International Journal of Research in Orthopaedics
Rashid M et al. Int J Res Orthop. 2018 Nov;4(6):841-847
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20184206

Elastic nailing of the femoral fractures in the 6-10 year age: a study from Kashmir

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Received: 12 September 2018
Revised: 28 September 2018
Accepted: 01 October 2018

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ABSTRACT

Background: Fractures of the femur are amongst the most common paediatric orthopaedic injuries. The aim of this study was to assess the efficacy of the stainless steel elastic nail in the management of these fractures in the 6-10 year age group.
Methods: Fifty patients in the age group of 6-10 years with displaced diaphyseal femoral fractures were stabilized with these nails. Patients were followed up clinically and radiologically for a minimum period of 1 year.
Results: There were 64% excellent and 34% satisfactory results. 2% patients had poor result.
Conclusions: These nails are a relatively easy to use, minimally invasive, physeal-protective implant system with high rate of satisfactory and excellent outcomes in children aged 6-10 years.

Keywords: Paediatric, Fracture, Femur, Elastic nailing

INTRODUCTION

Femoral diaphyseal fractures are the most common major pediatric injuries treated by the orthopaedic surgeon.[1] They represent about 1-2% of all bony injuries in children.[2,3]

Fractures in children over 6 years of age are largely due to high-energy trauma, with motor vehicle accidents accounting for more than 90% of injuries in this age group with a recent increase due to increased popularity of high-speed recreational devices and activities, such as all-terrain vehicles and youth sports.[4]

Treatment of a fractured femur in a child presents special challenges to the orthopaedician. In addition to smaller size, the presence of open physes and immature vascular patterns must be considered. Although the potential for rapid healing and remodeling during growth are helpful, the potential of interference with that growth introduces special hazards.[5]

Various methods are used to treat paediatric long bone fractures. These modalities are not without complications though. Non operative treatment with casting may cause pressure sores, especially in the lower back area and inability to maintain proper alignment with spica casting is a concern.[6] In addition, some methods may require prolonged hospital stay, periods of inactivity and aesthetically unsatisfactory scars.[7-9] Operative treatment provides significant advantages in certain clinical situations. However, these too are not without complications. External fixation may cause pin site irritation or infection, knee stiffness, and unsightly thigh scars.[10] These devices are difficult for children to tolerate psychologically, require pin care and cleaning several times daily. Recent reports of delayed union and refracture.[10,11]

Rigid intramedullary nailing may cause myositis ossificans at the entrance of the rod, premature closure of the greater trochanteric physis with a risk of increased femoral neck valgus, leg length discrepancy, and neurological problems with decreased sensation in the distribution of peroneal nerve.[12] Plating is an effective method but it also can has its drawbacks including the large incision, higher blood loss, reports of refracture and implant failure.[13,14]

Flexible intramedullary nails are relatively better as they are a simple, load-sharing internal splint allowing mobilization and maintenance of alignment for a few weeks until bridging callus formation. We carried out this study on 50 patients in the age group of 6-10 years to assess the results and complications of stainless steel flexible intramedullary nails. The purpose of this study was to assess the results in a relatively small age range of 6-10 years.

METHODS

50 patients with diaphyseal fractures of the femur were admitted in Skims MC, Bone and Joint hospital and MMABM Hospital from September 2008 to January 2015 for flexible intramedullary nailing.

The inclusion criteria were patients aged 6-10 years; closed fractures.

The following patients were excluded from the study pathologic fractures; open fractures; patients with additional fractures in ipsilateral limb.

All patients were admitted and proper history and a relevant physical examination carried out. The initial resuscitation was carried out and the limb immobilized by applying skin traction. Skeletal traction was applied in two cases only who reported 1 week after the trauma.

