CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.3382213

Available online at: http://www.iajps.com Research Article

FUNCTIONAL OUTCOME OF FEMORAL SHAFT FRACTURES IN CHILDREN MANAGED WITH TITANIUM ELASTIC NAILING

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Abstract:

Objective: *To assess the functional outcome of femoral shaft fractures in children managed with titanium elastic nailing.* ***Material and methods:*** *This case series study was conducted at Department of Orthopaedic Surgery, Civil Hospital, Bahawalpur from January 2018 to September 2019 over the period of 6 months. A total of 25 patients (children) with fractures of shaft of femur either male or female having age 5-15 years were selected and functional outcome was assessed by using Flynn criteria.* ***Results:*** *In our series of 25 patients treated by titanium elastic nail, the age of children varied from 5 to 15 years. Out of 25 patients, 18 were male and 7 were female. The most common cause of the fracture was road traffic accident (RTA) in 15 cases, followed by fall from height in 8 cases. Functional assessment was done by TEN scoring criteria by Flynn et al. After analyzing the final score of each patient according to the above criteria, results were classified as excellent, satisfactory and poor. In our series excellent results were obtained in 19(76%) cases, satisfactory in 4 (16%) cases and poor in 2(8%) cases.* ***Conclusions:*** *We concluded that titanium elastic nailing is an ideal method of femoral shaft fixation in children.*

Keywords: *Femoral shaft fractures, Children, Titanium elastic nailing*

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Please cite this article in press Abdul Munaf Saud. et al., ***Functional Outcome Of Femoral Shaft Fractures In Children Managed With Titanium Elastic Nailing.,*** *Indo Am. J. P. Sci, 2019; 06(08).*

INTRODUCTION:

The femur is the strongest bone in the adult human skeleton and is surrounded by the largest muscle mass. It is formed from primary ossification center (femoral body) and secondary ossification centres: the head, greater and lesser trochanters and the distal epiphysis.[1] Of all the long bones, except the clavicle, it is the first to show traces of ossification. This commences in the middle of the femoral body, at about the 7th week of fetal life, and rapidly extends proximally and distally. The distal ossification center is the last to fuse at around the twentieth year of life.[2]

Fracture of shaft of femur is a common fracture in children, which has usually been treated conservatively. In children, fractures of femoral shaft are commonly treated by various types of traction for about three weeks, followed by plaster cast immobilization.[3] An ideal fixation device for paediatric femur fractures would act as a load sharing "internal splint" maintaining reduction for a few weeks until callus forms. Most important, implantation should endanger neither the physis nor the blood supply of the femoral head. Both Ender's nail and Titanium elastic nails offer these features. For more than two decades, French surgeons have started using titanium implants for "elastic stable intramedullary nailing" stating "Enders nail are not elastic enough for treating children".[4] The principle of Titanium elastic nail (TEN) fixation differs from that of Ender's technique. Ender nails are stacked to improve canal-fill. But TEN techniques require balancing the forces of the two opposing flexible implants.[3] Titanium elastic nailing, otherwise known as Elastic Stable Intramedullary Nailing has revolutionized the management of fracture shaft of femur in children.[5]

The Titanium Elastic Nail in treatment of paediatric femur fractures has been reported to be a simple, load sharing internal splint allowing mobilization and maintenance of alignment for a few weeks until bridging callus forms. The device exploits a child's denser bone, rapid healing and ability to remodel, without risking the physes or blood supply to femoral head. The perceived advantages of this technique includes early union due to repeated micro motion at fracture site, early mobilization, early weight bearing, easy implant removal and high patient satisfaction rate.

MATERIAL AND METHODS:

This case series study was conducted at Department of Orthopaedic Surgery, Civil Hospital, Bahawalpur from January 2018 to September 2019 over the period of 6 months.

A total of 25 patients (children) with fractures of shaft of femur either male or female having age 5-15 years were selected. Patients with segmental fracture, Winquist types III and IV comminuted fractures, previously diagnosed neuromuscular disease, osteomalacia, pathological fractures, and history of previous fracture or deformity were excluded from the study.

Soon after admission, the child was kept on an above knee skin traction set till surgery. This helped to prevent movement at the fracture site and to reduce pain and spasm of the surrounding muscle. Antero-posterior and lateral radiographs of the thigh showing both the knee and hip joint were taken. A routine chest x-ray, pelvic x-ray and USG of abdomen and pelvis were done to exclude any associated injury. Preoperative x-ray of contra lateral femur was used to estimate the nail diameter. Measurement of the narrowest diameter of the medullary canal with a ruler was done. The proper nail diameter is no more than forty percent of the width of the canal.

