



Treatment of refracture occurring after external fixation in paediatric femoral fractures

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With a mean follow-up of four years, we assessed the outcomes of 11 refractures which occurred following paediatric femoral fractures treated by external fixation; the refractures were treated conservatively with simple immobilisation in a spica cast.

A total number of 104 children with a femoral fracture were treated with external fixation between 1993 and 2000 in our institution. Refracture occurred in 11 cases after fixator removal. These patients were immediately placed in a hip spica cast. All 11 patients were boys, with a mean age of 7.3 years (range : 6 to 9), and the mean follow-up time was 4 years (range : 2 to 7). Mean hospitalisation time after refracture was 2 days (range : 0 to 4). Refractures occurred an average of 8 days (range : 1 to 21) after fixation removal. The mean time to union after refracture was 55 days (range : 35 to 62). On final evaluation, a mean limb length discrepancy of 0.9 cm (range : 0 to 2.5) was noted. Radiological study showed a mean lateral angulation of 5.6° (range : 0 to 17) and a mean anterior angulation of 7.4° (range : 0 to 20).

Based on these findings, we believe that closed reduction and spica cast immobilisation is sufficient in cases with refracture of the femur after external fixation, but the option of surgical treatment should be considered when satisfactory anatomic reduction is not achieved.

INTRODUCTION

In the treatment of paediatric femoral fractures, conservative methods such as traction followed by

casting, or early casting, are generally favoured (1, 2, 5, 6, 8, 12). However, in cases with multiple trauma, head trauma, or open fracture, operative techniques may be used (1, 2, 5, 6, 8, 12). These techniques include plate and screw osteosynthesis, intramedullary nailing, and external fixation (5, 6, 8). Some authors use external fixators to treat closed femoral fractures in order to mobilise the patient early, reduce the hospitalisation period, and facilitate patient care (1, 5, 6, 8). However, their popularity is limited because of refracture and pin tract infection. Refracture in particular is a major complication (1, 3, 5, 8, 11, 13). The reported incidence of refracture ranges from 0% to 20% and relationships between refractures and fracture type have been established (5, 6, 9, 11). There is, however, insufficient data concerning the continuation and outcomes of therapy after refracture, and there is no general agreement on the subject (2, 5, 11, 15).

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Table I. — Demographic data of the patients

| Patients | Age | Mechanism of injury | Side | Type of fracture | Time to refracture (days) | Angulations (degrees) | | Shortening (cm) |
|----------|-----|---------------------|------|------------------|---------------------------|-----------------------|-----------|-----------------|
| | | | | | | AP plane | Lat plane | |
| 1 | 8 | FH | L | Transverse | 5 | 12 | 0 | 1 |
| 2 | 7 | FH | L | Transverse | 4 | 4 | 0 | 0.6 |
| 3 | 6 | FH | L | Transverse | 1 | 0 | 3 | 0 |
| 4 | 7 | VA | R | Short oblique | 8 | 0.6 | 10 | 1.5 |
| 5 | 8 | FH | L | Transverse | 2 | 0 | 7 | 0 |
| 6 | 7 | VA | R | Transverse | 12 | 15 | 20 | 2.5 |
| 7 | 6 | VA | L | Transverse | 21 | 4 | 5 | 0.5 |
| 8 | 7 | FH | R | Short oblique | 6 | 17 | 8 | 2.5 |
| 9 | 9 | VA | L | Butterfly | 13 | 9 | 12 | 1.2 |
| 10 | 7 | FH | R | Comminuted | 7 | 0 | 9 | 0.7 |
| 11 | 8 | VA | R | Short oblique | 10 | 0 | 8 | 0 |

FH : Fall from height.

VA : Motor vehicle accident.

In the present study, the treatment outcomes of spica casting in patients with refracture after external fixation are assessed.

MATERIALS AND METHODS

A total number of 104 patients with femoral fractures were treated with external fixation between 1993 and 2000. Eleven patients who had presented a refracture were summoned for final examinations by telephone or by letter.

The mean patient age at the time of trauma was 7.3 years (range : 6 to 9). All were male. Fractures were caused by falls from a height in 6 cases and by motor vehicle accidents in 5 (table I). During initial treatment, fixators were applied with closed reduction in one case and open reduction in 10 cases (fig 1 a, b). Those initially treated with open reduction were patients with multiple trauma, or children who had sought treatment late, or whose treatment was neglected. Wire sites were examined in patients diagnosed with refracture, and those with no wound complications were immediately placed in spica casts. Those with wound complications were admitted to the hospital and their wounds were dressed. They subsequently underwent reduction and spica casting and were discharged. Further reduction was attempted in patients who had angulation ; in two patients, however, reduction was not completely successful, and angulation persisted. Surgery was not considered in these cases because of poor bone quality and

wound complications. After being discharged, patients were followed up with monthly examinations.

Follow-ups continued until patients had completely healed. On final examinations, hip, knee, and ankle movements were assessed. In addition, leg length discrepancy was determined by measurement of the distance between the anterior superior iliac spine and the medial malleolus. Angulations were assessed on radiography. All measurements and radiographic assessments were performed by the same investigator in order to minimise the margin of error. Results were assessed according to the scoring system shown in table II.

