

## MANAGEMENT OF PEDIATRIC FEMORAL FRACTURES USING K-WIRES

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The objective of this study was to evaluate intramedullary Kirshner wire (K-wire) fixations, a surgical technique, in the management of proximal, midshaft and distal femoral fractures in children. It is a retrospective study of 40 children (30 male and 10 female) with fractures of the femur who were treated by closed reduction and stable intramedullary K-wire fixation.

The standard for the management of most femoral fractures has always been conservative, i.e., a period of traction to maintain the reduction until early stabilization by fracture callus, followed by hip spica until fracture union. There are many circumstances in which surgical intervention is indicated.<sup>1-4</sup> These may be the result of polytrauma, floating knee, head injuries, spasticity, open fracture, vascular injuries or the failure to obtain satisfactory reduction with traction.

The surgical methods which are commonly used include plate osteosynthesis, external fixation and intramedullary nailing.<sup>5-8</sup> Although the introduction of these surgical methods has been a major advance in the management of closed fractures of the proximal (3 cm distal to lesser trochanter), midshaft and distal femoral shaft (3 cm proximal to distal femur growth plate), they are not without complications. Infection, deformity, growth disturbance, delayed union and the need for another surgery have frequently been reported. We share our experience with the use of the elastic stable intramedullary pinning (ESIP) technique for the treatment of closed fractures of the femoral shaft in children.

### Patients and Methods

The medical records of 40 children with closed fractures of the femoral shaft treated with closed reduction and followed by intramedullary K-wire fixation in King Fahad National Guard Hospital from 1997 to 2000 were reviewed.

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### Operative Technique

On the fracture table, we used traction to reduce the fracture and placed the unaffected hip in abduction and external rotation. Two K-wires (one medial and one lateral, size 3 mm/400 mm) with a C-arm fluoroscopy were employed. For distal fracture, the entry point of the K-wire was 2-4 cm proximal to the growth plate. Following closed reduction of fractures under general anesthesia and fluoroscopy, 2 cm skin incisions were made on the medial and lateral sides of the lower thigh and deepened to the bone. Using an awl, two holes were prepared in the medial and lateral cortices of the lower femur at the same level and above the growth plate. Through the holes, two thick K-wires (size 3 mm in diameter) were introduced with a blunt, bent (10°) proximal end to prevent cortical penetration and facilitate the passage of the wires through the medullary canal. Under fluoroscopy, once the wires passed the fracture site, the traction was released and the wires were pushed further, fixing their tip in the spongy tissue of the metaphysis. The K-wires crossing each other in a curved manner provided double three-point fixation. Care was taken during the wire insertion to avoid rotational deformity and by keeping the wires under the iliotibial band. The skin was closed over the bent distal ends of the wires, which were deep in the muscles. The procedure time was usually between 45 and 120 minutes (mean 90 min).

### Results

There were 30 boys and 10 girls aged 4 to 12 years (mean 7 years). The mode of injury varied, with 28 cases (70%) being the result of motor vehicle accident, 8 (20%) being pedestrian/vehicle accident, and 4 (10%) the result of falls. Most of these children sustained isolated fractures but some had other injuries (Table 1). A large number of children had closed fractures, while a few had open fractures. The vast majority of fractures (85%) were midshaft transverse fractures, while the rest were proximal and distal. All patients were on skin traction from the time of admission until operation time.

During the first week, partial weight-bearing ambulation with crutches was started as soon as the patient could tolerate it. Duration of hospitalization ranged from three to

TABLE 1. *Associated injuries.*

Injuries	Numbers
Isolated	28
Closed head trauma	5
Chest trauma	0
Closed abdominal trauma	2
Spinal injuries	0
Pelvic fractures	2
Other extremity fractures	3

TABLE 2. *Documented complications.*

Complications	Numbers
Infection	0
Skin ulceration	2
K-wire failure	0
Refracture	0
Avascular necrosis	0
K-wire back out	2
Heterotopic bone formation	0
Loss of joint motion	0
Nonunion/malunion	0

five days, with an average of four days. Full weight-bearing was resumed 4 to 8 weeks after surgery. Superficial skin ulceration was seen over the protruded distal ends buried under the skin in two cases. K-wire backout was also seen in two patients. No other complications were seen. There were no K-wire failures, refractures, heterotopic bone formation, loss of joint motion or avascular necrosis (Table 2). All fractures healed well within 6 to 10 weeks.

#### *Clinical and Radiological Follow-up*

After one week, sutures were removed, a rehabilitation program began and check x-ray was obtained. After three weeks, hip and knee range of motion was checked and strengthening of the thigh muscles started. X-ray showed immature callus. At six weeks, the children were back to normal activities, and x-ray showed bridging callus. At 3-4 months, the K-wires were removed in day surgery. Sports activities were allowed at six months, and at 12 months, there was a limb length discrepancy (LLD) scanogram. Patients were reviewed after a mean follow-up period of 18 months (range 12-24 months). Eight patients were lost to follow-up after 15 months. Almost all patients had full range of motion of the knee and hip. There was no significant LLD, except in two patients with -10 mm and +15 mm discrepancy and less than 5 degree angulations in the frontal and coronal planes, which had no clinical significance.