The procedure was always performed under general anesthesia. We used fracture table in all of our cases. The patient was kept supine with injured limb in full extension at hip and knee while uninjured limb was kept slightly flexed at hip and knee and abducted at hip to allow room for image intensifier

Closed reduction was achieved by applying axial traction to the lower limb, with or without reduction maneuvers according to the displacement of bone fragments. We used stainless steel nails in every patient as we were convinced by various studies, comparing stainless steel and titanium nails that prove both to be equally effective, stainless steel nails being more effective in certain situations like in an obese child, unstable femoral fractures and in children >10 yrs old.[15-19] We used to select the largest diameter nail that could be accommodated. The appropriate size was determined by measuring the diameter of the medullary canal on a radiograph: Nail diameter = 0.4 × diameter of medullary canal or = diameter of medullary canal/21 mm. Proper nail was always selected as it is critically important in the femur, which is subjected to extremely high forces. Length was measured between the physis of the greater trochanter and the distal physis. Nails were contoured according to the type and location of the fracture. We used nails which were blunt and slightly curved (30-40°) over a length of 5 mm near the tip. Contouring and bending was performed in the same plane to achieve a uniform concave curve. Only mild contouring was done to create a very smooth curve. Minor adjustments if necessary, were made by forcing the nail against the wall as it is advanced through the medullary canal (Figure 1 and 2)

Surgical technique

Two incisions were made (medially and laterally) in the distal metaphysis immediately below the hard cortical bone area, 20-40 mm proximal to the distal femoral physis. After preliminary bone scraping, a hole was created with the awl in the midline (in the sagittal plane). The nail was inserted into cancellous bone and advanced up the medullary canal. It was initially introduced perpendicular to the entry hole and then immediately rotated 180° so that its concave side faced the entry point and its leading end did not catch on the opposite wall.

The nail was pushed across the fracture site with the help of a hammer. We always visualized the nail path (both AP and lateral) using fluoroscopy to properly orient its tip for an easy crossing of the fracture site. Optimal reduction was achieved. Once the nail had entered the opposite fragment, it was advanced further by hand. The same procedure was repeated with the opposite nail.

To achieve a stable construct, we tried to have two nails with opposing curves. But the forces that apply to the construct were taken into account. Therefore, the nails were positioned in a way to achieve both adequate reduction and maximum stability. After the fracture site had been crossed, the nails were advanced by hand as far proximally as possible and are anchored in the metaphysis. Prior to impaction, axial traction was relieved. Reduction was assessed and if inadequate, the position of the nails was adjusted accordingly. In most cases, both concavities would face each other with their apices located at the fracture site. After closure of the wounds a compressive dressing was applied. The trailing ends were cut. Once trimmed, the nail ends spring back and lie flush against the bone.

The patients were allowed to do quadriceps setting exercises on the second post op day and partial weight bearing was allowed on the 3rd post op day. Regular follow up was done till nail removal which was done 8-12 months after the surgery. The results were tabulated and the mean of the results was used for statistical analysis.

RESULTS

The age of the children ranged from 6-10 years. Average age of presentation was 7.16 years. Out of 50 children 37 were males and 13 were females ratio of 2.84:1.

In our study out of 50 patients, there were 7 (14%) cases having associated injuries with fracture shaft of femur comprising of 2 (4%) cases of closed head injury, 1 (2%) case each of fracture lateral condyle of humerus, blunt trauma to chest, blunt abdominal trauma, soft tissue injury of shoulder and fracture both bones of forearm. Rest of the 43 (86%) patient had sustained isolated femoral shaft fractures. 26 (52%) patients had fracture of right femur and 24 (48%) had fracture of left femur.

Table 1: Mechanism of injury of the study group.

Mechanism of injury	Number of patients (%)
Fall	21 (41)
Road traffic accidents	25 (50)
Others	4 (8)
Wall collapse	2
Fall of heavy stone	1
Fall of wooden log	1

Out of 50 cases, 25 patients sustained the fracture due to road traffic accident. 21 patients had a fall from height or from level ground. 4 sustained the fracture because of other reasons as shown in Table 1.

