

Original article:

Management and outcome of diaphyseal femur fracture in Children: A tertiary care Experience

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Abstract:

Introduction: In children fractures of the femoral shaft are commonly treated by various types of traction for about 3 weeks, followed by plaster cast immobilization. However little is known about the functional outcome and its complication in Indian scenario. Therefore our aim of study was to analyse the functional outcome in femoral shaft fractures of children operated by flexible intramedullary nails.

Material and Methods: In this study 40 patients, aged 5 to 16 years, with fracture shaft of the femur visiting at department of orthopaedics of a tertiary care centre, Indore in the period from September 2012 to September 2014. Patients with comminuted and segmental fractures, Type III Compound fractures and very distal (or) very proximal fractures that precludes nail insertion were excluded from the study. Observations were made regarding the alignment of the fracture, the range of motion of knee and hip, limb length discrepancy, degree of pain or swelling and rotational deformity of the femur.

Results: The mean time interval between trauma, and surgery was 2-4 days. In 80% of cases stainless steel nails were used and in remaining 20 % of cases titanium nails were used. Selection of nails was done based on patient affordability. In most of the cases (50%) 2.5 mm diameter nails were used. 3 mm nails were used in 35% of the cases and in other 10% cases 3.5 mm were used. Only in two cases 2 mm nails were used. Mean Hospital stay was 11.4±3.05 days.

Conclusion: The advantages of the present study include minimal scarring, closed reduction, load sharing device, fracture heals by secondary callus formation which is stronger and refracture is not a risk. Rigid intramedullary nailing is also described in the management of femoral shaft fractures.

Keywords: femoral shaft fractures, children fractures

Introduction

Femoral shaft fractures account for 1.6% of all pediatric bony injuries.¹ There is little controversy over the treatment of adult femoral shaft fractures with intramedullary nail fixation. Similarly, there is little controversy over the treatment of infants and toddlers with femoral shaft fractures by using spica casting² but the treatment of pediatric and adolescent (age 6 to 16 years) femur fractures remains controversial. Differences of opinion about treatment are greatest for patients who are too old for early

spica casting and yet too young for adult type of treatment with a reamed rod. Current treatment options include early spica casting, traction, external fixation, ORIF with plating, flexible intramedullary nails and reamed intramedullary rods.³

In children fractures of the femoral shaft are commonly treated by various types of traction for about 3 weeks, followed by plaster cast immobilization. The two major drawbacks with this treatment are prolonged bed rest leading to separation of the child from routine activities and the

expenditure incurred on the treatment during the stay in the hospital.⁴

Time and experience of many clinicians have shown that children with diaphyseal femur fracture do not always recover with conservative treatment. Angulation, malrotation and shortening are not always corrected effectively.⁵

The management of pediatric femoral shaft fractures gradually has evolved towards a more operative approach in the past decade. This is because of a more rapid recovery and reintegration of the patients and a recognition that prolonged immobilization can have a negative effect even in children.⁶

Plating of femoral shaft fracture offers rigid fixation, it requires a larger exposure with the potential for increased blood loss and scarring. It is a load bearing device and refracture is a risk. Antegrade nailing techniques have shown a risk of proximal femoral deformities and avascular necrosis of the femoral head.^{7,8,9}

Elastic internal fixation in the form of flexible intra medullary nailing provides a healthy environment for fracture healing with some motion leading to increased callus formation.⁹

Flexible nail fixation in the paediatric population is simple, effective and minimally invasive. It allows stable fixation, rapid healing and a prompt return of the child to normal activity. However little is known about the functional outcome and its complication in Indian scenario. Therefore our aim of study was to analyse the functional outcome in femoral shaft fractures of children operated by flexible intramedullary nails.

Material and Methods

In this study 40 patients, aged 5 to 16 years, with fracture shaft of the femur visiting at department of orthopaedics of a tertiary care centre, Indore in the

period from September 2012 to September 2014. Patients with comminuted and segmental fractures, Type III Compound fractures and very distal (or) very proximal fractures that precludes nail insertion were excluded from the study.

