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Functional Outcome of Paediatric Diaphyseal Fractures of Femur Treated with Closed Reduction and Multiple K Wire Fixation

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ABSTRACT

Background: Diaphyseal fracture of the femur in children is one of the common causes of paediatric morbidity. These fractures in children above the age of five years, depending upon the fracture personality, can usually be managed satisfactorily using different intramedullary implants, including Kirchner wires, Rush nail, as well as extramedullary implants using various combinations of plates and screws. Each of these methods of fracture fixation has its own merits and demerits. The current study is aimed at assessing the efficacy of internal fixation of these fractures using closed reduction and percutaneous 'K' wire fixation. **Methods:** Twenty six (n=26) children with a mean age of 7.2 years (range 5-14 years) were treated using closed reduction and multiple percutaneous K wire fixation under image intensifier. The minimum follow up period was twelve months. The final clinical and radiological assessment of patient was done at the end of one year. Three patients (n=3) were lost to final follow-up and were excluded from the final statistical calculations. **Results:** Twenty one fractures (n=21) united at an average time interval of 4.1 months (range 3-6.5 months). Two patients had delayed union and one had malunion. Superficial wound infections were seen in two (8.7%) patients. Impingement of bent k wires was felt by another two (8.7%) patients. Stiffness of the knee joint was seen in three patients (13%) during follow-up. Out of three (n=3) patients with knee stiffness two responded well to vigorous physiotherapy programme, while one (n=1) patient had limited knee range of motion even at the final follow-up. Malunion was seen in one (n=1) patient. **Conclusion:** Closed reduction and percutaneous K wire fixation is a safe, economical, technically non-demanding and highly efficacious technique for the treatment of paediatric femoral diaphyseal fractures.

Keywords: Paediatric, Diaphyseal, Femur, Closed reduction, K wires, percutaneous reserve..

INTRODUCTION

Femoral shaft fractures are responsible for 1.6% of all skeletal injuries in children.[1] 0These injuries are usually the result of high energy trauma in an otherwise healthy individual.

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Diagnosing femoral shaft fractures in children is usually possible with the help of through clinical history and relevant clinical examination and can later be confirmed by a plain radiograph of the injured thigh comprising antero-posterior and lateral views [Figure 1]. Additional investigations in form of CT scan, MRI and angiography may also be required at times, as per the requirement in individual cases. Young children less than five years of age have considerable growth and remodeling potential, therefore conservative treatment in the form of closed reduction even with suboptimal alignment and then immobilization using various splints and hip spica gives satisfactory results in these patients. As the age of the child advances growth and remodeling potential becomes limited, therefore the need of more optimal initial fracture reduction as well as maintaining the achieved acceptable reduction arises in patients older than five years of age. To achieve this goal various methods of internal fixation have been described by different authors including plates[2], intramedullary nailing[3], or

flexible intramedullary pinning[4,5]. Titanium elastic nails (TENS) were advocated by Ligier J et al. as early as in 1985. Few authors have treated paediatric femur fracture using external fixation as the primary and a definitive mode of fixation [6, 7].

Figure 1: Preoperative radiograph (AP and lateral views) of the femur showing displaced middle third fracture of the left femur

Rush has treated paediatric femur fractures using self designed round intramedullary rods[8] with satisfactory outcomes. During the latter half of the 20th century, it was Enders et al who made the intramedullary nailing of paediatric femur fracture popular across the Europe.[9] Some authors have also recommended the use of closed K wire fixation in femur shaft femur fractures in children.[10, 11] Treating shaft femur fractures in children older than five years of age using closed reduction and hip spica or traction is fraught with many complications including plaster or bed sores, prolonged bed rest, increased cost of treatment and joint stiffness. Similarly, each of the above mentioned method of treatment has its own merits and demerits. The present study has been undertaken to evaluate the role of closed reduction and percutaneous K wire fixation in shaft femur fractures in children.

MATERIALS AND METHODS

This prospective longitudinal study was done at a tertiary care hospital after approval from the institutional ethical committee. Children between five to less than 14 years of age with closed and Gustilo grade I and II fresh traumatic diaphyseal fractures of the femur were included in the study. All the children older than 14 years, having neglected, Gustilo grade III open fractures and pathological fractures were excluded from the study. All the patients were thoroughly worked for the femoral shaft fracture as well as for any other associated injury. An informed written consent was taken from all the patients participating in the study regarding the treatment plan, hospital stays including cost of treatment and any possible risk and complications encountered during the study. All the patients were operated under regional or general anesthesia as per the anesthetist's discretion. The majority of the patients were less than 7 years of age [Table 1].

