

## Closed Flexible Intramedullary Nailing for Pediatric Femoral Shaft Fracture

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**Abstract :** Intramedullary nailing with flexible nails is an easy and safe method to avoid plaster immobilization for a diaphyseal fracture in childhood. This method is safe as an elective trauma surgery and is especially useful in polytraumatized children. This retrospective study reviews our results with flexible intramedullary nail fixation in 57 patients (61 limbs). The purpose of this retrospective study was to investigate the advantages and disadvantages of using a flexible intramedullary nail for treating pediatric shaft femur fracture. When indicated, we prefer intramedullary nailing fixation depending upon age, fracture pattern, and size of canal. Surgical experience and careful judgments are required to decide on the appropriate treatment in each case.

### Introduction

The management of pediatric femoral fractures varies considerably with the age of the patient, level of fracture, degree of comminution, and the preference of the treating physician. Current treatment options include early spica casting, traction followed by spica cast, external fixation, plate fixation, and flexible intramedullary nails.

With the development of a new generation of pliable pins of different thickness, flexible intramedullary nailing has emerged as a treatment of choice for treating a femoral shaft fracture in a child, especially for emergency trauma surgery. Intramedullary nails to fix femoral shaft fractures, was first advocated by

Griessman<sup>4)</sup> and Kuntscher, who used the rods they designed. The technique was made popular by Ender and Simon-Weidner in Europe<sup>5)</sup> and by Pankowitch in USA<sup>14)</sup>. The reasons for the popularity of this treatment is the advantage of earlier union, high bony union rate, earlier mobilization, shorter hospitalization, and significantly less economic stress, with a low incidence of any complications such as shortening, malunion, infections and neurologic complications. The operative treatment for a pediatric shaft femur fracture has few indications, since children tolerate conservative treatment quite well. Generally accepted indications include<sup>1)</sup> multisystem/multiple long bone injury<sup>2)</sup> Failure of conservative treatment (antero posterior/lateral/rotational angulation >10 degrees,

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Table 1 Mechanism of Injury

	No. of Patients
Vehicular Accident	11
Pedestrian Accident	23
Fall from Height	13
Domestic Injury	09
Pathological Fracture	05

Table 2 Fracture Demographics

Location	No.	Pattern	No.
Subtrochanteric	08	Transverse	29
Proximal 1/3	11	Oblique	15
Middle 1/3	37	Spiral	10
Distal 1/3	05	Comminuted	07

Table 3 Ender's nailing outcome

	Excellent result	Satisfactory result	Poor result
Articulotrochanteric distance variation	< 1.0 cm	1-2 cm	> 2 cm
Rotational malalignment	< 7 degrees	7-10 degrees	> 10 degrees
Pain	None	Mild	Significant/Lasting
Complication	None	Minor/Resolved	Major Complication and/or lasting
Patient result (n= )	44	17	00

shortening > 2 cm)<sup>3)</sup> adolescence<sup>4)</sup> head Injury<sup>5)</sup> dermatologic disorders contraindicating plaster management<sup>6)</sup> pathologic fracture<sup>7)</sup> social reasons-Psychological, educational, and economic reasons Intramedullary nailing has been our preferred treatment whenever possible. The purpose of this study was to review our experience from using closed flexible intramedullary nailing for pediatric femoral fractures, with reference to results and complications.

### Materials and methods

Between November, 1999 and December, 2004, 57 patients (61 fractures), with an age range of 3-15 years, were managed using close flexible intramedullary nails at Civil Hospital, Ahmedabad and Model Hospital, Ahmedabad.

The mechanisms of injury that lead to these femoral shaft fracture were as follows : pedestrian accident : -23 patients ; vehicular accident : 11 patients ; fall from height : 13 patients ; domestic injury : -09 patients and pathological fracture : -05 patients. The majority were pedestrian accidents.

