Original Article

Percutaneous K-Wire Fixation for Femur Shaft Fractures in Children: A Treatment Concepts for Developing Countries

Sahu RL

Department of Orthopedics, SMS and RI, Sharda University, Greater Noida, Uttar Pradesh, India

Address for correspondence:
Dr. Ramji Lal Sahu,
11284, Laj Building No 1 Doriwalan,
New Rohtak Road, Karol Bagh,
New Delhi, India.
Email: drrlsahu@gmail.com

Abstract

Background: Fractures shaft femur is a major cause of morbidity and mortality in patients with lower extremity injuries. **Aims:** The aim of this study was to evaluate the efficacy of intramedullary Kirschner wires for the treatment of femoral shaft fracture in children. **Subjects and Methods:** This prospective study was conducted in the Department of Orthopaedic surgery in M. M. Medical College from June 2005 to June 2010. Sixty eight children with a mean age of 7.7 years (range, 2-14 years) were recruited from Emergency and out patient department having closed fracture of femoral shaft. All patients were operated under general anesthesia. All patients were followed for twelve months. **Results:** Out of sixty eight patients, sixty four patients underwent union in 42 to 70 days with a mean of 56 days. Touch down weight bearing was started on 2nd post-operative day. Complications found in four patients who had insignificant delayed union which were united next three weeks. Intramedullary Kirschner-wires were removed after an average of five months without any complications. The results were excellent in 94.1% (64/68) and good in 5.8% (4/68). **Conclusion:** This technique is simple, quick to perform, safe and reliable and avoids prolonged hospitalization with good results and is economical.

Keywords: Children, Femoral shaft fractures, Kirschner wires

Introduction

Fractures shaft femur is a major cause of morbidity and mortality in patients with lower extremity injuries.[1] Conventional treatment of femoral shaft fractures in children is by traction followed by a hip spica or a Thomas' splint.[2] Conservative treatment of femoral shaft fractures gives good results in children under 5 years of age. But above that age, all such fractures cannot be treated by conservative methods. There is a possibility of loss of reduction and malunion. Plaster immobilisation has its own complications like pressure sores, nerve palsies, soiling of the skin and the plaster, breakage of the plaster, joint stiffness. The child is immobilised and needs an attendant for personal care.[3] Operative methods for femoral shaft fractures in children include external fixation,[2,4] plating,[5] rigid or flexible intramedullary nailing[2,6-9] Flexible intramedullary nailing has revolutionised the treatment of femoral shaft fractures in children. The idea of using multiple flexible intramedullary nails (Ender nails) was first conceptualised by Ender and Simon Weidner.[10] More recently Ligier and Métaizeau advocated the use of elastic titanium nails (Nancy nails) for femoral shaft fractures in children.[2,6-8] Pradeep Kumar,[11] Shakeel[12] and Zahrani[13] recommend the efficacy of Kirschner wires for flexible intramedullary nailing of femoral shaft fractures in children. Shakeel reports reduced psychological trauma on the child and the parents.[12] We present our experience with the use of percutaneous Kwire fixation for femoral shaft fractures in children.

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Subjects and Methods

This prospective study was carried out at Orthopaedics department of M. M. Medical College from June 2005 to June 2010. It was approved by institutional medical ethics committee. A total of 68 children with fracture femur admitted to our institute were included in present study. A written

