rested at the same level on the fracture site to ensure a good equal recoil force. The nails are cut according to required length. The diameter of the individual nail was selected as per Flynn et al's[29] formula (Diameter of nail = Width of the narrowest point of the medullary cavity on A/P and lateral view x 0.4 mm). Fractures were reduced under fluoroscopic guidance and two nails of identical diameter were inserted in retrograde fashion with medial and lateral incision 2.5 cm above the physis. Figure-1 shows the preoperative picture of fracture shaft of femur, Figure-2 & 3 shows the per-operative fluoroscopic view of intramedullary nailing of femur fracture and Figure-4 shows postoperative picture of fracture.

Figure-1: Fracture shaft of femur (preoperative)

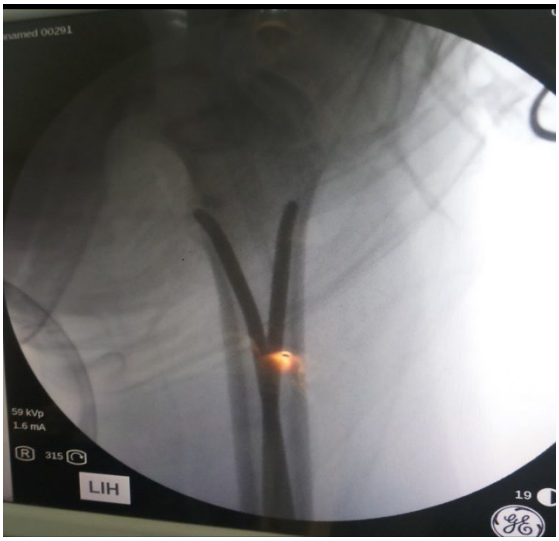

Figure-2: Fluoroscopic view of femur fracture (per-operative)

Figure-3: Intramedullary nailing of the femur fracture (per-operative Fluoroscopic view)

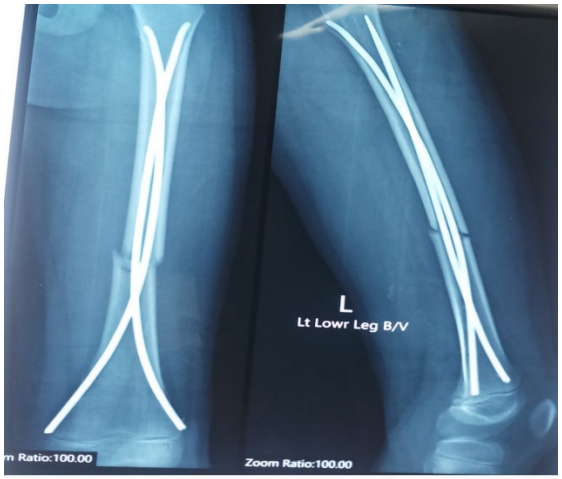

Figure-4: Postoperative view of femur fracture

Nail insertion to proximal fragment was failed in two cases due to soft tissue interposition and require open reduction. Duration of operation varies from 40-90 minutes (mean duration 62.9 minutes). Stabilization by two elastic nails was sufficient for almost all patients except 3, of which two require long leg back slab and one require hip spica.

All patients were instructed for elevation of leg resting on a pillow and isometric exercise as soon as possible. Patients were mobilized non-weight bearing after 1 week of operation, partial weight bearing was started after 3 weeks of operation and full weight bearing was started after 6-8 weeks of operation depending on fracture configuration and callus formation.

Table-I: Assessment of results according to Scoring Criteria by Flynn et al.

Criteria	Excellent	Satisfactory	Poor
Limb length discrepancy	<1 cm	1-2 cm	>2cm
Malalignment (degree)	<5º	5º-10º	>10º
Pain	Absent	Absent	Present
Complication	Absent	Mild	Major complication and/ or extended period of resolvable morbidity
Number of patient (n=45)	n = 40	n = 5	n = 0

Results:

Valgus angulation (10° and 15°) developed in two patient and varus angulation (10°) developed in one patient due to inadequate reduction and instability of fractures that were remodeled with time leading to favorable outcome. Limb length discrepancy (1-2 cm) seen only in two patients. Full range of movement was achieved by 8-10 weeks (mean duration 8.39 weeks). The clinical results were excellent in 32 patients (88.9%), satisfactory in 4 patients (11.1%). According to Flynn's criteria of scoring, no poor result was found which is seen in Figure-5. Flynn's criteria of scoring are described below in Table-I. Radiological unions were seen in all patients within 8-12 weeks (mean duration 10.4 weeks). Anthony et al. scale for grading callus formation is described in Table-II.