All the selected patients were managed with Titanium elastic nails. Patients were followed up every month for 9 months. Radiographs were taken at regular interval to access the union status; malalignment etc. Regular physiotherapy was advised for first 4 months. Full weight bearing was allowed after union of the fracture which was ascertained both clinically as well as radiologically. According to TEN criteria by Flynn the results are classified as excellent, successful or poor.5

Findings were entered in pre-designed proforma alongwith demographic profile of the patients.
All the data was entered in SPSS version 18 and analyzed. Mean and SD was calculated for numerical data and frequencies were calculated for categorical data.

RESULTS:

In our series of 25 patients treated by titanium elastic nail, the age of children varied from 5 to 15 years. Out of 25 patients, 18 were male and 7 were female. The most common cause of the fracture was road traffic accident (RTA) in 15 cases, followed by fall from height in 8 cases. Two patients had sports injuries.18 patients had fractures of right side while 7 cases had fractures of left side.21 cases were closed and 4 cases were open fractures among which 2 cases were Gustilo

grade-I compound and 2 cases were grade-II compound. Among the 25 femoral shaft fractures in 25 patients, 16 fractures were present in the middle 1/3rd, 6 were in upper 1/3rd and 3 in distal 1/3rd. In our study of 25 femoral shaft fractures, 11 patients had transverse pattern, 7 had oblique, 4 had spiral and 3 had comminuted fractures. The cases without any associated injury were operated within 5 days of injury after stabilization of general condition. Patients with head injury and chest injury were operated within 5-10 days of injury. Close reduction was possible in 21 cases and open reduction was done in remaining 4 cases.2.5 mm in 5 cases, 3 mm in 9 cases, 3.5 mm in 10 cases and 4mm nail was used in 1 case. Union was assessed clinically and radiologically every month till complete healing. Union occurred in all cases with an average time of 7.9 weeks (6-12 weeks) (Table 3).

Five patients had nail site irritation with bursitis leading to infection in 2 cases which required early removal of implant. There was no case of nonunion or delayed union in our series. There was no rotational malalignment. No case of implant failure or refracture after implant removal was noted. Pain in the knee occurred in 5 cases and in thigh in 1 case. Limb length discrepancy occurred in 6 cases. 3 cases had stiffness in knee. Angular malalignment occurred in 4 cases which were >5 degree (Table 4).

Limb length discrepancy was measured clinically comparing with the other limb. Average lengthening of 11 mm (9-13 mm) was noted in 4 cases and average shortening of 6 mm (5-7 mm) was noted in 2 cases after 6 months of surgery. 19 cases had no limb length discrepancy (Table 5).

Restriction of knee joint range of motion was noted in 3 cases with average range from 0-110 degree.21 cases had 0-5 degrees of malalignment, 3 cases had 5-10 degree and 1 case had >10 degrees of angular malalignment (Table 6).
Functional assessment was done by TEN scoring criteria by Flynn et al. After analyzing the final score of each patient according to the above criteria, results were classified as excellent, satisfactory and poor. In our series excellent results were obtained in 19(76%) cases, satisfactory in 4 (16%) cases and poor in 2(8%) cases (Table 7).

Table 1: Functional assessment scoring.

Variable	**Excellent**	**Successful**	**Poor**
Limb length discrepancy	<1 cm	<2 cm	>2 cm
Sequence disorder	5 degree	10 degree	>10 degree
Pain	Absent	Absent	Present
Complication	Absent	Mild	Major complication and/or extended period for resolvable morbidity.

Table 2: Demographic data.

Parameters	**Mean±S.D**	**Range (Max-Min)**
Age (years)	7.82±3.59	(5-15)
Sex(m:f)	18:7	
Weight (kg)	21.26±5.95	(14-32)
Surgical Time (minutes)	60.75±16.11	(34-78)
Radiological Union (weeks)	8.2±2.45	(5-12)

Table 3: Time of union.

Time of union	**No. of patients**	**Percentage (%)**
6-8 weeks	14	56
8-10 weeks	9	36
>10 weeks	2	8
Total	25	100

Table 4: Post-operative complications.