Four patients had bilateral shaft femur fractures. Six patients had multiple injuries. Frac-

ture demographics showed that 37/61 fractures in this series were in the middle 1/3 of the femur, 8 fractures were in the subtrochanteric region, 11 fractures were in the proximal 1/3 while 5 were in the distal 1/3. 29 fractures were transverse, 15 fractures were oblique, 10 fractures were spiral, 7 fractures were comminuted and 3 were open (2 grade II and one grade I). The average age of the patients in this study was 6 years (range 3-15 years).

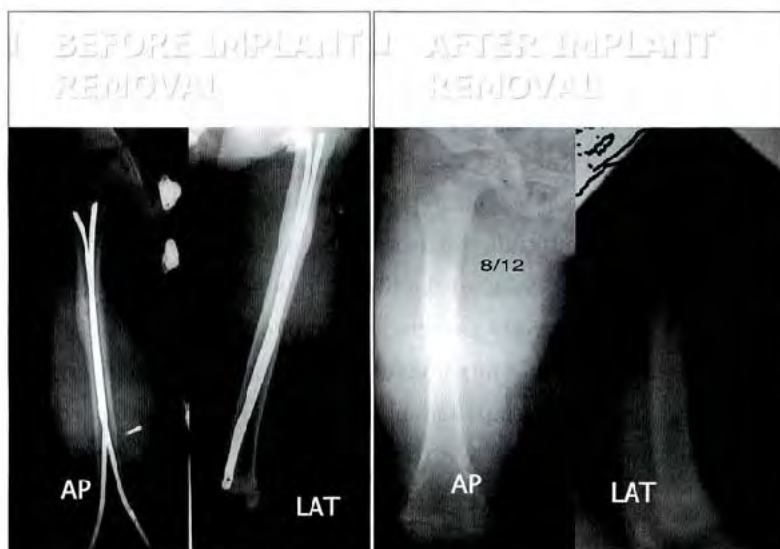
In 43 cases, two retrograde nails were used one from the medial side and the other from the lateral side. In another 13 cases, one retrograde ender nail was used, while in another 5 cases 3 nails were used-one antegrade nail was used in addition to two retrograde nails. All patients were given high above-knee plaster cast for 2-3 weeks followed by femoral brace for 3-4 weeks. The average hospital stay was 5-7 days for an isolated femur fracture. Non-weight bearing was started on average at 3 weeks and weight bearing was started at 6-8 weeks depending upon radiological evidence of callus formation.

In 5 cases, open reduction was required (In 3 Patients due to failure of conservative treat-

a|b



**Fig. 1.**  
M/8 Years  
a : Pre-op  
b : Post op



**Fig. 2.**  
M/8 Years

ment, in 1 patient due to pathological fracture where cortex was paper thin and ender nail used to come out from various site after entering intramedullary canal, and in 1 case of comminuted fracture where we could not negotiate the ender nail through fracture site using the close method). In 7 cases, postoperative skin irritation occurred due to the nail backing out, but there was no problem with fracture union in these cases, and the nail was removed after 6 weeks, in all these cases. In the remaining cases the nail was removed on average after 6 months.

### ●operative technique

Medial and lateral incisions were made above the knee centered on the femoral epicondyle, about 2-2.5 cm in length. Avoiding the geniculate artery, entry was taken 1 cm proximal to the distal femoral epiphyseal line. The nails were driven proximally across the fracture site. After crossing the fracture site, the pins were rotated as necessary to realign the bone. Proximally the pins were impacted up to femoral neck/greater trochanter avoiding the epiphysis. Entry for a third antegrade nail, if required, was made 1.5 cm below the tro-

chanteric epiphysis.

## Results

Retrospective follow up was conducted at an average of 35.8 months (6 months–65 months) with a minimum follow-up of 6 months. Charts and radiographs of all 57 patients (61 limbs) which were treated with flexible intramedullary nailing were evaluated. Clinical and radiological criteria were used for the evaluation of the results. In radiological criteria, X rays findings only were used for determining status of union, malalignment, and shortening. The average hospital stay was 6.6 days (range 5–20 days). A longer hospital stay was needed in patients with multiple injuries, due to associated injuries. A review of the literature was done to find out various associated complications related to flexible intramedullary nailing in treating a pediatric shaft femur fracture and our results are discussed with respect to this review.

