

# External fixation in femur fractures in children

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## SUMMARY

The effects of external fixation in femoral fractures in children were investigated in a prospective study. Twenty-four children with twenty-six femur fractures (23 closed fractures and three open fractures) were treated with external fixation from 1997 to 2000. Mean age was eight years and eight months (ranging from six to 13 years). All fractures were followed up for up to six

months after consolidation, which was observed in 100% of the cases when the external fixator was removed after a mean time of 87 days (ranging from 63 to 135 days). Infection through the screw hole was frequent, but none of the patients had osteomyelitis. The major complication was refracture (17%), which required a new procedure with external fixator.

**Keywords:** External fixators; Femoral fractures; Children.

## INTRODUCTION

Diaphysial and metaphysial fractures of the femur in children accounts for approximately 1.6% of all fractures in pediatric population and can be considered severe due to the intensity of energy released and associated lesions, head injuries being the most common associated lesions. The distribution of femoral fractures is bimodal, with peaks at the age of 2 and during adolescence<sup>(6)</sup>.

Several methods have been currently recommended. The most conservative treatment with previous traction and plaster of Paris cast or immediate plaster of Paris cast has been the most supported. However, despite the fact that this method is not invasive, it is not free from complications, the most frequent ones being reduction loss resulting in shortenings and angular deviations, and long periods of home confinement, a common complaint in older children. During the last decades, an increase in the indication of internal and external fixation for these fractures has been seen because of the complications mentioned above<sup>(1,2,4,6)</sup>. Van Tets and Werken<sup>(24)</sup> report that these types of treatment should be used only in patients with open fractures, multiple traumas, specially when associated with head injury<sup>(24)</sup> while Blasier et al.<sup>(4)</sup>, Aronson and Tursky<sup>(2)</sup>, and Alonso and Horowitz<sup>(1)</sup> also recommend surgical treatment even for closed femoral fractures.

Skin traction and later preparation of hip-foot plaster of Paris cast or immediate use of plaster of Paris cast are usually adopted for children aged less than 4 because they are well tolerated and associated with excellent results. In children aged 4 to 12 years who present an isolated femoral fracture, skeletal traction can be used, the main disadvantages of which are long hospital stay, difficult management of the patient, need for specialized nurses, and high hospital costs<sup>(19)</sup>. Patients with multiple fractures or open fractures can be treated with external or internal fixation. Little controversy about this type of treatment exists in literature.

Recent reports showed that internal fixation with the intermedullary nail through the great trochanter in children aged 6 years or more has been associated with some complications, the most common ones being deformity of proximal femur with coxa vara at first and coxa valga later<sup>(21)</sup> and ultimately halted growth of the great trochanter. Avascular necrosis of the head of the femur is more frequent when the access is through the piriform fossa<sup>(26)</sup>. Due to these factors and the need for a new operation for removal of the intramedullary nail, this procedure has been less indication than external fixation.

Self-compression plates have been little used because more extensive exposure is required, it is associated with greater blood loss, overgrowth, relatively high rates of infection, as well as because a new procedure is required for removal of synthesis material<sup>(4,27)</sup>.

Recent studies have used external fixation in older children and adolescents with isolated femoral fractures<sup>(3,5,9,10,13,15, 17,23)</sup>. The authors have reported that the main advantages of this therapeutic modality are short hospital stay, stabilization without the risk associated with open surgery, low incidence of complications, easy cleanliness, specialized nurses being not required, good tolerability to heat, early return to daily and school activities, as well as low cost<sup>(7,8)</sup>. The present study aimed to evaluate the advantages and disadvantages of external fixation in the management of femoral shaft fractures in older children ( $\leq 6$  years).

## MATERIAL AND METHODS

The present study was carried out at the Department of Orthopedics and Traumatology of the Base Hospital of the Medicine School of São José do Rio Preto-SP (DOT-HB-FAMERP) and evaluated 24 patients with a total of 26 femur shaft fractures from February 1997 to July 2000. Study patients underwent osteosynthesis with lateral linear external fixator and were followed up for one year and eight months, on average (follow-up range: 8 mon-

Study carried out at the Department of Orthopedics and Traumatology of the Base Hospital of Medicine School of São José do Rio Preto – FAMERP

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Received on May 05, 2003. Approved on December 12, 2004.

ths-3 years). Patients were aged six to thirteen years (mean age: 8 years and 8 months), as shown in (Table 1).

Nineteen (79%) male and 5 (21%) female patients with a total of 24 patients were treated for 23 closed and 3 open fractures in the present study.

"The most frequent mechanisms of trauma were as follows: 9 (37.5%) car-pedestrian accidents, 9 (37.5%) falls, 4 (17%) car accidents, and 2 (8%) motorcycle accidents, as shown in Graph 1. Unilateral fractures were found in 22 (91.5%) cases (right fracture in 45.7%; left fracture in 45.7%) while two patients (8.5%) had bilateral fractures. As for the fractured site, middle diaphysial fractures were seen in 24 (92%), distal diaphysial fracture was found in one case (4%), and proximal diaphysial fracture was seen in one case (4%). As for associated lesions, the most frequent injury associated with femoral fracture in the present study was head injury (5 [20%] patients), followed by lung contusion and pneumothorax (2 [8%] patients), forearm fracture (2 [8%] patients), and splenic injury (1 [4%] patient)".