Table 1: Age distribution of patients in the study

Age group	No. of patients	Percentage
5-7	13	56.5
9-11	4	17.5
12-14	6	26
Total	23	100

Road traffic accident was the most common cause of injury leading to the femoral shaft fractures in the present study [Table 2]. Fall from the height was the second most common cause of injury leading to this fracture. There were no cases related to gunshot injuries or child abuse.

Table 2: Showing demographic characteristics of patients included in the study

Mode of injury	Male	Female	Total	Percentage
Road traffic accident	12	4	16	69.5
Fall from height	5	2	7	30.5
Gunshot injuries	0	0	0	00
Child abuse	0	0	0	00
Total	17	6	23	100

Surgical technique: Preoperative intravenous antibiotic was given one hour prior to skin incision. After the adequate anesthesia, the patients were mounted on the operation table. In open fractures thorough surgical wound debridement was done. Closed reduction of fracture was achieved and checked under image intensifier with standard acceptable limits for the age and weight of the child. Depending upon the femoral medullary canal diameter two or more 2.0 mm, 2.5 mm or 3.0 mm Kirchner (K) wire prepared for intramedullary internal fixation of the fracture. Entry point for the insertion of the K wire was made in the distal lateral and medial metaphysis of the femur at least 2.5 cm proximal to the growth plate. The prepared K wires were inserted through the respective entry point and negotiated through the fracture into the proximal fragment under image intensifier. Minimum 80% of the canal was occupied by the intramedullary K wires to achieve a reasonably strong internal fixation. Final position of the inserted K wires was checked under the image intensifier. All the K wires were cut and bent and buried inside the fascia and skin. Postoperatively a Thomas knee splint was used in non cooperative patients for a period of three weeks.

Postoperative protocol: A check radiograph of the operated extremity was done on the first postoperative day [Figure 2]. All the patients were switched over to oral analgesics on the first or second postoperative day depending upon patient's tolerance to pain. Static quadriceps exercises were started on the first or second postoperative day. First wound inspection was done on the third postoperative day and injectable antibiotics were switched to oral antibiotics in patients with satisfactory wounds. Stitch removal was done on the eleventh postoperative day.

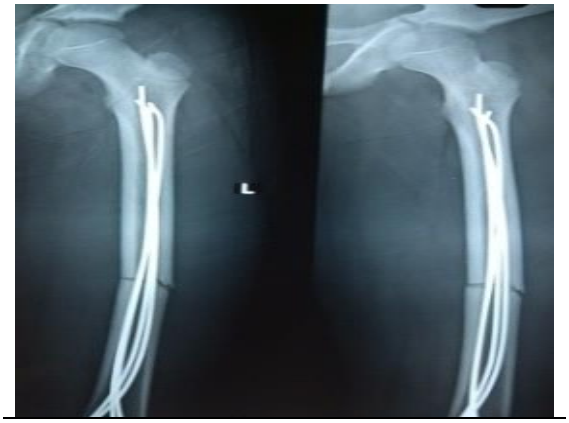

Figure 2: Immediate postoperative radiograph of the same patient showing well-reduced fracture with multiple k wires in situ.

Follow-up: Patients were called for further follow-up at four-week interval or as the need arises for the first six months thereafter every two months till one year. The union was defined as presence of bridging callus across the fracture site and the absence of clinical tenderness at the fracture site. All the patients were assessed for clinico-radiological union, delayed union, nonunion, limb length discrepancy, infection, K wire migration, and knee range of motion during the follow-up as well as any other complication arising during the study. K wire removal was done at the end of 7-8 months follow-up.

RESULTS

At the end of one year follow-up three (n=3) patients were lost to follow-up and did not turned up even on repeated communications. All the three patients were excluded from the final statistical calculations of the study. Union defined clinically as the presence of bridging callus across the fracture site was seen in 21 patients (n=21) at an average time interval of 4.1 months [Figure 3] with a range of 3-6.5 months. Delayed union defined as the insufficient bridging callus formation along with palpable tenderness at the fracture site at the end of 4.5 months. Two patients (8.7%) showed signs of delayed union, but eventually healed over due course of time without any major intervention.