The study includes patients with femoral shaft fractures admitted and examined according to protocol. Associated injuries were noted. Clinical and radiological investigations were carried out and medical fitness for surgery to undergo flexible nailing fixation for the sustained fracture was taken. Patients were followed up at 1, 2, 3, 6 months intervals till fracture union and once at 1 year after surgery.

As soon as the patient was brought to casualty, patient's airway, breathing and circulation were assessed. A complete survey was carried out to rule out other significant injuries. Plain radiographs of AP and lateral views of the femur were taken including both hip and knee joints, to assess the extent of fracture comminution, the geometry and the dimensions of the fracture, i.e. fracture lines that propagate beyond the obvious fracture[figure1]. Diagnostic radiographs must be of sufficient quality. Radiographs of whole length of femur with knee and hip joints are mandatory in all patients to avoid missing of associated fractures of the trochanter and neck of femur.

On admission to ward, a detailed history was taken, relating to the age, sex, occupation, mode of injury, past and associated medical illness. Patients were then put through a thorough clinical examination and general condition was assessed regarding hypovolemia, associated orthopedic or other systemic injuries and resuscitative measures were taken accordingly. Wounds when present were cleaned thoroughly and the limb was immobilized either in a Thomas splint or in skin traction. Analgesics,

antibiotics, tetanus toxoid, tetanus immunoglobulins and blood transfusion were given as needed.

Routine investigations were done for all patients. Patients were operated as early as possible once the general condition of the patient was stable and patient was fit for surgery. Flexible nail fixation was done according to method described by Kasser et al⁹.

The patients were mobilized with a walker on the morning after operation, with non weight bearing on the affected limb. Sutures were removed on the 10 postoperative day and patients were discharged and advised non weight bearing.

Further follow ups were done at 1 month, 2 month, 3 months, 6 months and 1 year. Each patient was individually assessed clinically and radiographically. Observations were made regarding the alignment of the fracture, the range of motion of knee and hip, limb length discrepancy, degree of pain or swelling and rotational deformity of the femur.

Results:

The mean age of patients was 10.15 ± 2.58 year (range 6 to 14 year). The male to female ratio was 2.3: 1. The major cause of fracture in our study was RTA in 22 (55%) patients and fall while playing in 16 (40%) patients. Fractures were transverse in 26 (75%) cases, oblique in 6 (15%) whereas 4 (20%) were spiral fractures. Middle 1/3rd of the shaft was involved in 34 (85%) cases and proximal 1/3rd in 6(15%) cases. 36 (90%) were closed fractures and 2 (10%) were open fractures. Both open fractures belonged to Gustilo Type I. The mean time interval between trauma, and surgery was 2-4 days. In 80% of cases stainless steel nails were used and in remaining 20 % of cases titanium nails were used. Selection of nails was done based on patient affordability. In most of the cases (50%) 2.5 mm diameter nails were used. 3 mm nails were used in 35% of the cases and in other 10%

cases 3.5 mm were used. Only in two cases 2 mm nails were used. Mean Hospital stay was 11.4 ± 3.05 days.

Fracture union was defined as the period between operation and full weight bearing without external support and a radiographically healed fracture. In our series, time to union ranged from 10 to 12 weeks average being 10.2 weeks.

Post-operative immobilization was not done in all cases. All patients were allowed to walk with the help of walker from the 1st post-operative day, not bearing weight on the operated limb.

All patients had full range of hip motion in the present study. Among the complications Limb length discrepancy is the most common sequelae after femoral shaft fractures in children and adolescents. No patient in our study had significant limb length discrepancy (i.e. $> \pm 2$ cm). There was no superficial infection seen in any case in our study which was controlled by antibiotics. Nail impingement was seen in only 1 patient. No other complication was occurred in any other patients.

Discussion:

The treatment of femoral shaft fractures in children, particularly those who are between 5 to 14 years of age is controversial. Operative treatment is becoming better accepted. Each of the surgical methods described have specific advantages and potential complications that must be appreciated by the treating surgeon. The present study was conducted to assess the results of flexible nail fixation of femoral shaft fracture in children and adolescent patients.