### **Discussion**

Fractures of the femur in children are generally managed nonoperatively. The standard management for most femoral shaft fractures in children has always been traction followed by hip spica. Hip spica casting without traction for femoral fracture in children aged 0-4 years

produces excellent results and continues to be the treatment of choice. Internal fixation is the treatment of choice for patients 13 years and above. However, traction often fails to align fractures of the proximal third of the shaft, and maintaining reduction is usually difficult. Aronson et al.<sup>9</sup> reported angulation deformity of more than 15 degrees and LLD of more than 13 mm after nonsurgical treatment in 20% of cases with proximal third fracture, which increased to 53% in older children. Surgical management of this type of fracture is gaining strong support because of the desire for more rapid recovery and reintegration of the child into his social life and the need to decrease the length and cost of hospitalization.

Hansen et al. recommended the use of plate osteosynthesis.<sup>5</sup> It has the disadvantages of increased risk of infection and delayed union, in addition to the need for another operation for the removal of the plate.<sup>4,10</sup> Krettek et al. suggested the use of the external fixator, which offers good stability and early mobilization, but 25% of his patients developed infection at the site of the screws and 19% of the patients were unhappy with the device.<sup>11</sup> Intramedullary nail fixation affords good alignment, rigid fixation and allows early weight bearing, with early hip and knee motion.<sup>7</sup> However, it is not without complications. Added to the need for another surgery for nail removal, it has the risk of infection and rotational deformity, avascular necrosis and growth disturbance. The use of intramedullary (IM) Rush pin and Ender's nail has been preferred by some authors,<sup>9,10,12</sup> but it is not elastic enough for treating children and may lead to the straightening of the normal curve of the bone. Ligier et al. used elastic stable intramedullary nailing (ESIN) technique using multiple thick K-wires for treating fractures of the femoral shaft in children.<sup>6</sup>

In our study, we used the principle of ESIP to treat fractures of the proximal, midshaft and distal shaft of femur with two ordinary K-wires in children between 4 and 12 years of age. This technique provides a combination of stable and elastic immobilization. In contrast to techniques using rigid fixation, stability is ensured not only by the wires, but also by the surrounding soft tissue. Bone provides axial stability by cortical contact when the wires are anchored in the metaphysis. Rotational stability is achieved by the curved wires which provide three-point fixation.<sup>8</sup> Soft tissues, muscles in particular, serve as guy-ropes. This explains the spontaneous postoperative correction of the slight angular deviation.<sup>6</sup> Stability provided by living tissues allows rapid returns of functions and weight bearing without the fear of secondary displacement. On the other hand, elastic mobility allows a certain amount of movement at the fracture site stimulating callus formation.

The results of the present study further support the use of this technique for fractures of the femoral shaft in children. ESIP encourages early mobilization during the first postoperative week without external splints, while

allowing full weight bearing 4 to 8 weeks after surgery and formation of good callus, without evidence of delayed union. None of our patients developed avascular necrosis of the head of femur or growth disturbance. We believe that closed pinning<sup>3</sup> was the reason for the very low incidence of infection in our series. In this technique, the scars are small and are accepted cosmetically by most parents.

In conclusion, fractures of the shaft of the femur are common in children. Proximal third and sometimes distal third fractures of the femoral shaft in children are difficult to treat conservatively. The ideal age for closed flexible IM pinning is 4 to 12 years for children who are too large for hip spica cast and too immature for the conventional IM nail. The use of an IM nail in children <12 years is associated with a high risk of growth plate injury. These fractures can be successfully managed by closed reduction and intramedullary K-wire fixation under an image intensifier. A transverse type of fracture is the best pattern for this mode of fixation. Achieving 3-point fixation is the key for successful treatment. Closed K-wire fixation for femoral fractures in children appears to be a rapid, safe and effective method of treatment. The system is uncomplicated. The technique can be learned rapidly by an orthopedic surgeon and can be used by a hospital that has an appropriate fracture table and C-arm. It is especially useful in cases of polytrauma. Some of the advantages of this technique are: 1) it is minimally invasive and simple; 2) it does not disturb the fracture site; 3) there is minimal risk of infection; 3) vascular compromise to femoral head is avoided or is minimal; 4) early weight-bearing mobilization is possible; 4) there is only a remote possibility of relevant deformity; 5) it promotes early mobilization of knee and hip

joints; 6) there is no possibility of growth plate arrest; 7) short hospital stay; 8) early return to school; and 9) cost effectiveness.

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