At follow up, six patients (8 fractures) showed a slight reduction in knee flexion (10–20 degrees) which gradually became normal within one year. No or minimal tenderness was considered as clinical criteria, and good quality of bridging callus was considered as radiological evidence of bony union—seen in all cases at an average of 8.7 weeks (range 6–12 weeks). Limb length discrepancy was measured with tape. 44/61 limbs had equal limb length on follow-up, while 17/61 patients had a discrepancy between 1–2 cm (average 1.7 cm).

In seven patients, post-operative skin irritation occurred around the knee due to backing out of the nail, without any infection, which was cured on implant removal. No nonunion occurred, and only mild malunion was seen in 17

patients, which was clinically insignificant (The criteria used for detecting malunion is given in Table 3). Minor variation in the articulo-trochanteric distance and neck-shaft angle were seen in 11 patients but they were clinically insignificant.

## Discussion

The problems of prolonged immobilization and complications associated with traditional spica casting and traction in treating a pediatric shaft femur fracture have made pediatric orthopaedicians try a variety of methods<sup>3,4,11,12,17</sup>. Recent studies have also increased the awareness of the psychosocial, educational and economic effects of spica casting on children and their families<sup>18</sup>. The operative stabilization of a pediatric diaphyseal fracture decreases hospitalization, shortens rehabilitation time, and decreases the incidences of fracture malunion and shortening. External or internal fixation for operative stabilization has also been a controversy among orthopaedicians.

External Fixation has yielded good results<sup>19</sup>. Complications reported in the literature include temporary loss in range of knee motion, pin tract infection, and even refracture after fixator removal<sup>16</sup>. Even with early dynamisation, external fixators may shield the fracture site from the forces necessary to encourage sufficient callus formation<sup>20</sup>.

The ideal device to treat a pediatric femur fracture would be a simple, load-sharing internal splint allowing mobilization and maintenance of alignment for a few weeks until bridging callus forms<sup>21</sup>. The device would utilize a child's dense bone, rapid healing and ability to remodel without risking the physes or blood

supply to the femoral head<sup>9)</sup>. Ender's nails are stainless steel implants that are effective for a pediatric femur fracture, proving to be a good candidate for an ideal device. Heinrich et al reported excellent results and no significant problems in 78 children<sup>17)</sup>. Ligier et. al published an analysis of 123 femoral shaft fractures that were treated with pliable medullary nails. All their fracture united with 13 significant complications<sup>12)</sup>. Fein et. al reported Ender's nail stabilization in twenty five femoral shaft fractures with all achieving union. He reported 12 degrees and 20 degrees angulations, 1.3 cm overgrowth and 0.5-1.5 cm shortening, in different cases<sup>6)</sup>.

We used flexible Ender nails of 2.7 mm, 3 mm, and 3.5mm for internally fixing the pediatric shaft femur fracture. We used close surgical procedure for oblique, transverse, spiral, displaced and even open grade I fractures. We found no major complication such as avascular necrosis of head of femur<sup>2)13)18)</sup>, infection, delayed union, malrotation, trochanteric arrest<sup>16)</sup> or coxa valga. Early mobilization was possible, and the duration and area of cast, if needed, was very short. The results obtained in this study were comparable to those in previously published studies, even though the indications and appropriate age limits were expanded.

In the light of our experience, we recommend intramedullary stabilization using flexible intramedullary nails in children in the age group 3-15 years, with an oblique, transverse or even spiral fractures, and even certain segmental fractures. Polytrauma patients, floating knee injuries, associated head injuries with spasticity<sup>20)</sup>, associated dermatological disorders, and any pre existing pulmonary dysfun-

ction can be good relative indication for opting for close flexible intramedullary nailing in pediatric shaft femur fracture<sup>7)19)</sup>. The operative stabilization of a pediatric diaphyseal fracture decreases hospitalization, shortens rehabilitation time, decreases the incidence of fracture malunion and limb shortening, and is safe in right hands.

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