Because of the increasing costs of health care, surgical fixation of children's fractures with resultant early mobilization and discharge from the hospital has become increasingly popular.

Recognizing the relative safety and efficacy of femoral fracture fixation with flexible intramedullary nails, several large medical centres in the United States and Europe have reported on series of femoral fractures in children and adolescents, proving the value of this method.

In our study, transverse fractures accounted for 13 (75%) cases, Oblique fractures accounted for 3 (15%) cases and spiral fractures accounted for 4 (20%) cases. Similar to our study Heinrich et al,⁵ Cramer et al⁷ and Nascimento et al¹⁰ reported higher prevalence of transverse fractures as compared to oblique or spiral fracture.

Fractures involving the middle 1/3rd of the femoral shaft accounted for 17 (85%) cases and those involving the proximal 1/3rd accounted for 3 (15%) cases in our study. Ozturkman et al,¹¹ noted 18 (69.23%) fractures in the middle 1/3rd and 3(11.53%) fractures in the proximal 1/3rd of the shaft, whereas Heinrich et al⁵, noted 54 (69.23%) fractures in the middle 1/3rd and 10 (12.82%) fractures in the proximal 1/3rd of the shaft. Cramer et al,⁷ noted 40 (70.17%) fractures in the middle 1/3rd and 13 (22.8%) fractures in the proximal 1/3rd of the shaft.

In present study, closed reduction was done in 16 (80%) cases and open reduction was done in 4 (20%) cases. One patient presented to us with fracture femur treated with locking compression plate the patient had done early weight bearing and hence had broken plate in situ. Open reduction was done and plate was removed and fracture was fixed with flexible nails.

Another patient, presented to us after 1 month of fracture. There was overriding of the fracture fragments with shortening of 5 cm. This patient was treated with open reduction and internal fixation. In one patient, the fracture was in the proximal 1/3rd. Closed reduction was attempted but was not possible.

In 5 (6.41%) fractures, open reduction was done to facilitate passing the nail across the fracture site in Heinrich et al⁵ study. Closed nailing was done in all cases in a study conducted by Nascimento et al¹⁰ In the study conducted by Rios et al.¹² The fracture focus had to be opened to perform the reduction in 11 (21.5%) fractures.

In our present study titanium elastic nails were used in all cases were used. In our country, titanium implants are costly; therefore stainless steel nails present an effective, more economical alternative in the treatment of femoral shaft fractures. The results reached in both the short and the long term are the same as those reached with titanium nails, as reported in the literature. However titanium elastic technique is used for 3 point fixation technique which is not possible for stainless steel rods.

Mechanical testing of femoral fracture fixation systems showed that the greatest rigidity is provided by an external fixation device and the least by flexible intramedullary rodding. Stainless-steel rods are stronger than titanium in bending tests. Stainless-steel rods have greater intrinsic strength and therefore are not as dependent on the opposing bend technique.¹²

In present study, no post-operative immobilization was done either in the form of pop cast or supplementary immobilization. Infante et al¹³ treated 190 children with immediate hip spica casting, the average duration of immobilization in their study was 7 weeks. Ferguson et al¹⁴ treated 101 children with immediate hip spicacasting. They immobilized children on an average duration of 6 to 8 weeks with spica casting. The average length of immobilization in plaster was 67.4 days in Gross et al¹⁵ study. In the study conducted by Rios et al¹² no other immobilization treatments like plaster or orthosis

were used. In the study conducted by Nascimento et al¹⁰ no casts for supplementary immobilization were used. The advantage of the present study was early mobilization of the patients.