Table-II: Anthony et al. scale for grading callus formation

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

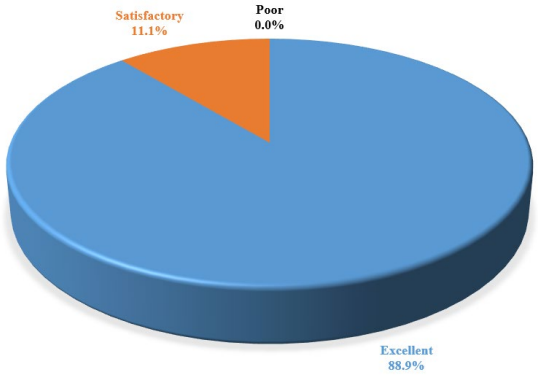

Figure-5: Clinical outcomes of the operative procedure

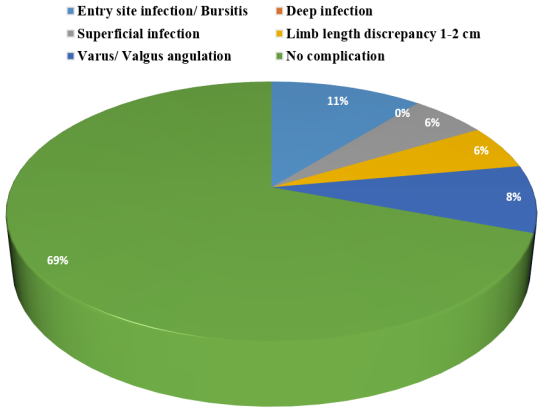

Figure-6: Percentages of Complications after the operative procedure

Most of the patient recovered without complication, but 4 (11%) patient developed bursitis at the entry point of the nail and 2 (6%) patients developed superficial infection which was resolved by oral antibiotic. There was no history of deep infection or any other complications. Type and percentages of the complications are illustrated in Figure-6.

Discussion

As healing process is rapid and angulation is corrected spontaneously, conservative treatment provides good outcome in children younger than 6 years of age. On the other hand, angular deformity is not corrected by growth and adequate reduction is mandatory in skeletally mature adolescents with age more than 16 years. Antegrade interlocking intramedullary nailing is the treatment of choice in children with age more than 16 years. But choice of treatment between 6 and 16 years of age is very much difficult.

Due to loss of reduction, angulation, malunion, psychological intolerance, conservative treatment is not fruitful in older children above 6 years of age; that's why treatment of fracture shaft of femur in older children with 6 to 16 years of age has turned towards the operation which is associated with the less immobilization, early recovery, shorter rehabilitation period and less psychological impact to the children[22]. Plate osteosynthesis is associated with large exposure, blood loss, repeated dissection for plate removal and risk of infection and delayed union[23,24]. Interlocking nail in skeletally immature patient may be associated with avascular necrosis of femoral head and coxa valga[25]. External fixator may be associated with pin track infection and re-fracture through the pin track[26,27].

TEN is a load sharing internal splint that provides more strength in spite of light weight. It maintains alignment and allows early mobilization without physeal injury or periosteal disturbance; micromotion promotes rapid external bridging callus across the fracture site. Selection of surgical techniques depends on location and geometry of fracture. Similar to our study Saikia KC et al.[28], Flynn et al.[29] and Narayanan et al.[8] stated that transverse, short oblique and minimally comminuted fractures are suitable for TEN.

Conclusion

The TEN is very much effective and valuable treatment option in fracture shaft of femur in the children of 6-16 years age group with advantage of early union, early mobilization and minimal complications.

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