

Original Article

Paediatric Femur Fractures Treated by Ender's Nail — A Prospective Study of 15 Cases

Anil J Nayak¹, Harshal N Damor², Dhrumil S Dave³, Parag M Tank⁴, Dhavalkumar V Patel⁵

Background : The most common major Paediatric injuries treated by Orthopaedic Surgeons are Femoral Shaft Fractures. Early reduction and hip spica are used to treat young children under five years old, whereas intramedullary interlocking nail is used to treat young teenagers over 15 years old.

Objectives : To know prevalence of Femoral Fractures in paediatric age groups, to classify fracture type, mode of injury, course of healing and to evaluate the result of low cost-least invasive Ender's Nail Fixation in Paediatric patients in developing country.

Materials and Methods : It is prospective study with 15 patients of 6-15 years age group with Femur Diaphyseal Fracture were treated with retrograde Ender's Nail in our Orthopaedic Department with minimum 6 months follow up. Fracture location was in the upper third of the femur in four cases (26.66%), mid shaft in nine (60%) and (13.34%) lower third in two.

Results : All patients had union within an average of twelve weeks (8 to 16 weeks). Skin irritation caused by a nail was found in one case. Twelve patients achieved excellent results, while three individuals good results, according to Flynn criteria.

Conclusion : Enders nailing is recommended for Femoral Diaphyseal Fracture Fixation because it is safe, simple to apply and economical with a lower rate of complications.

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Key words : Paediatric Femur Fractures, Ender's nail fixation,

Children's bone injuries comprise 1.6% of femoral Diaphyseal Fractures. Transverse fractures result from low-velocity trauma while comminuted or segmental fractures are caused by high-velocity trauma^{1,2}. Due to the operational treatment's quicker recovery and shorter immobilization period, it has become more appropriate to treat Paediatric Femoral fractures in recent years as opposed to conservative treatment³. Early reduction and hip spica are used to treat young children under five years old, whereas intramedullary interlocking nail is used to treat young teenagers over 15 years old. Traction, hip spica, flexible/elastic stable retrograde intramedullary nail,

Editor's Comment :

- The most common significant paediatric orthopaedic injury necessitating hospitalisation is a femoral shaft fracture.
- The use of intramedullary nails to treat femoral shaft fractures in children is becoming more common due to the benefits of early mobilisation, rapid healing, and better alignment control.
- Ender's nail fixation is a good and satisfactory way of treatment for femoral shaft fractures in children aged 6 to 15 years in developing country.

or external fixators are used to treat children aged 5 to 13 years⁴. The experience of numerous practitioners and time have proven that children with Diaphyseal Femur Fractures do not usually recover with conservative treatment. Operative approach is the main stand for the management of Femoral Shaft Fractures in children presently. The benefits of flexible intramedullary nails as a fixation device include closed insertion, which preserves the fracture haematoma and lowers the risk of fracture site infection; no reaming is necessary and thus the endosteal blood supply is generally retained⁵. With the advantages of safe, minimally invasive, economic, simple learning curve and few complication flexible intramedullary nailing has become well established now⁶. External fixators and antegrade intramedullary nailing both carry the risk of bone refracture and pin tract infection, respectively, as well as osteonecrosis of the Femoral Head.

¹MS (Orthopaedics), Professor and Head, Department of Orthopaedics, Banas Medical College and Research Institute, Palanpur 385001

²MS (Orthopaedics), Assistant Professor, Department of Orthopaedics, Smt. NHL Municipal Medical College, Ahmedabad 380006

³MS (Orthopaedics), Assistant Professor, Department of Orthopaedics, Smt. NHL Municipal Medical College, Ahmedabad 380006

⁴MS, Associate Professor & Head of Unit, Department of Orthopaedics, Smt. NHL Municipal Medical College, Ahmedabad 380006 and Corresponding Author

⁵MBBS, Resident Doctor, Department of Orthopaedics, Smt. NHL Municipal Medical College, Ahmedabad 380001

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Therefore, the care of Paediatric Diaphyseal Femoral Shaft Fractures has increasingly relied on retrograde flexible or elastic stable intramedullary nailing. Early good results using flexible (Ender) or elastic stable (Nancy) intramedullary rods have been reported by several European and American Researchers.