Greisberget al¹⁶ compared the study of flexible intramedullary nailing with hip spica casting. They noted average hospital stay of 6 days in flexible intramedullary nail versus 29 days in hip spica casting group. Gross et al¹⁵ conducted a study on cast brace management of the femoral shaft fractures in children and young adults. The average length of hospitalization in their study was 18.7 days. Average hospitalization time in the study conducted by Nascimento et al¹⁰ was 9.43 days. Compared to the above studies conducted on conservative methods and cast bracing, the average duration of hospital stay was less in our study i.e. 11.4 days. The reduced hospital stay in our series is because of proper selection of patients, stable fixation and fewer incidences of complications. In the present study, average time to union was 10.2 weeks. Oh et al¹⁷ reported average time for union as 10.5 weeks. Aksoy et al¹⁸ compared the results of compression plate fixation and flexible intramedullary nail insertion. Average time to union was 7.7 (4 to 10) months in the plating group and 4 (3 to 7) months for flexible intramedullary nailing. In the study conducted by Nascimento¹⁰ et al average healing time was 7.73 weeks. In our study, closed reduction of the fracture, leading to preservation of fracture hematoma and minimal soft tissue dissection led to rapid union of the fracture compared to compression plate fixation.

In the present series, nail impingement was seen in 1 (5%) patient. In the study conducted by Nascimento et al¹⁰ acute complications were seen in two patients (6.7%). One had a migration of a nail and the other

had a soft tissue irritation. The first patient needed a second intervention in order to have the tip of the nail cut. One felt pain during the first week post-operatively and needed another surgery to correct the loss of reduction of the fracture. In the study conducted by Rios et al,¹² seven (14%) cases of inflammation were observed at the insertion site because the nails were inserted within a cortical distance superior to the one suggested by the surgical technique; six of those cases occurred in the medial approach; and five required early reoperation (2 week) because of imminent skin injury.

Some degree of angular deformity is frequent after femoral shaft fractures in children, but this usually remodels after growth. In our study there was no varus/valgus malalignment. Heinrich, et al⁵ reported 5° of varus angulation in one child in their study and 11% of fractures had an average varus or valgus malalignment of 6°. Ferguson et al¹⁴ noticed 7° varus angulation in one patient in their study. Herndon, et al¹⁹ compared the results of femoral shaft fractures by spica casting and intramedullary nailing in adolescents. They noticed varus angulation ranging from 7 to 25° in 4 patients treated with spica casting and no varus angulation in surgical group. Herndon, et al¹⁹ noticed 12 degree valgus angulation in one patient treated with spica casting. Rios et al¹² observed two angular deformities in the valgus. Nascimento et al¹⁰ noticed valgus in 12(40%) and varus in 3(10%) patients. The varus and valgus malalignment that occurred in our study are within the acceptable limits. In the present study, there were no antero posterior angulation. Anteroposterior angulation ranged from 5.6° to 7.6° in children treated with immediate spica casting in Infante, et al¹³ study. Ozturkman et al¹¹ noted an anterior angulation of 7° and a posterior angulation of 6° in 2 patients respectively. Herndon

et al¹⁹ noticed anterior angulation ranging from 8° to 35° in patients treated with traction and spica casting. 8% of the patients had an average anterior or posterior angulation of 8° in Heinrich, et al⁵ study. Bar-on, et al²⁰ noticed one case of posterior angulation treated by external fixation. Nascimento et al¹⁰ noticed 23(76.7%) anterior angulation and 5 (16.6%) posterior angulation.

A difference of more than 10° has been the criterion of significant deformity. In toeing or out toeing was not reported in our study, Heinrich, et al⁵ reported out toeing in 4 children with an average of 6° and two children with 7.5° of in toeing following flexible intramedullary nailing. No patient in our study had significant rotational deformity.

In present study no proximal migration of nails was seen in any of the cases. Bar-on et al²⁰ noticed proximal migration of the nail in one case. Kregor et al²¹ reported 13° anterior angulation in one case and overgrowth of the injured femur averaging 0.9 cm in patients treated with compression plate fixation.

The advantages of the present study include minimal scarring, closed reduction, load sharing device, fracture heals by secondary callus formation which is stronger and refracture is not a risk. Rigid intramedullary nailing is also described in the management of femoral shaft fractures. Raney et al²² noticed premature closure of the greater trochanteric physis consequent to intramedullary nailing.

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