Out of 50 patients 36 had fractures involving middle 1/3rd of femur, 7 had proximal 1/3rd involvement, while 6 patients had involvement of distal 1/3rd of femur.

Out of 50 cases, 26 patients had transverse fractures, 10 had oblique and 8 cases had spiral fracture and 6 had comminuted fracture.

The patients stayed in the hospital from a period of 5 days to 20 days with an average of 10.66 days. Closed reduction of fracture was done in 48 cases, out of these 48 cases, in 5 (10%) cases where closed reduction was difficult we used two Schanz screws, one above and one below the fracture to disimpact and reduce the fracture. Open reduction was done in 2(4%) cases, in one case to reduce the fracture and in other for driving the nails across fracture site.

Prophylactic hip spica was used in 2 (4%) patient. In one patient it was used because of gross comminution at fracture while in other because a proper construct of nails was not achieved. Thigh brace was used in one (2%) patient. Radiographic union was evident at an average time of 10.06 weeks (7 weeks - 15 weeks) as depicted in Table 2.

Table 2: Timelines to union in the study group.

Radiographic union	Number of patients (%)
7-9 weeks	19 (38)
10-12 weeks	27 (54)
13-15 weeks	4 (8)

At final follow up all patients were assessed clinically for limb length discrepancy. Out of 50 patients 8 patients had limb length discrepancy of less than 1 cm and 7 patients had limb length discrepancy of 1-2 cm which did not manifest clinically. None of the patient in our study had LLD exceeding 2 cm at 1 year follow up. Out of 50 patients, 38 (74%) patients had no malalignment. 6 (12%) patients had moderate amount of angulation while only one (2%) patient had angulation of more than 10°. Patients who needed unplanned surgery prior to fracture healing and elective hardware removal were categorized as having a “major complication.” Patients who did not need surgery to address their complication were categorized as having a ‘‘minor complication”. In this series of 50 children, 18 (36%) had complications. There were 17 (34%) cases with minor complications and one patient (2%) with major complication.

Table 3: Final results in the study group.

Result	Number of patients	Percentage (%)
Excellent	32	64
Satisfactory	17	34
Poor	1	2
Total	50	100

Minor complications

The minor complications included pain at the insertion site in 16%, minor angulation (6-10°) in 6%, minor limb length discrepancy of 1-2 cm in 14%. Superficial wound infection occurred in 2% patients.

Acute synovitis of the knee 1(2%) patient suffered from an unusual complication of acute synovitis of knee due to intra-articular penetration of nail. Routine investigations revealed normal white cell count, ESR and CRP. Joint aspiration was carried out that yielded blood. Radiographs revealed no change in position of nails. Patient was managed conservatively on intra venous antibiotics for one week and responded well. After one month at the time of elective removal of nails the lateral nail was found penetrating the suprapatellar pouch. Both nails were removed and postoperative course was uneventful.

Table 4: Results according to age.

Age (years)	Excellent (%)	Satisfactory (%)	Poor	Total
6-7	21 (72.4)	8 (27.5)		29
8-9	4 (44.4)	5 (55.5)		9
10	7 (58.3)	4 (33.3)	1 (8.3)	12
Total	32	17	1	50

Table 5: Complications in the series.

Complication	Percentage (%)
Minor	
1. Pain at insertion site	16
2. Minor angulation	6
3. Superficial infection	2
4. Acute synovitis	2
5. Lossof motion (temporary)	4
6. Minor limb length discrepancy	14
Major	
1. Major angulation	2

