

## Flexible Intramedullary Nail Fixation in Paediatric Femoral Shaft Fractures

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### ABSTRACT

**BACKGROUND:** The objective of this prospective study is to assess the outcome of isolated closed fracture shaft femur, treated with flexible intra-medullary nailing technique in a cohort of 20 children.

**METHODS:** The children with age ranging from 5-15 years with isolated closed fracture shaft femur were included in the study. All the patients were treated with flexible intra-medullary nails using a standard surgical technique. Postoperatively, the patients were

mobilized non weight bearing. Patients were followed up at regular intervals and assessed for union clinically and radiographically. Once the signs of union were present, they were weaned off crutches gradually. Limb length, rotational alignment and recurvatum of knee were assessed clinically.

**RESULTS:** The mean age of the children was 8.9 (5.2 – 13.1) yrs. All fractures attained union. The average time of follow-up was 23.6 (19-27) months. Recurvatum deformity of the knee was not seen in any of the patients. Five patients had limb length discrepancy ranging from -5 mm to +8 mm, but none of them needed any treatment for this problem. Four patients developed average 5.5 (5-7) degree of external rotation deformity which was well tolerated.

**CONCLUSION:** We conclude that flexible intramedullary nail fixation of fracture shaft femur in children aged 5-15 years is a very acceptable way of treatment and is associated with minimal complications if the surgeon sticks to the proper way of applying this technique.

**Key words:** Paediatric; Femur; Flexible; Intramedullary

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### INTRODUCTION

Femoral fractures are the most common diaphyseal fractures of childhood after forearm and tibial fractures. These injuries are usually isolated injuries and in a majority of the cases, shaft of the femur is involved<sup>[1]</sup>. The most common cause for this type of injury in the paediatric population is a fall or a motor vehicle accident<sup>[2,3,4]</sup>. Although any reasonable form of treatment for fracture shaft femur gives satisfactory outcome yet the orthopedic surgeons remain divided over the optimal method of treating femoral fractures in children. The choice of treatment is usually influenced by the age of the child, the site and pattern of the fracture, associated injuries and to a major extent by surgeon's experience and preference<sup>[5,6]</sup>.

Literature provides little evidence to support the merits of one

method of treatment over another<sup>[6]</sup>. Traction, hip spica, external fixation, plating and intra-medullary nailing are the modalities of treatment described in literature for such fractures with variable outcomes and advantages.

Traditionally, conservative methods of treatment were the standard of care for these fractures<sup>[7,8]</sup>. But unfortunately these methods are uncomfortable and necessitate prolonged bed rest leading to social, psychological and financial impacts on the child and his/her family<sup>[9]</sup>.

The flexible intra-medullary nailing method allows early weight bearing, rapid healing and minimal disturbance of bone growth<sup>[10]</sup>. This method has gained widespread acceptance as a safe, minimally invasive and cost effective method of treatment in children 5-15 years of age<sup>[10-13]</sup>.

The objective of this prospective study is to assess the outcome of isolated closed fracture shaft femur, treated with flexible intra-medullary nailing technique in a cohort of 20 children.

## METHODS AND MATERIALS

This is a prospective study. All the children with age ranging from 5-15 years with isolated closed fracture shaft femur, who presented to our institute, were included in the study. All the patients were treated with flexible intra-medullary nails using a standard surgical technique. Postoperatively, once safe, the patients were mobilized non weight bearing. They were followed up at regular intervals and assessed for union clinically and radiographically. Once the signs of union were present, they were weaned off crutches gradually. Limb length, rotational alignment and recurvatum of knee were assessed clinically.

A standard surgical technique was used. After appropriate anesthesia, patients were placed supine on fracture table and closed reduction of the fracture was attempted initially. Once the fracture was reduced by closed means, two blunt ended flexible nails of 3-4mm diameter (depending upon size of the femur) were introduced through the medial and lateral aspects of the distal femur just proximal to the growth plate. The nails were negotiated through the fracture site under fluoroscopy, and were engaged in the subchondral bone in the proximal part of femur. Open reduction through a small

incision over the fracture site was done in those cases where closed reduction failed to achieve a satisfactory reduction (4 patients). Intra-operatively, the rotational alignment of the leg was checked by the axis passing through anterior superior iliac spine, patella, centre of the ankle joint and 2<sup>nd</sup> toe. The distal ends of the nails were left prominent to facilitate their removal later once the fracture has healed.

Operated limb was rested on a pillow post-operatively. All patients were kept in the hospital until they were safe and mobilized non weight bearing with crutches once pain free. Non-weight bearing mobilization was continued until the callus was seen on radiographs. Gradual weight bearing was allowed once the callus was seen on radiographs. Child was weaned off crutches once union was achieved clinically and radiographically. Radiological and clinical assessment was done at regular intervals until the fracture healed. An assessment of limb length discrepancy, rotational alignment and recurvatum deformity of knee was done clinically.

## RESULTS (TABLE 1)

The mean age of the children was 8.9 (5.2-13.1) yrs. All fractures were isolated injuries except one, which was associated with ipsilateral tibial shaft fracture. The surgery was done within 3 days of injury on an average. All the fractures, awaiting surgery, were immobilized with skin traction and Thomas splint. Four patients required open reduction through a small incision at the fracture site. Average operating time was 47 minutes in patients who did not require open reduction, and 62 minutes in those who required minimal exposure of fracture site. None of the patients required blood transfusion. One patient who developed superficial wound infection was treated with oral antibiotics and the infection resolved completely before discharge. None of the children needed any plaster or splint at the time of discharge except one patient who had an ipsilateral tibial fracture.

Each patient was followed up until their fracture had healed or until their last visit to outpatient department. The average time of follow-up was 23.6 (19-27) months.