informed consent was obtained from all the patients; they were explained about treatment plan, cost of operation, and hospital stay after surgery, and complications of anaesthesia. They were followed up after surgery, were clinically and radiologically assessed for fracture healing, joint movements and implant failure. According to the criteria the results are graded as excellent when the fractures unites within 10 weeks without any complication, good when union occur within 16 weeks with treatable complications 22 like superficial infection and knee stiffness and poor when union occur before or after 16 weeks with one or more permanent complications like infection (osteomyelitis), implant failure, non-union, limb shortening and permanent knee stiffness. Delayed union was recorded when the fracture united between two to four months while nonunion was noted when union had not occurred after four to six months of treatment. Follow-up was done for twelve months. Patients with closed femoral fracture with age less than 14 years and presented within a week of the injury and did not have any previous surgical treatment for the fracture were included in the study. Malnourished patients and those with open fractures, pathological fractures and fracture nonunion were excluded from the study. Examination of patients was done thoroughly at the time of admission to exclude other injuries. In majority of the patients percutaneous Kirschner wire fixation of the femur was performed on seventh to fourteenth day after the injury. In patients who were not fit for surgery due to associated injuries to vital organs, were haemodynamically unstable or due to active infection at injury site, or were pyrexial delayed Kirschner wire was performed when their over-all condition improved. Under general anaesthesia, the patient was placed supine on an orthopaedic table with the feet strapped to the footplates and longitudinal traction applied ensuring correct linear and rotational alignment clinically and radiologically using an image intensifier. The criteria used for acceptable fracture reduction and alignment in children: <15 varus or valgus, <20 anterior or posterior, <30 malrotation, <2.0 cm shortening. 2 stainless steel Kirschner wires of 30-45 cm length and 2.5-3.5 mm diameter (depending on the size of the medullary canal and the child) were prepared by bending them at an approximate angle of 45°, 2 cm from the tip and cutting off the sharp points to prevent inadvertent penetration of the cortex. The wires were not pre-bent in a 'C' or 'S' curve. The wires were loaded onto a 'T' handled introducer with a Jacob's chuck. Two small skin incisions were made proximal to the superior pole of the patella, one laterally and the other antero-medially. Entry portals were made into the distal femoral metaphysis proximal to the growth plate of the distal femur with a sharp bone awl laterally and antero-medially. The wires were introduced retrograde by hand or gentle hammering. The lateral wire was introduced first. The tips of the wire are placed just distal to the growth plates of the greater and lesser trochanters, the bends pointing towards the side of the entry portal. Angular and rotational malalignment spontaneously corrects on passage of the wires across the fracture by keeping the limb in normal anatomical position with adjusting traction.

Image intensifier screening in two planes perpendicular to each other confirmed proper placements of the wires [Figures 1 and 2]. The tail portions of the wires were bent towards the fracture and cut 1 cm away from the entry portal in the cortex. The skin wounds were sutured and dressed. Fracture stability, correct linear and rotational alignment was assessed on table. All patients had received a pre-operative bolus of intravenous antibiotic. Antegrade medullary Kirschner wiring was carried out in one small child with a single intramedullary Kirschner wire. The entry portal was on the lateral cortex distal to the growth plate of the greater trochanter. No cast supplementation was done in the immediate post-operative period. Evaluation on follow-up was done according to a fixed protocol. The time to weight bearing and to union was recorded, as well as the range of knee motion and limb–length discrepancy. Union was defined radio graphically when bridging callus was visible on two standard views with partial obliteration of the fracture line, and clinically when bony tenderness and pain on weight bearing were absent. Any difference in the limb length was

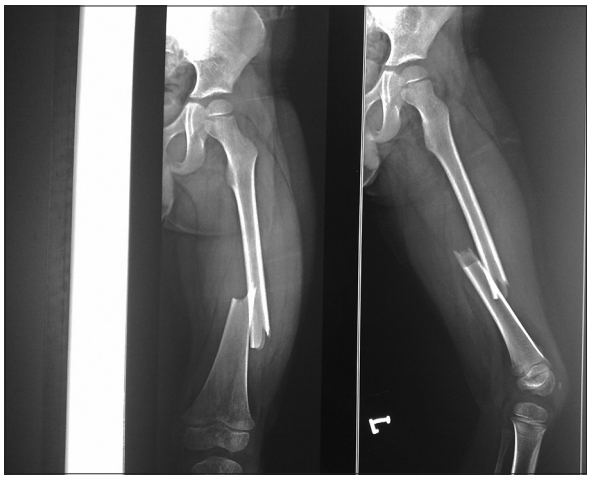

Figure 1: Pre operative photograph of fracture shaft femur of six years old child

Figure 2: Radiograph after six weeks of surgery showing callus formation around the fracture site

measured, keeping both lower limbs in identical position (with pelvis squared) and measuring the distance from the anterior superior iliac spine to the inferior tip of the medial malleolus. Rotational deformity was measured, with the patient prone and the knee flexed to 90º. The flexed leg was then moved sideways and the angle between the leg and the midline was measured. Any significant varus or valgus angulations at the fracture site was measured radio logically (More than 15º varus or valgus angulations). Patients were called for an out-patient visit, on the 12th post-operative day (for stitch removal), six weeks post-operatively (for partial weight bearing walking), at eight weeks (for full weight bearing and radiographic evaluation). Thereafter, they were called after five months, for implant removal. These patients were assessed clinically and radio logically for union timing at twelve months following surgery. Patients were assessed for delayed union (more than 8-16 weeks postoperative) and non union (twenty-four weeks following surgery). Stastical analysis was limited to calculation of percentage of patients who had unions, malunions, delayed unions, or non unions and excellent, good, and poor outcomes.