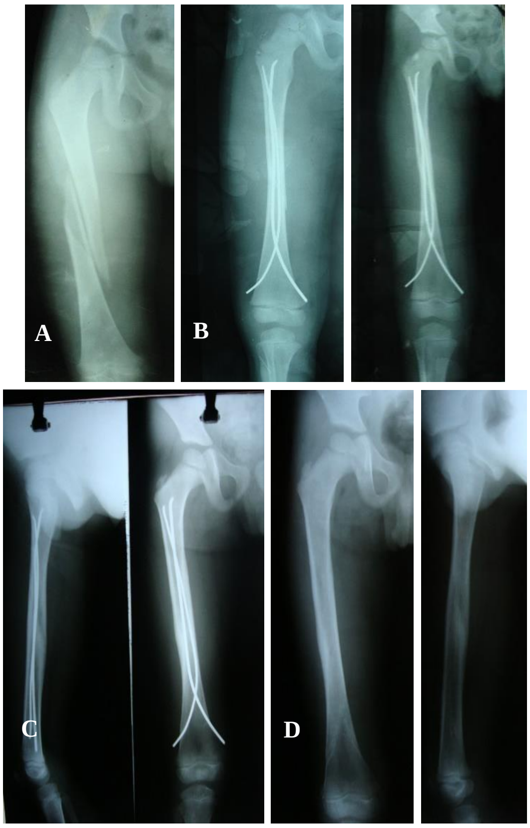

Figure 1: (A) Femoral fracture; (B) immediate postoperative radiograph; (C) radiograph at 6 months; (D) radiograph after hardware removal.

Loss of knee movement (worse than 10°-110°). (4%) patients developed stiffness of knee with flexion of less than 90°. Both were managed conservatively and recovered full movement within 3 months post operatively.

Major complication

Angulation exceeding guidelines: There was only one major complication in the form of angulation of more than 10°. Patient was operated 4 months after first surgery, correction of angulation and fixation was done using a dynamic compression plate.

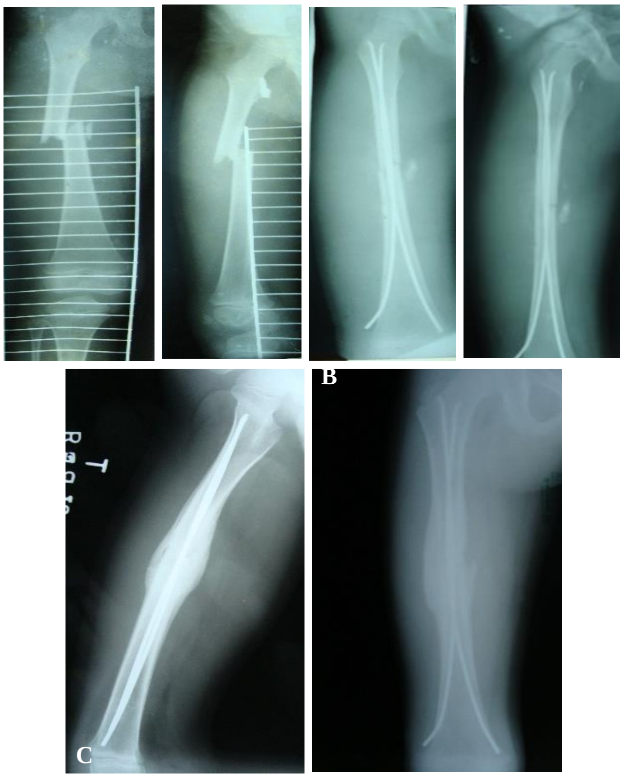

Figure 2: (A) Fracture of the femur; (B) postoperative radiograph of the nailed femur; (C) radiograph at 6 months.

There were no cases of nonunion, delayed union, rotational malalignment, deep infection, surgery to revise nail placement or neurovascular injury.

As per the scoring system devised by Flynn et al.[1] 32 (64%) had excellent result, 17 (34%) patients had satisfactory result and 1 (2%) had poor result (Table 4).