Complication	No. of patients	Percentage (%)
Nail site bursitis	5	20
Infection (ulceration at nail tip)	2	8
Pain in knee/thigh	6	24
Limb length discrepancy	6	24
Stiffness of knee	3	12
Angular malalignment (>5 degree)	4	16
Nonunion	0	0
Delayed union	0	0
Rotational malalignment	0	0
Implant failure	0	0
Refracture	0	0

Table 5: Limb length discrepancy.

Limb length discrepancy	No. of patients	Percentage(%)
Lengthening	4	16
Shortening	2	8
No discrepancy	19	76

Table 6: Angular malalignment.

Angular malalignment	No. of patients	Percentage (%)
0-5 degree	21	84
5-10 degree	3	12
10-15 degree	1	4

Table 7: Functional assessment.

Results	No. of patients	Percentage (%)
Excellent	19	76
Satisfactory	04	16
Poor	02	08
Total	25	100

DISCUSSION:

The ideal device to treat paediatric femur fractures would be a simple, load-sharing internal splint allowing mobilization and maintenance of alignment for a few weeks until bridging callus forms. The device would exploit a child's denser bone, rapid healing, and ability to remodel, without risking the physes or blood supply to the femoral head. Both Ender nails and TENs offer these features.[6-8] Ender nails are stainless steel implants that proved to be inadequate for adult femur fractures, but effective for pediatric femur fractures. In a small prospective, randomized study, Baron et al reported better results with flexible nails than with external fixation.[9] Ender nails are not elastic enough for treating children" courted by Ligier et al.[10]
Radiological and clinical union occurred with an average of 7.9 weeks (range 6-12 weeks) in our series. 56% cases achieved union within 6-8 weeks.

Nail site irritation was the most common complication. In our study five (20%) patients had nail site irritation with bursitis leading to infection in 2 cases which required early removal of implant. Pain in the knee occurred in 5 cases which responded to anti-inflammatory analgesics and two cases needed additional antibiotics for ulcerations. We examined the range of motion of the knee at each visit and final

assessment done at 4 months. We encountered stiffness of knee in 3 cases with range of motion from 0-110 degree. This was due to protrusion of nail in the distal femur causing blockage of the iliotibial tract, thus inhibiting knee flexion. Slongo et al reported the similar cause for knee stiffness due to excessive length of nail. All 3 cases regained full range after nail removal.[11]

Limb length discrepancy occurred in 6 (24%) cases. 4 cases had limb lengthening (average 11mm) and 2 cases had shortening (average 6mm). The limb length discrepancy was not described as a complaint by the patients and their relatives. None of them required additional surgery. Hoshian et al found a leg-length discrepancy of up to 1 cm in 6 children.[12] In a series of 112 children with 118 diaphyseal fractures.[13] Jubel et al noted a mean lengthening of the injured leg of 2.4 mm. Heinrich et al reported that 22% of their patients had an extension over 5 mm, and 11% had a shortness under 5 mm.[14] In our series angular malalignment occurred in 4 cases which were > 5 degree. In a study by Memduh et al found angulation less than 10 degrees toward varus/valgus or antero/posterior only in four femurs (11.4%).[15] Herndon et al reported that malunion developed in seven of 24 patients who were treated with traction while no malunion was observed in 21 children who were treated using intramedullary nailing.[16] In the antegrade elastic intramedullary nail (TEN) practices carried out by Carey and Galpin et al no clinically significant rotational or angular deformity were found while an angulation less than five degrees was evident in the frontal and coronal plate of the radiographic follow-up. [17] In an antegrade and retrograde TEN study by Galpin et al reported that 35 out of 37 patients had excellent improvement in terms of angular deformity.[18] Flynn et al reported 6 out of 58 cases were having angular malalignment >5 degree with 2 cases having >15 degree. Functional assessment was done by using TEN scoring criteria by Flynn et al.[5] In our series excellent results were obtained in 19 (76%) cases, satisfactory in 4 (16%) cases and poor in 2 (8%) cases. Saikia et al had found excellent results in 13 (59%) cases, satisfactory in 6 (27.2%) cases and poor in 3 (13.6%) cases.19 Singh et al found excellent results in 25 cases, satisfactory in 8 cases and poor in 2 cases.20 All above studies agree with our study findings.

CONCLUSION:

Titanium elastic nailing (TEN) is an effective and viable treatment option in selected cases of femoral diaphyseal fractures in 5-15 years age group. The management of such fractures in this age group is still controversial with proponents of both conservative and surgical methods. There has been resurgence for operative fixation at present. The indications for TEN for paediatric femoral fractures are expanding as their advantages are realized and complications of other operative methods of stabilization are reported.

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