MATERIAL AND METHODS

Between May 2019 to May 2021, 15 consecutive patients with femur diaphyseal fracture were treated with retrograded Ender's Nail in our Orthopaedic Department after Institutional review board approval. Studies were considered acceptable for inclusion in the prospective if they meet the following criteria:

- (1) Age 6-15 years
- (2) Closed fracture
- (3) Open fractures up to grade 2
- (4) Diaphyseal fracture

The Exclusion criteria were :

- (1) Skeletally matured patients
- (2) Open fracture grade 3
- (3) Pathological Fracture.

Data were analyzed for 15 patients 6 female, 9 male (Table 1); mean age 10.7 years (range 6-15). On admission patients were given above knee slab up to groin region, elevation, analgesic and antibiotic in open fracture. Routine Anteroposterior and Lateral Radiographs are performed following temporary fracture immobilisation. The fracture pattern was subdivided into AO, transverse, oblique and spiral types and according to Femur Bone segment. There were no additional complications and everyone underwent surgery in three days.

Surgical Technique :

During surgery after proper anaesthesia patients is taken on fracture table. Traction is given to achieve reduction under IITV guidance. Over the medial and lateral surfaces of the distal femur, a 2 to 3 cm linear skin incision was made. Nail size is determined by keeping it on femur under IITV. Entry taken with awl just above proximal to distal femur physis. It is not less than 40% of the narrowest diameter of the diaphysis. C-shaped curved is given and the tip of the enders nail is bent slightly more than the curve. We usually used 3 and 3.5 mm Ender's Nail. First proper size nail is inserted medial side with the help of inserter under image intensifier up to fracture site then reduction

was achieved and nail is advance up to 1-1.5 cm distal to proximal physis of Femur. Second nail is inserted to achieve and maintain better reduction at fracture site. Long above knee plaster was applied after operation. Both stitches and plaster were removed 15 days after surgery. Then Physiotherapy started and allowed weight-bearing around 4 weeks. The initial follow up was done weekly for 2 months then monthly for 6 months. Measured all the parameters like observed fracture alignment after surgery, any infection, union status and time of union, limb length discrepancy and knee rang of motion with Radiological and Clinical Examination. Removal of implant is mandatory in growing children in view of growing bone. Nail were removed as soon as Clinical and Radiological evidence of solid union was present usually 8-9 months after Surgery.

OBSERVATION

We had fifteen patients with Shaft Femur Fracture treated with Ender's Nail . There were nine male(60%) and six female (40%) patients. Out of fifteen patients, Nine patients (60%) presented with road traffic accident injury, four patients (26.6%) had sports injury and remaining two patients (13.4%) had fall down history. Closed fracture was seen in eleven patients (73.3%) whereas open fracture was seen in four patients (26.7%). On the Gustilo Classification three fracture were type I(75%), one fracture was type II(25%), none of type III (Table 2). Fracture location was in the upper third of the femur in four cases (26.66%), mid shaft in nine (60%) and (13.34%) lower third in two (Table 3). In eleven patients Femur Fracture was an isolated injury, three had associated head injury and one had Distal Radius Fracture. Nine were left side and six were right side fracture. Mode of injury in Nine patients was road traffic accident, in four patients was fall from height and in two patients was sport injury. Operation of Enders nailing was done on first day in

Gender	Number of patients	Percentage
Male	09	60%
Female	06	40%
Total	15	100%

Type of Fracture according to Gustilio classification	Number of patients	Percentage
Type I	03	75%
Type II	01	25%
Type III	00	0
Total	04	100%

Femur Bone Segment	Number of patients	Percentage
Upper 3 rd of Femur	04	26.66%
Mid-shaft of Femur	09	60%
Lower 3 rd of Femur	02	13.34%
Total	15	100%

nine patients, between two to three days in six patients. None of them required special postoperative care or blood transfusions. Postoperative above knee plaster was given for 2 weeks. At two weeks, Physiotherapy was begun using quadriceps drills, quadriceps strengthening exercises and hamstring strengthening exercises. Patients were prevented from bearing weight for eight weeks and Partial weight bearing was started from eighth to tenth week. After ten weeks full weight bearing, gait training was advised. Only one patient (6.6%) had skin impingement whereas rest fourteen patients (93.4%) didn't have any complication. Patients were planned for follow-up assessments one, two, three and six months after surgery. Within one to two months, clinical union signs showed. The earliest Radiological Union was observed at eight weeks, the latest at sixteen weeks with a mean of twelve weeks (Figs 1,2). Patients were advised to schedule visit after nine months of Surgery. Results were evaluated using Flynn, *et al* scoring criteria for Ender's Nail. Twelve patients (80%) had excellent and three patients (20%) had good outcome (Table 4).