DISCUSSION

Femoral shaft fractures in children are usually associated with long periods of morbidity. Traditional methods do give satisfactory results in younger children but older children may have complications such as malunion, delayed union, rotational deformities and psychological problems.[20] Choice for fixation is based on many factors, including the age and size of the child, associated injuries, the location and pattern of the fracture, and the social situation of the child.[21] Treatment of the femoral shaft fracture in children is controversial especially in children of age 6-12 years.[22]

There is little disagreement regarding the treatment of younger children (usually less than 6 years of age) and adults (>16 years). For children aged between 6-14 years, there are wide varieties of surgical and nonsurgical treatment options available with no clear consensus as to the preferred treatment.[23]

Conservative care is an effective modality of treatment but increasing attention has been focused on the difficulty of caring for an older in a body cast for 2 to 3 months.[24-28] Such prolonged immobilization stresses the child and the family with missed school, lost work, and deleterious psychosocial effects. In adolescents, psychological implications are equally important. Frequent complaints include the weight and smell of the cast, hygiene difficulties, and requirement for one parent to miss work for child care.[29] Operative treatment results in shorter hospitalization, which has psychological, social, educational, and economic advantages over conservative treatment.[30,31] Operative treatment has advantages in several clinical situations. However, complications are not uncommon. external fixation may cause pin site irritation or infection, knee stiffness, and unsightly thigh scars, psychological issues and refractures.[10] Nailing may cause myositis ossificans gluteal muscles, premature closure of the greater trochanteric physis and leg length discrepancy.[12] Plating also has its drawbacks including the large incision, higher blood loss, reports of refracture and implant failure.[13,14]

Several studies prove stainless steel nails to be more effective in certain situations like in an obese child, unstable femoral fractures and in children around ten years of age. Other reason for selecting stainless steel nails was that majority of our patients were from poor socioeconomic background and it was difficult for them to purchase titanium nails which have double the cost as compared to stainless steel nails.[15-17] We chose a six to ten year age group for our study because it is a more homogenous group and the behavior of the femoral bone in response to the fracture is similar. Concerns have recently been raised regarding the use of FIN in older, heavier children and in unstable fracture configurations. Moroz et al reported a series of 234 femoral fractures treated with FIN from six separate institutions and demonstrated poorer outcomes for older children and for heavier children.[32] Similarly the stainless steel nail has some advantages as a recent paper compared steel elastic femoral nails to titanium elastic femoral nails used for paediatric femoral fractures.[16] The authors demonstrated a 23% malunion rate when titanium nails were used compared to a 6% malunion rate when steel nails were used.[33] The comparison of age ranges in various series in literature is given in the Table 5.[1,17,18,34,35]

Most of the complications in our group were of a minor nature and did not leave any permanent disability. The one major complication that we faced was managed by plating. This patient also went on to have a good result in the end. We used hip spica in 2 cases as we felt that we did not achieve a stable intraoperative construct. It was only used as a precaution and not as a necessity. It is pertinent to point out that a spica can be used in such a situation while as it is not possible to apply it in a case with a weak external fixation or a wrongly applied plate.

Even within this group the maximum excellent results were obtained in the 6-7 year age group.

In the children between the ages of 6 and 10, new surgical treatment modalities have been tested with good outcomes, and, as new data emerge, flexible intramedullary nailing is becoming preferable to other modalities treatment.

CONCLUSION

Use of flexible intramedullary nailing for definitive stabilization of femoral shaft fractures in children is a reliable, minimally invasive, and physeal protective treatment method. Operative treatment with flexible nails greatly reduces hospital stay, allows early mobilization, rapid return to normal function in this age group and strengthens literature regarding the effectiveness of these nails in this age group.

We do acknowledge certain drawbacks to this procedure including minor malalignments, minor LLD, nail site irritation as previously outlined. However the benefits of this treatment modality in terms of early mobility and early return to pre-injury status of activity and minimizing missed school and work time are significant.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Rashid M, Ali MF, Dhar SA, Mir MR, Dar TA, Kawoosa AA, et al. Elastic nailing of the femoral fractures in the 6-10 year age: a study from Kashmir. Int J Res Orthop 2018;4:841-7.