RESULTS

Patients were followed up for an average of 4 years (range : 2 to 7). Six of the fractures were on the left side and 5 were on the right. Mean hospitalisation period after refracture was 2 days (range : 0 to 4). Initial fracture type was transverse in 6 cases, oblique in 3 cases, butterfly in 1 case, and comminuted in 1 case (table I). All refractures occurred after fixator removal, in an average of 8 days (range : 1 to 21). Refracture occurred as a result of early fixator removal in another clinic in one patient who had undergone closed reduction, in 9 cases during daily activities, and in one case during sports activity. All were in the original fracture region. Angulation in the anterior-posterior



Fig. 1. — Male six-year-old patient with a diaphyseal fracture of the left femur.
a. Radiograph after motor vehicle accident. b. Radiograph after external fixation. c. Radiograph after refracture. d. AP view after treatment with spica cast. e. Lateral view after treatment with spine cast. f. Anterior posterior view at 6 years follow-up. g. Lateral view at 6 years follow-up.

Table II. — Results according to scoring system

| | Excellent results | Satisfactory results | Poor results |
|-----------------|-------------------|----------------------|---|
| Shortening | < 1.0 cm | < 2.0 cm | > 2.0 cm |
| Malalignment | 5 degrees | 10 degrees | > 10 degrees |
| Pain | None | None | Present |
| Complications | None | Minor and resolved | Major complication and/or lasting morbidity |
| Patient results | 4 | 5 | 2 |

and medio-lateral plane was determined on AP and lateral radiographs taken after refracture. Healing was observed in all fractures (fig 1). The mean time to union after refracture was 55 days (range : 35 to 62).

On final measurements, a mean length discrepancy of 0.9 cm (range : 0 to 2.5) was determined. Radiography showed a mean lateral angulation (valgus) of 5.6° (range : 0 to 17) in the AP plane, and a mean anterior angulation of 7.4° (range : 0 to 20) in the lateral plane (table I).

Hip, knee, and ankle movements were within normal range in all patients. Limping was present in one patient who had marked angulation on radiography and a leg length discrepancy of 2.5 cm. Nonunion did not occur in any of the patients.

Based on the scoring system indicated in table I, good or excellent outcomes were achieved in 9 cases, and the outcome was poor in 2 cases.

DISCUSSION

Paediatric femoral fractures are generally treated conservatively because, in comparison to fractures in adults, they heal rapidly, they exceptionally fail to unite, and they have a potential for remodeling (1, 5, 6, 7). Operative techniques are used only in cases with multiple injuries or head trauma, or if the fracture is comminuted (1, 11, 12). These techniques include intramedullary nails, plate and screw fixation, and external fixation. External fixators are also used to treat isolated closed paediatric femoral fractures, to achieve early mobilisation and shorten hospitalisation, although they are associated with complications such as infection and refrac-

ture. Their use is limited by these disadvantages. Infection rates of 8 to 12% have been reported in cases treated with external fixation (1, 2, 3, 4, 13). The most common are pin-tract infections, which may be treated in three ways : local dressing, drainage, or pin removal followed by antibiotic therapy (1, 2, 3, 5, 11, 13). No cases of deep infection or osteomyelitis are reported in the literature. Similarly, in the present study there was a 5% incidence of pin-tract infection, but no deep infection or osteomyelitis.

Refracture is a major complication, the incidence of which is increased by factors such as early fixator removal, open reduction or open fracture, and forced rehabilitation. Refracture rates as low as 0 to 1.8% are reported following external fixation after closed reduction, which do not significantly differ from those reported following conservative treatment (1, 6). The incidence after open fracture or open reduction is reported to be as high as 20% (11). Likewise, the incidence of refracture in the present study was 1.8% in cases treated with closed reduction, and 20% in cases treated with open reduction. Some authors have investigated the relationship between refracture and fracture type, and have found a higher incidence in transverse fractures (14). The present study supports this finding, with refracture in 6 cases of transverse fracture. In published studies, it is contended that the incidence may be reduced by dynamisation, waiting for sufficient callus tissue formation, and protective casting after fixator removal (6, 11). The actual problem is not refracture, but which treatment may be used once refracture has occurred, because the patients again undergo therapy, and morbidity is increased.

Review of the literature reveals not only that there is no clear consensus on the choice of treatment in cases of refracture, but also that different modalities may be used in the same clinic (1, 2, 11). Probe *et al* (13) have reported 2 cases of refracture treated successfully with intramedullary nails. In most studies, detailed information is not given on cases treated for refracture. Operative techniques may be used in these cases ; however, if internal fixation is to be used after external fixation in cases of early refractures, then a waiting period of at least 15 days is necessary to reduce the risk of infection (16). In addition, there are disadvantages such as the need for the patient to be anesthetised and undergo surgery a second time, and the need for still further surgery for removal of the implant material. Furthermore, rates of infection and nonunion of the primary fracture are higher with surgical treatment than with conservative methods. In view of these complications, closed reduction and hip spica casting were performed in all of our cases. The fact that complete healing was achieved in all of our cases suggests that conservative treatment is adequate in cases of refracture.

Overgrowth may occur after treatment in femoral fractures (10). In our cases, there was a mean shortening of 0.9 cm, which we think resulted from union with angulation. Therefore, in cases with unacceptable angulation, correction should be attempted again and, in case of failure, surgery should be considered.

In conclusion, we think that closed reduction and spica casting are sufficient in the treatment of cases of refracture after external fixation, but that operative techniques may be used when acceptable anatomic reduction is not achieved.

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