ORIGINAL ARTICLE

Role of Elastic Intramedullary Nail for the Treatment of Femur Shaft Fractures in Children

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ABSTRACT

Objective: To demonstrate the effectiveness of intramedullary fixation of femur shaft fracture in children using elastic intramedullary nails.

Method: This prospective observational study was performed from January 2014 to December2016**.** 26 patients admitted with femur diaphyseal fractures with mean age from 6 to 12 years, who subsequently underwent femur elastic intramadullary nail insertion in retrograde fashion for the treatment of femoral shaft fractures were enrolled in the study. Patients were in regular follow up till radiological union achieved. Flynn scoring criteria is used to assess the functional outcomes at 6 months follow up.

Results: The Mean age of patient in our study was 9 years (6- 12 years), all 26 patients were in regular follow up for average 26 weeks (14-36 weeks). Radiological union achieved in all patients in a mean time of 9 weeks (range 6-12 weeks). Two patients had skin breakdown at entry site, which lead to superficial infection. One patient had limb length discrepancy upto1.5cm and one patient had varus angulations up to (10º) and in one proximal migration of nail. According to Flynn Criteria outcome was excellent in 19 patients (73.1%), satisfactory in 6 patients (23.1%), poor in 1 patient (3.8%) respectively

Conclusion: The use of elastic intramedullary nail in femoral diaphyseal fracture is better option in pediatric age group as it gives satisfactory outcome with minimum complication rates because of simple operating technique with less operating time and satisfactory radiological union achieved to accomplish the goal of treatment. So it could be considered as a favorable treatment option for femoral shaft fracture in pediatric age group.

Key words: Elastic, Intramedullary Nail, Fracture, Femur Shaft, and Children

INTRODUCTION

Trauma is the commonest cause of mortality and morbidity in pediatric population, second only to acute infections [1]. Femoral fractures constitute only 2% of the orthopedic trauma in children [2]. These femur fractures have a major impact on the patient as well as on their families and utilization of financial resources [3]. In past, these fractures have been treated through different modalities. Historically these fractures were managed conservatively in cast by applying hip spica, which in return produces acceptable results [4]. Such method of treatment produces too much physical and mental stress on patient and his/her family [5]. Titanium elastic nailing (TEN) has gained popularity over the last two decades and is now being most widely performed procedure for femur shaft fractures in children aged 6 and above [6]. Elastic intramedullary nailing provide stable fixation and allow rapid postoperative functional recovery. Despite of several advantages of Elastic Nails complication rate of about 60% been reported, mostly due to faulty operative technique and improper patient selection. Common complication related to (TEN) is soft tissue injury at the insertion side of the nail [7]. Nail prominence can lead to other serious complications include skin breakdown, superficial and deep abscess, osteomyelitis. .In 1982 Nancy group introduce flexible intramedullary nailing for femoral shaft fractures [8]. Elastic intramedullary nailing has become the standard treatment of femur shaft fractures in pediatric group because of favorable results and lack of major complications, as it is mini-invasive surgery, no need for casting, early mobilization and discharge as well as growing concerns toward cost-effectiveness.

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METHODS

This is a prospective observational study including children from age group of 6-12yrs having femur diaphyseal fractures treated with elastic intramedullary nail during a 2 year period from January 2014 to January 2016. Patients were registered using a predesigned Performa. Approval from institutional ethical review committee was taken prior to commencement of the study. Formal informed written consent was obtained from patients registering in the study. Patients having metabolic bone diseases, pathological fractures, compound fractures and with neuromuscular disorders were excluded from the study. Surgical indications were displaced femur shaft fractures with open physis. Study was conducted on 26 patients having diaphyseal femur fracture of Transverse, Oblique, Spiral and minimally comminuted variety. There were 18 male patients and 08 female patients with average age 09yrs (range 6- 12yrs) at the time of injury. All patients with femoral diaphyseal fractures were managed with TEN. Diaphyseal fracture further divided on the basis of anatomical location as proximal third shaft, middle third and distal third shaft. Three patients suffered from proximal third diaphyseal femur fracture, while nineteen and four had middle third and distal third of femur shaft respectively. Fractures were classified according to AO pediatric (*Arbeitsgemeinschaft für Osteosynthesefragen)* classification for femoral shaft fracture 32-D (4.1,4.2, 5.1 and 5.2). All patients were gone under the surgery within 1 week from injury. All surgeries were performed under general anesthesia in supine position on radiolucent operating table under image intensifier control by pediatric orthopedic surgeon more than 10 years of experience. Nail size determined pre-operatively from radiograph of contra lateral femur that each nail occupies at least one-third to 40% of narrowest part of the intramedullary region. Fractures were reduced by close methods using two flexible nails, which were inserted across the fracture through proximal to distal femoral physis in retrograde fashion. The nail entry points were 2.5-3.5cm superior to the distal femoral physis. The pre-requisite for ensuring a good equal recoil force is to pre bend both nails of equal diameter sufficiently so that the apex of both bowed nails should lie and provide diagrammatically opposed curves at the fracture site. The nails were inserted proximally till the tips anchored 1-2cm distal to proximal physis in divergent fashion, confirmed on image intensifier on both anterio-posterior and lateral views.