After the patient was first evaluated by the trauma group at the emergency room, radiographs were taken and the patient was submitted to skin traction with Braun splint. Surgery was carried out under general anesthesia one day after hospitalization on average. The patient under traction was positioned on an orthopedic table (Figure 1). In all cases, the femoral fracture was reduced, a shortening of up to 1.0-1.5 cm being allowed with no rotational or angular deviation. After disinfection and aseptic cleaning of the leg, the linear external fixator was applied. The linear external fixator consists of a hardened aluminium shaft (length: 300 mm), steel-138 Schanz screws (Æ: 4.5 mm; length: 200 mm), as shown in Figure 2. The fixator was placed under visual control with the help of an imaging enhancer. Two Schanz screws were placed both proximal and distal to the fracture site with a total of four Schanz screws. They were then fastened with two parallel lateral bars (Figure 3). Anteroposterior and lateral radiographs were taken. If the reduction was considered satisfactory and Schanz screws were well positioned, a dressing as then applied.

The mean hospital stay was 5 days and ranged from 2 to 20 days. As for patients with closed femur fracture not associated with other lesions, the mean hospital stay was 3 days.

On the first postoperative day, isometric exercises of the thigh and active moments of the ankle were stimulated, a dressing was applied to the area where Schanz screws had been inserted, and passive physiotherapeutic exercises of the knee and hip were carried out. Partial load was allowed within 40 days on average and the total load was allowed within 60 days following surgery. The dynamization of fixators was carried out within 60 days on average (range: 30 to 110 days).

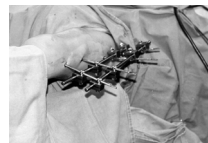
The time until fixator removal ranged from 63 to 135 days with a mean of 87 days. The external fixator was removed after confirmation of fracture consolidation (bone callus) at the surgery room with the patient under narcosis, hospitalization being not required.



**Figure 1 - Patient under general anesthesia, placed on an orthopedic table.**



**Figure 2 - External fixator used in patients under study**



**Figure 3 - Immediate postoperative period**

Patient - Sex	Age (years)	Mechanism of trauma	Type of fracture	Hospital stay (days)	Associated lesions
1-M	8	Car-Pedestrian Accident	Closed	2	No
2-M	8	Car Accident	Closed	5	Head injury
3-F	6	Car-Pedestrian Accident	Closed	2	No
4-M	13	Car Accident	Closed	18	Head injury - Hemothorax
5-M	10	Fall	Closed	5	No
6-M	7	Car-Pedestrian Accident	Closed	6	Head injury
7-M	8	Fall	Closed	3	No
8-M	9	Fall	Closed	2	No
9-M	9	Fall	Closed	4	No
10-M	10	Car-Pedestrian Accident	Closed	2	No
11-M	11	Car-Pedestrian Accident	Closed	3	No
12-M	7	Motorcycle Accident	Closed	4	Head injury - forearm fracture
13-M	9	Fall	Closed	6	No
14-M	12	Motorcycle Accident	Open	8	No
15-M	8	Car Accident	Open	12	No
16-M	8	Fall	Closed	20	Arm Hemothorax
17-M	7	Car-Pedestrian Accident	Closed	2	No
18-F	13	Car-Pedestrian Accident	Closed	3	No
19-M	6	Car-Pedestrian Accident	Closed	3	No
20-M	7	Fall	Closed	2	No
21-F	9	Car Accident	Closed	2	Head injury - forearm fracture
22-M	7	Car-Pedestrian Accident	Closed	5	No
23-F	9	Fall	Closed	3	No
24-F	10	Fall	Open	7	No

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**Table 1 - List of patients under study**

## RESULTS

Eight patients (33%) developed infection along the pathway of Schanz screws and were given oral cephalosporin for one week with daily dressings. They were periodically reevaluated.

No patient developed osteomyelitis. Intravenous antibiotic therapy was not needed in any patient.

Rigidity of the knee was seen in one patient. It persisted after removal of the external fixator. Joint motility returned to normal following intensive physiotherapy.

Bone scans with leg length measurements were carried out six months after fracture consolidation with the following results: overgrown bone in 17 (66%) legs (mean: 0.94 cm; range: 0.2 - 2.3 cm), shortened bone in 7 (26%) legs (mean: 1.4 cm; range: 0.7 - 1.7 cm); two patients (8%) had no dissymetry. Despite de high rate of dissymetries, no clinical complication was associated with them; patient's diseases are in course and further evaluation is required.

The greatest complications developed in four patients with refracture (17%) who were treated with external fixator according to the

same procedures used in the treatment of the initial fracture with consolidation in all cases.

Consolidation of femoral fracture was seen (Figures 4, 5, 6, 7, and 8) in all patients treated with external fixation. No significant angular or rotational deviation was seen.