Out of 23 patients, 3 patients had Gustilo grade I open femur fractures and 2 patients were having Gustilo grade II open femur fractures. Out of these five open femur fractures two patients (8.7%) developed superficial wound infections. The superficial wound infection in these patients was managed conservatively. Skin irritation by the bent K wires was seen in two patients, the skin irritation was resolved after K wire removal.

Figure 3: Radiograph of the same patient at 4 months follow up showing well united fracture of the femur with multiple k wires in situ.

Three patients (13%) between the ages of 12-13 years showed decreased knee range of motion during the initial follow-up. These patients were noncompliant to the physiotherapy protocol. These patients were readmitted for the supervised intensive knee range of motion exercises programme. Eventually all the patients showed excellent knee range of motion [Figure 4a &b]. One patient had 10º extensor lag, this was managed on outdoor basis and the patient regained full knee extension of subsequent follow-up. Malunion was seen in one (n=1) obese patient with distal third femur fracture, his fracture united in 20º varus union. [Table 2] shows the various complications encountered during the present study. After the fracture union K wires were removed at an average follow-up of 7-8 months.

Figure 4a & b: Clinical photographs of the same patient at 4 months follow-up showing normal range of motion at hip and knee joints.

Table 3: Various complications seen during the study

Complications	No. of patients	Percentage
Superficial wound infection	2	8.7
Bent K wire impingement	2	8.7
Knee stiffness	3	13
Nonunion	0	00
Malunion	1	4.3
Delayed union	2	8.7

DISCUSSION

A fracture shaft of femur is common in pediatric age group and the majority of these fractures healing with satisfactory outcomes, unless grossly neglected. A comprehensive treatment plan of treating these fractures involves thorough consideration about the patient's age, fracture personality, associated injuries and other relevant social mental and environmental factors.[12] The major goals of treating the displaced diaphyseal femur fracture in these children include union without a limb length discrepancy and at the same time avoiding or preventing any iatrogenic damage to the adjacent growth plates. Until recently shaft femur fractures in children were managed by closed reduction and hip spica cast application or traction or other suitable forms of splinting the fracture [13]. However, these methods of treatment are time consuming along with other inherent complications. Although a few authors like Caired MS et al. have reported that results of treating the isolated femoral shaft fractures as well as multiply injured patients are comparable with other methods of treating these fractures.[14] The major complications of treating the shaft femur fractures in children by MIPPO technique have been reported by Collin May et al. in five patients, in the form of wound infection , malunion, and limb length discrepancy requiring a second major operative intervention comprising wound debridement, corrective osteotomy and epiphysiodesis in respective cases.[15] Conventional open plating for treating these fractures has even more complications in the form of longer skin incision, wound infection, increased per operative blood loss, increased need of postoperative blood transfusion and a second major surgery required for hardware removal. Use of external fixation for treating the shaft femur fractures in children was once favored over spica casting and traction methods in terms of preventing mal-union, however no significant differences were observed in terms of physical function.[16] The external fixator application in shaft femur fracture is associated with increased Refracture rate, pin tract infection and poor cosmetics at the pin insertion site therefore it is not a favored implant as of now except under certain specific circumstances.[17] Use of conventional locked intramedullary nailing with a piriformis entry is not favored in children due to its deleterious effects on the vascularity of the femoral head.[3] Use of elastic stable intramedullary nails (ESIN) has revolutionized the treatment of paediatric shaft femur fractures. Treating these fractures using ESIN imparts all the advantages of biological fixation and therefore has clear advantages over other methods available to treat these fractures. After closed reduction ESIN can be introduced through small incisions into the femur under image intensifier, without periosteal and other soft tissue stripping and disturbing the fracture haematoma. The most common complication associated with ESIN is skin irritation by the protruding nail ends.[18] Closed reduction and intramedullary fixation of pediatric femur fractures using K wires has all the advantages of ESIN fixation and it also qualifies the criteria of a successful treatment option for pediatric femur fractures as stated by Staheli.[19]

CONCLUSION

Closed reduction and percutaneous K wire fixation is a safe, technically none demanding and highly efficacious technique for the treatment of paediatric femoral diaphyseal fractures.

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