Ethics

The protocol was approved by Institutional ethics committee and thus meets the standards of the Declaration of Helsinki in its revised version of 1975 and amendments made to it in 1983, 1989 and 1996 (JAMA 1997;277:925-6).

Results

There were sixty eight children in this study, forty two children were male and twenty six children were females. The children were aged two years to 14 years. There were 30 left sided and 38 right-sided fractures. 44 children had met with a road traffic accident and 24 had a fall from a height. All were closed fractures. There were 47 transverse, 8 oblique, 5 spirals, 7 comminuted and 1 segmental fractures. Femoral fractures at middle one third were forty two out of sixty eight, fractures in twelve cases were at proximal one third and fractures in fourteen cases were at distal one third [Tables 1 and 2]. The patients were divided in four groups according to their age for simplicity. Age group between two to four years, in this group there were seven males and five females. Age group between 4-8 years, this group included eight females and twelve males. Age group between 8-12 years, this group consisted of seven female and fourteen males. Age group between 12-14 years, this group consisted of six female and nine males. All patients were followed for twelve months. None was lost to follow-up. The clinical results of our study were rated on the basis of the criteria of union, nonunion, delayed union or malunion. The patients were followed according to their clinical status. Sixty four patients had union within ten weeks. Union was achieved in four patients in ten-sixteen weeks [Table 3]. Rehabilitation-We allowed our patients to start touch down walking with crutches on the 2nd day of operation as they feel comfortable. All patients, except two, started partial weight bearing on the 6th week and full weight bearing on the 12th week. These two patients had non weight bearing ambulation till the callus became visible on radiographs. They had comminution at fracture site (Winquest and Hensen type III). All of our patients had full range of motion of their knees and hips. Three patients out of sixty eight complained post operative knee pain, which was spontaneously resolved in two weeks. None of the patients in our series developed migration or sinking of the intramedullary wires. Skin irritation by the protruding wire ends was encountered in twelve patients. In our study There were four i.e. 5.88% (4/68) delayed unions which were healed spontaneously within three weeks. Kirschner wires were removed after an average of five months. The results were excellent in 94.1% (64/68) and good in 5.8% (4/68) patients [Table 4]. Out of 68 cases, 10 mm (1 cm) shortening was observed in nine cases. Six patients had varus angulations (Less than 12º) whereas two had valgus angulations (Less than 15º) and three patients had eight degree angulations in the anteroposterior plane. Limb lengthening of less than 1.5 cm was found in three cases both clinically as well as radiologically, which was clinically insignificant.

Table 1: Age and sex variations in study group (*n*=68)

Age	Male	Female	Total
2-4	7	5	12
4-8	12	8	20
8-12	14	7	21
12-14	9	6	15
Total	42	26	68

Table 2: Site of femoral fracture (*n*=68)

Femoral site	No.	Percentage
Proximal 1/3rd	12	17.6
Middle 1/3rd	42	61.7
Distal 1/3rd	14	20.5

Table 3: Percentage of cases who had unions, malunions, delayed unions, or non unions (*n*=68)

Fracture healing	Total cases	Percentage of cases
Union	64	94.1
Non union	0	0
Delayed union	4	5.8
Malunion	0	0

Table 4: Out come of results of Kirschner wires (*n*=68)