Postoperatively the operated leg kept elevated for 24 hours, post-operative rehabilitation included hip and knee motion exercise on 1st post operative day, followed by non-weight bearing mobilization on 5th to 7th day post operatively. Partial weight bearing was started at 03 weeks followed by full weight bearing at 6 to 8 weeks once radiological union was observed.

Outcome of all fracture pattern were assessed by using Flynn et al scoring criteria for TEN as excellent, satisfactory and poor [9].

Table 1: Flynn Criteria For Femur Shaft Fracture

	Excellent result	**Satisfactory result**	**Poor result**
Length discrepancy	<1.0 cm	<2.0 cm	>2.0 cm
Malalignment	5 grades	10 grades	>10 grades
Pain	No	No	Yes
Complications	None	Minor and solved	Major and/or residual morbidity

Table 2

Location Of Fracture		
Proximal 1/3 Shaft	03	11.5%
Middle 1/3 Shaft	19	73.1%
Distal 1/3 Shaft	04	15.4%
Pattern Of Fracture		
Transverse	11	42.3%
Oblique	09	34.6%
Spiral	03	11.5%
Comminuted	03	11.5%

RESULTS

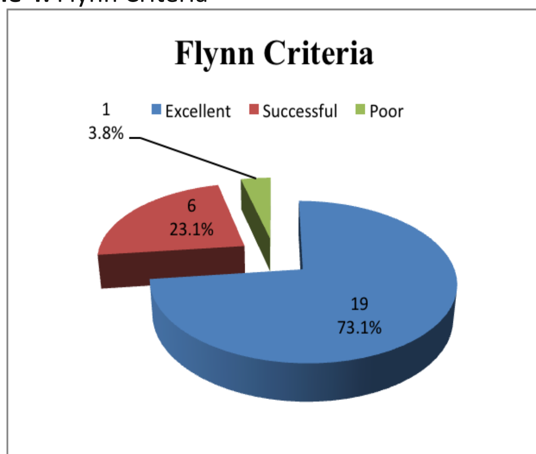
The Mean age of patient in our study was 9 year (range 6- 12) years, with mean weight of 23.88 (SD± 5.56). The median duration of surgery was 55 minutes (range 35-90) minutes. All 26 patients were in regular 26 weeks (14-36 weeks) follow up. Radiological union achieved in all patients in a mean time of 9 weeks (range 6-12 weeks). There were 11 transverse fractures (42.3%), 9 oblique (34.6%), 3 spiral (11.5%) and 3 comminuted fractures (11.5%). According to the functional scoring

criteria proposed by Flynn the 19 patients (73.1%) had an excellent result, 6 patients (23.1%) had satisfactory outcome and 1patient (3.8%) had a poor outcome. In present study it is found that outcome depend on fracture pattern, results were excellent in 100% in oblique fracture. In transverse fracture it was excellent in 72.7%and successful in 27.3%. In spiral fracture results were excellent in 33.3% and successful in 66.7% and in comminuted fracture results were excellent in 33.3%, successful in 33.3% and poor in 33.3 %. Results were significant having (p value ≤ 0.05) (i.e., $p < 0.05$ shows significant difference between groups) consider significant using Chi square test. Entry site irritation occurred in 03 patients secondary to prominence of nail. Two patients had skin breakdown at entry site, which lead to superficial infection. One patient had limb length discrepancy upto1. 5cm and one patient had varus angulations up to (10º). One patient required nail removal at 5th month due to wound break down at proximal thigh due to proximal migration of nail.