## DISCUSSION

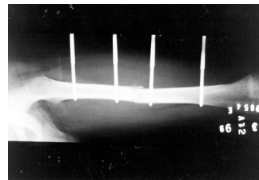
Although femoral fractures in children have been treated without surgery with good results, an increasing interest in internal or external fixation has emerged for treatment of this type of fracture, specially during the last decades, so as to improve patient's quality of life during treatment and final outcomes.

Several surgical techniques have been used, including fixation with a plate, intramedullary nail, and external fixation, each of them with advantages and disadvantages. Not only surgeon's expertise and patient selection play an important role, but also socioeconomic aspects should be also taken into account.

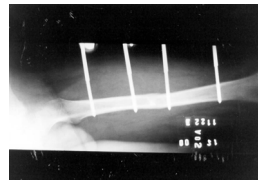
Despite the fact that early reports associated fracture fixation with a plate with negative results, according to Ziv e Rang<sup>(27)</sup>, better results have been obtained and reported by several authors<sup>(6,14,18,25)</sup> in recent years. Despite these reports, such procedures have not been used very often due to the need of great exposure, a higher risk of infection, as compared to that associated with other methods, as well as to the need of another operation for plate removal and technical limitations as far as comminuted and juxtaarticular fractures are concerned.



**Figure 4** - X-Ray of a well-aligned fracture



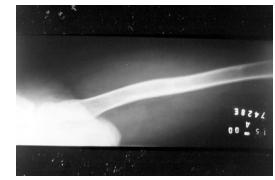
**Figure 5** - X-Ray of intraoperative control (Anteroposterior projection)



**Figure 6** - Early postoperative lateral X-Ray



**Figure 7** - AP X-Ray showing consolidation of femoral fracture 6 months after removal of the external fixator



**Figure 8** - Postoperative Lateral X-Ray (6 months)

Intramedullary nails have been used in children aged 6 or more, as reported by Kirby et al.<sup>(12)</sup> and Timmermann and Rab<sup>(22)</sup>. The main complications evidenced by Sola et al.<sup>(21)</sup> and Ziv et al.<sup>(26)</sup> are avascular necrosis of the head of the femur, coxa valga, and halted growth of the great trochanter. Another operation is also required to remove intramedullary nails.

The use of an external fixator is technically easy to carry out and has been associated with low rates of complications. In the present study, fracture consolidation was found in all cases with no joint motility limitation six weeks after removal of the fixator.

Despite the fact that infection along the pathway of Schanz screws is relatively common and occurs at a rate of 0% to 45% according to literature<sup>(6)</sup>, routine use of prophylactic antibiotic therapy is not indicated. In the cases where antibiotic therapy was needed, oral cephalexin for one week combined with daily dressings led to cure. No patient developed osteomyelitis or needed intravenous antibiotic therapy.

Another advantage of external fixation is the short hospital stay, thus resulting in lower costs, as compared to those of other interventional techniques.

Reduction was not lost in any case despite the fact that an auxiliary pin was not used, as recommended by Sola et al.<sup>(21)</sup> for unstable fractures.

Shortening and overgrowth (more frequently found) occurred following consolidation at a relative frequency but were not associated with any clinical impact.

Refracture following removal of fixator has been reported<sup>(4,16,20)</sup> with rates of 1.6 to 21.6% according to some reports. According

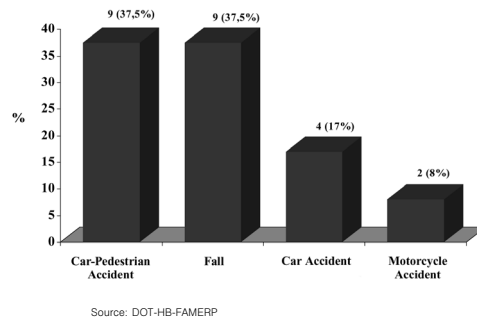
to Sola et al.<sup>(21)</sup> the main factor for refracture is probably the lack of fixator dynamization at opportune time. Therefore, dynamization and load stimulation are recommended for at least 30 days before removal of fixator. Skaggs et al.<sup>(20)</sup> correlated refracture and the number of corticals with bone callus. According to the authors, if a bone callus is present in at least three corticals when the fixator is removed, there is a chance of 33% of refracture while the chance of refracture is reduced to 4% if a bone callus is present in three or four corticals<sup>(26)</sup>.

As for the mean time until removal of the fixator, Davis et al.<sup>(6)</sup> and Miner and Carrol<sup>(16)</sup> have reported a range of 63-107 days.

The great advantage of external fixation, mainly as compared to the most conservative treatments, such as traction and plaster of Paris casts, is that the patient is easily manipulated for hygiene and physiotherapeutic purposes, both factors being highly important in patients with multiple trauma. The easiness of manipulation both during hospitalization and at home leads to fast social and psychological recovery, the child being able to return to even to school activities during treatment.

## CONCLUSION

External fixation has been shown to be a very efficient method and an important therapeutic alternative for treatment of femur shaft fractures in older children ( $\geq 6$  years) and adolescents. Despite the fact that external fixation is not free from complications, it has many advantages, such as a high rate of fracture consolidation and a low rate of refracture after initial treatment. In addition, it is a procedure easy to carry out.



**Graph I - Mechanisms of trauma**

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