Out comes	No.	Percentage
Excellent	64	94.1
Good	4	5.8
Poor	0	0

Discussion

Fractures of the femur in children are generally managed conservatively, in the form of traction or hip spica immobilization, It had been the treatment of choice in the past and is still being used at many centers worldwide.[14] Conventional treatment exposes to the problems of malunion, pressure sores, redisplacement of fragments, prolonged immobilization and psychological problems.[3] To combat them, there has been an increasing trend towards surgical management of these fractures in older children.[3,7,9,15,16] Compression plating is recommended[6] it does provide anatomical reduction and rigid immobilization, but has the disadvantages of larger soft tissue dissection, a large scar and a second major operation for removal of the plate. The risk of deep infection and repeat fracture, after implant removal, due to the stress shielding effect, is always there. External fixation advocated by some authors[5] has advantages of stability and early mobilization, but it is associated with problems of pin track infection and refractures through the pin tracks. Rigid intramedullary nailing with a kuntscher nail or interlocking nail offers advantages of good stability, rigid fixation and early weight bearing, but rigid nailing in children is associated with problems of physeal damage and coxa valga or epiphysiodesis of the greater trochanter, a vascular necrosis of the femoral head and growth disturbances.[17] Ender nails and Rush pins are not sufficiently elastic for pediatric fractures and they may cause straightening of normal femoral curves.[12] Flexible intramedullary titanium nails (Nancy nails) devised by Ligier and Métaizeau, *et al*.[8-11] revolutionised the treatment of femoral shaft fractures in children. Based on the concept of flexible intramedullary nails Al-Zaharani, *et al*.[18] and Qidwai and Khattak,[12] recently advocated the use of intramedullary Kirschner wire fixation for femoral fractures in children with encouraging results. Huber, *et al*.[19] advocated flexible titanium nailing for the treatment of all diaphyseal fractures in children. The principle of osteosynthesis with intramedullary K-wires is a biomechanical idea that aims at early bridging callus formation leading to rapid restoration of bony continuity.[19] Just like the Nancy nails, the flexible K-wires allow controlled oscillating micro movements that permit changing compression on different parts of the fracture line, leading to early external callus formation. Each K-wire provides three points of fixation: One at the entry point, a second at the apex of the curve of the K-wire and a third at the tip, which is embedded in the cancellous bone of the proximal metaphysis. Stability is provided not only by the intramedullary K-wires but also by the bone itself and surrounding soft tissues.[8-11] The bone provides axial stability and each wire provides three point fixations. The bent tips provide rotational stability. The surrounding muscles also provide stability by acting as guide-ropes. Increasing the number of K-wires enhances the stability of fixation.[8-12] Kiely, *et al*.[20] tested the mechanical properties of different combinations of flexible nails in a model of a paediatric femoral fracture. They found no difference in the mechanical properties of paired straight, S-shaped and C-shaped nails. In most of our cases, we used K-wires from both medial and lateral cortices. In five cases with a distal femoral shaft fracture, ante grade K-wiring was done from the subtrochanteric region, avoiding the trochanteric apophysis. Reduction was easier by rotating the wire tip in the smaller distal fragment with the added advantage that the entry point was far away from the fracture site.[12] In our series, three patients out of sixty eight complained post operative knee pain, which was spontaneously resolved in two weeks. None of the patients in our series developed migration or sinking of the intramedullary wires. In 12 cases, we encountered skin irritation by protruding wire ends at the entry point. Cutting the wires close to the bone and hairpin bend of the wire ends minimised this problem. There were four cases of delayed unions which were corrected within three weeks. Percutaneous K-wire fixation for femoral shaft fractures in children has distinct advantages over other conservative and over operative techniques. The low cost and universal availability of K-wires (as compared to titanium nails and the short hospital stay make this treatment cost effective and particularly suitable for developing and underdeveloped countries. This is a simple technique, and sophisticated instrumentation is not required. This is a minimally invasive technique with small stab incisions at the entry point. The amount of blood loss is small as compared to plating.[12] Cosmetic damage is minimal (as compared to other open techniques like plating). In contrast with the hip spica, it affords advantages of easy nursing care, early mobilisation and avoidance of psychological problems due to prolonged immobilization.[8-11] As the children are mobilised early on axillary crutches, they can return to school and playing activities, earlier. The technique is of considerable value in head injury and comatose patients, when compared to traction or spica cast immobilisation. Percutaneous K-wire fixation is a biological method of fixation, which provides a combination of elastic stability and mobility. Closed methods leave the fracture haematoma intact, leading to the formation of early bridging callus. This is an easy to learn technique, with a small learning curve. It may be adapted to treat other diaphyseal fractures in children.[8-11]

Conclusion

Percutaneous closed intramedullary K-wire fixation for femoral shaft fractures in children is a simple surgical technique that has excellent clinical and functional results and is recommended for all freash fractures where internal fixation is indicated.

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