Table 3: Demographics

	Mean± S.D	Range (Max-Min)
Age (years)	8.69 ±1.91	(6-16)
Weight (kg)	23.88±5.56	(15-36)
Surgical Time (minutes)	58.08±15.23	(35-90)
Radiological Union (weeks)	9.00± 1.67	(6-12)

Table 4: Flynn Criteria



DISCUSSION

Femoral shaft fractures in peadiatric age group had been treated previously with non-operated method and hip spica [4]. By the invention of newer devices or techniques shows the positive outcome in the treatment of diaphyseal fractures in children and adolescents. In order to avoid prolonged immobilization, reduce the loss of school days and to provide better nursing care surgical interventions are become standard in treating such kind of fractures. A different operated method has been used for internal fixation, including rigid fixation with plate [10], intramedullary nail, with external fixator [11] and recently flexible intramedullary nail [9]. Plate Osteosynthesis is easier to perform still widely used; it bears the risk of large exposure, delayed union, infection and later re dissection for implant removal. This method of fixation has relatively longer duration of immobilization as compare to flexible intramedullary nailing. External fixator is associated with pin tract infection and relatively took longer period for weight bearing but simultaneously it provide good stability and early mobilization, but it [11]. Every method of fixation has its advantages and disadvantages.

Flexible intramedullary nails had been in fashion for fixing peritrochentric fracture [12], but the use of titanium elastic nail in paediatric shaft fracture was popularized by Nancy in 1982 [8]. Surgical procedure using TEN particularly in this age group had advantages because it is simple, load sharing internal device that does not disturb the open physis, allows early mobilization and maintain alignment. Elasticity of the titanium nail provides micro-motion, which promotes faster external bridging at fracture site and callus formation. As a close procedure there is no disturbance in fracture hematoma or periosteum is not disturbed, therefore less risk of infection.

In earlier days TENS was only used in-patient of 6-12 years age group, but later several studies showed an excellent outcome in younger children as well [13]. Currently surgical indications for TENS include all femoral shaft fractures with open physis. Flynn reported in his study that TEN has advantages over hip spica in management of femoral shaft fractures [14]. Saikia K C reported that results were excellent in (59.0%), successful in (27.2%) and poor in (13.6%). He also reported that result were better for children less than 10 yrs of age (p value .0001) [15].

In our study what we found that functional outcome depend on the fracture pattern, oblique fracture had an excellent outcome as compare to other fracture pattern, all patient who registered in our study achieved radiological union in a mean time of 9 week

our results are comparable to Lohyia who reported in his study the outcome of femur shaft fracture treated with TENS were excellent in 37, successful in 3 and poor in 3. They observed complete radiological union at an average of 11 weeks average [16]. Narayanan reported 79 femoral shaft fractures stabilized with TENS all were united without any difficulties and having good outcome [17]. Fracture pattern and its location is an important consideration for selection of surgical techniques. In our study we also found that fracture of mid shaft femur along with oblique or transverse pattern had a good outcome as compare to spiral or comminuted fracture. L.A Moroz in his study found that distal femur fracture carried a poor outcome in (18%) of cases, as compared with middle and proximal third, which was (9%), although it was not statistically significant [18].

The stability in communicated or long spiral fractures was adequate if treated with titanium elastic nail, than appropriate option other than elastic nail should be consider.

Our study also supports various other studies that most of these femur fractures when fixed with TENS heal well with fewer complications. Studies showed that outcome were better in children of age 10 years and below [15, 17]. But in our study there was no significant outcome in different age group (p value= 0.455). The most common complication of using TEN was pain at nail site insertion and skin irritation. Similar complication reported in previous studies by Narayanan and Flynn [9, 17]. In our study entry site irritation occurred in three patients due to nail tip prominence, while two other cases had skin breakdown at entry site which lead to superficial infection.

Other complication includes infections, angulations either varus or valgus and limb length discrepancy.

Sink reported that 60 % of complication of limb length discrepancy was either due to unplanned surgery or unstable fractures configuration, specifically long oblique fracture and comminuted variety [19]. But in our study we reported only one patient had limb length discrepancy upto1.5cm in comminuted fracture.

Table 5: Flynn Criteria In Relation With Fracture Pattern

			FLYNN CRITERIA			Total
			Excellent	Poor	Successful	
PATTERN OF FRACTURE	comminuted	Count	1	1	1	3
		% within PATTERN OF FRACTURE	33.3%	33.3%	33.3%	100.0%
	oblique		9	0	0	9
			100.0%	0.0%	0.0%	100.0%
	Spiral		1	0	2	3
			33.3%	0.0%	66.7%	100.0%
	transverse		8	0	3	11
			72.7%	0.0%	27.3%	100.0%
Total		**(P –value 0.05)**	19	1	6	26
			73.1%	3.8%	23.1%	100.0%

CONCLUSION

Treatment of femoral shaft fractures with flexible elastic nail in peadiatric age group gives satisfactory outcome with minimum complication rates because of simple operating technique with less operating time and satisfactory radiological union achieved time, so we recommend treatment of femoral diaphyseal fracture with flexible elastic nail in paediatric group should be considered as a favorable treatment option. To achieve better outcome pre operative planning and case selection is very important.

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