Removal of hardware was done electively at an average of 6.9 (6-

**Table 1** Demographics and results of flexible intramedullary nail fixation in pediatric femoral shaft fractures.

Sr.No.	Age (In years)	Unilateral /bilateral	Hardware Removal (Months)	Rotation difference ( in degree)	Leg length discrepancy (in mm)	Recurvatum	Follow-up (months)	Complications
1	6.4	Unilateral	7	5° ER	0	0	22	None
2	8.1	Unilateral	6	0	0	0	25	None
3	11.5	Unilateral	8	5° ER	0	0	23	None
4	9.8	Unilateral	6.5	0	8	0	26	Superficial wound infection
5	7	Unilateral	6.5	0	0	0	20	None
6	13.1	Unilateral+ tibia fracture	8	0	-5	0	23	None
7	7.3	Unilateral	6.5	0	0	0	21	None
8	13	Unilateral	7	7° ER	0	0	19	None
9	8.1	Unilateral	6	0	0	0	22	None
10	10.2	Unilateral	7	0	0	0	25	None
11	7.4	Unilateral	8	0	0	0	25	Difficult removal
12	7.8	Unilateral	6	0	3	0	26	None
13	8.5	Unilateral	6.5	0	0	0	27	None
14	9	Unilateral	7	0	0	0	24	None
15	10.1	Unilateral	7.5	0	0	0	25	None
16	8.9	Unilateral	6	5° ER	0	0	27	None
17	5.2	Unilateral	6	0	0	0	25	None
18	8.6	Unilateral	9	0	0	0	23	Difficult removal
19	10.4	Unilateral	8	0	8	0	22	Difficult removal
20	8	Unilateral	7	0	4	0	23	None

ER: External Rotation

9) months post-operatively. Three patients had difficult removal of the metal because of the impaction of the nail in the subcalcar area.

Recurvatum deformity was not seen in any of the patients. Five patients had limb length discrepancy ranging from -5mm to +8mm, but none of them needed any treatment for this problem. Four patients developed average 5.5 (5-7) degree of external rotation (ER) deformity which was well tolerated.

## DISCUSSION

Femoral shaft fractures in paediatric population have been traditionally treated by conservative methods such as different ways of traction, splints and spica cast immobilization<sup>[7, 8]</sup>. Spica cast has remained the standard for the treatment of children less than 5 years of age<sup>[14-19]</sup>, whereas older children are now more commonly treated with surgical intervention<sup>[20, 21]</sup>. Multiple fixation modalities are available for the treatment of femoral shaft fractures, but the choice of the optimal fixation device is an area of ongoing controversy, especially in a 5-12 year old child. The choice of fixation method in this age group depends mainly on stability of the fracture, age, and weight of the patient and surgeon's preference and experience.

In children of age 13 years or more, rigid antegrade intramedullary nailing has become the standard of care<sup>[22-24]</sup>. Some authors have advocated the use of rigid nailing in children younger than 13 years of age also<sup>[25]</sup>, but the concern of iatrogenic complications like femoral head avascular necrosis (AVN)<sup>[26-27]</sup> and proximal femoral growth disturbance<sup>[27,28]</sup>, have led others to limit its use to primarily older children.

Plating of fractures of the femoral shaft provides anatomic reduction, stable fixation, maintenance of length, early mobilization without casting, and can be done to any size of femoral shaft but requires a large exposure, resulting in extensive soft tissue injury and stripping of the periosteum, which may result in overgrowth of the operative extremity, skin scarring, risks of plate breakage and stress fracture after plate removal<sup>[29-31]</sup>.

Flexible intramedullary nailing has increased in popularity in the United States in the 1990s<sup>[11,32]</sup> and is now the most commonly used treatment method for fractures of the femur in school-aged children<sup>[33,34]</sup>. Flexible nailing helps to achieve biological and minimally invasive fixation and allows rapid mobilization with an overall low risk of physeal injury, femoral head AVN, or refracture<sup>[34,35]</sup>.

Fixation with flexible nailing depends on balancing the forces of two opposite implants<sup>[10]</sup> so that the two nails should be symmetrical in size and length to work properly. It functions as an internal splint that holds length and alignment but permits enough motion at the fracture site to generate sufficient callus<sup>[11]</sup>. This fixation technique is good to fix mid shaft transverse femoral fractures<sup>[33]</sup>. Fixation of proximal or distal end or comminuted fracture type with elastic intramedullary nailing will need further supplementation, either with a cast or a brace.

Limb length discrepancy is a recognized complication in elastic intramedullary nailing of paediatric femoral shaft fractures. This overgrowth results due to local hyperemia or the release of growth factors secondary to trauma or surgery that stimulate physeal growth<sup>[36-38]</sup>. Parsch<sup>[39]</sup> has reported that overgrowth after intramedullary nailing of shaft fractures is about as much as that after other modalities of treatment with an average overgrowth of 4-7 mm. In another study, Ligier *et al*<sup>[10]</sup>, in their series of 123 femoral shaft fractures in children showed a low incidence of growth change with mean lengthening of only 1.2 mm after 22 months. In this study of 20

fractures in children ranging from 6 to 13 years, none of the children had any significant limb length discrepancy, rotational deformities or recurvatum of knee which necessitated treatment.

We conclude that flexible intramedullary nail fixation of fracture shaft femur in children aged 6-15 years is a very acceptable way of treatment and is associated with minimal complications if the surgeon sticks to the proper way of applying this technique.

## COMPLIANCE WITH ETHICAL STANDARDS

This study was conducted in compliance with ethical standards of the institution. No funding or any benefit or help was received, whatsoever, from any source by any of the contributing authors with regard to this study. No animals were involved in this study. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and the national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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