DISCUSSION

Children today are more likely to have Lower Limb Long Bone Fractures from playground injuries or traffic accidents. One of the most frequent fractures in children's age groups that needs hospitalisation and surgery is a Shaft Femur Fracture. Besides that, numerous articles have been written for various fixation

Flynn Criteria Rating	Number of patients	Percentage
Excellent	12	80%
Good	03	20%
Fair	00	0
Poor	00	0
Total	15	100%

methods using Titanium elastic nail systems, newly plated/interlocking nails, although the most of them lean toward TEN system⁷. Few studies have been done on the effectiveness of Enders' nailing in treating Paediatric Shaft Femur Fractures. nailing has proven superior to plating, external fixation or interlocking nails and conservative management. Since its inception in early 1900s stainless steel implants were modified gradually from type 302 to 316L for Orthopaedic Surgery which contain 17-19% Chromium and 14% Nickel and later molybdenum. Corrosion resistance was enhanced with a minimal amount of Carbon^{8,9}. Even more Ender's nail benefits include economical, pre-counteracted, instant fracture fixation, least soft tissue interruption, lesser infection and low refracture rates, early mobilisation and rapid return to normal day-to-day activity with little to no complication and quick removal with the aid of the enders nail's "eye." Since a stainless steel implant has more advantages than a Titanium one, we exclusively chose these. Stainless steel nails are more stable under bending, torsion, and axial forces¹⁰. When compared to Titanium

nails, enders nails were superior in adolescence and unfavourable canal diameter¹¹. Lascombes, *et al* recommended using elastic nails with accuracy of entry and complete comprehension of fracture geometry with fixation procedures in the upper and lower limbs. It takes skill and a tough task to cure a Femur Fracture with these elastic nails, which have a precise diameter depending on the child's age and are inserted successively in the proximal, transverse, distal shaft, comminuted, and long oblique fractures¹². Children treated conservatively for lower limb fractures experienced longer cast immobility, study abandonment, joint stiffness and psychosocial difficulties with their parents¹³. Kaiser researched composite femur synthetic bone models using two groups, one for elastic nail fixation and the other for steel nail fixation. Excellent biomechanical loading demonstrated perfect compatibility, strength in cortical connections and stiffness under bending and shearing¹¹. They had a significant advantage over elastic nails when it came to steel nails. In



Fig 1 — Radiograph of 10 year/Male paediatric patient, (A) Pre-operative, (B) Immediate Postoperative, (C) Final Follow up.



Fig 2 — Radiograph of 9 year/Male paediatric patient, (A) Pre-operative, (B) Immediate postoperative, (C) Final Follow up.

comparison to elastic titanium nails, stainless steel nails had superior healing, stability, tolerance to deforming forces, a lower rate of complications, no metal allergy reaction and were economic¹⁴. Proximal entry for Femoral Shaft Fractures causes coxa valga, greater throchanter epiphyseal growth inhibition and varying degrees of Capital Femoral Dysplasia¹⁵. In spite of Diaphyseal Long Bone Fractures in either direction and with extended indication in children, Parsch, *et al*/Ender's Nails were used in patients from three to eighteen years of age with good outcomes¹⁶. Ender's nails were an adequate implant for paediatric femoral diaphyseal fracture stabilization and expense, as well as for the technique's adaptability once acquired for surgeons of all ages¹⁷. Sutphen, *et al* in his 198 paediatric population femoral fracture group treated with flexible nails, rigid nails and submuscular plates found that 23% malunion rate as compared to 11% owing to long oblique unstable Femoral Diaphyseal Fracture and heavy weight¹⁸. With comparison to locked nails, the callus and bone healing around minimum Telescopy with outstanding elasticity and flexibility were seen in enders nailing¹⁹. No cases of infection, growth arrest, femoral epiphysis injury, delayed union, nonunion, refracture after implant removal. Skin impingement Sutphen, *et al* in his 198 paediatric 17 population femoral Fracture group treated with flexible nails, rigid nails and submuscular plates found that 23% malunion rate as compared to 11% owing to long oblique unstable Femoral Diaphyseal Fracture and heavy weight of enders nail present in two patients were undergone implant removal when X-ray revealed full callous after 9 month. Ender's Nail is appropriate for open fractures of grades 1, 2, and 3A.

CONCLUSION

Ender's nailing is recommended for femoral Diaphyseal Fracture fixation in age group of 6-15 years because it is safe, simple to use and economical, with a lower rate of complications.

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