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ORIGINAL STUDY

Flexible intramedullary nailing versus external fixation of paediatric femoral fractures

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Treatment outcomes were compared in two groups of children with femoral diaphyseal fractures which were treated with external fixation (20 fractures) or flexible intramedullary nailing (20 fractures).

These 40 children were between 5.4 to 14.1 years of age. The duration of the operation averaged 52 minutes for the external fixator compared with 70 minutes for the flexible nail group. The time taken to gain full weight bearing, full range of movements and return to school was shorter in the flexible intramedullary nail group. There was a higher complication rate in the external fixator group than in the flexible nail group.

At final review, three patients in the external fixator group had pain, two had leg-length discrepancy of up to 1 cm, and four had malalignment of 5°-10°. In the nailing group, there were no leg-length discrepancies or malalignments.

We recommend the use of flexible intramedullary nailing for fractures of the femoral shaft in children which require surgery, and reserve external fixation for open or severely comminuted fractures.

Keywords : femoral diaphyseal fractures ; children ; external fixation ; flexible intramedullary nailing.

INTRODUCTION

Femoral fractures are among common injuries treated by an orthopaedic surgeon in the paediatric age group. These fractures typically occur either in early childhood when weak woven bone is changing to the stronger lamellar bone, or during adolescence when children are subject to high-energy trauma from motor vehicle accidents or from sports (*22*).

In children, fractures of the femoral shaft have been traditionally treated by immobilisation in a spica cast, either immediately or after a period in traction. The operative treatment was reserved for patients with open fractures, head injuries (*17*) or multiple injuries (*2-4*). There has been a growing trend to widen the indications for surgical treatment (*19*) as attention has been focused on the difficulty of caring for children in a body cast for 2-3 months (*5*). Besides, increasing health care costs have inspired all to consider the most efficient use of resources (*7*).

We have been using external fixation for femoral fractures in children who require surgery, but have

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Fig. 1. — Fracture of the left femoral diaphysis in a 10-year-old girl treated with an external fixator.

subsequently introduced flexible intramedullary nails for treatment of these fractures (*11-13*). We compared the outcome of these two methods.

MATERIALS AND METHODS

Over a period of three years and 8 months, 40 children were admitted to Victoria hospitals with a femoral shaft fracture. Children between 5 and 15 years were eligible for inclusion in this study. Patients with fracture of the femoral shaft from 3 cm distal to the lesser trochanter to 3cm proximal to the distal physis, or open fractures of Gustilo grade I and II, or comminution with less than 50% of the width in a butterfly fragment (Winquist I and II) were included (table I).

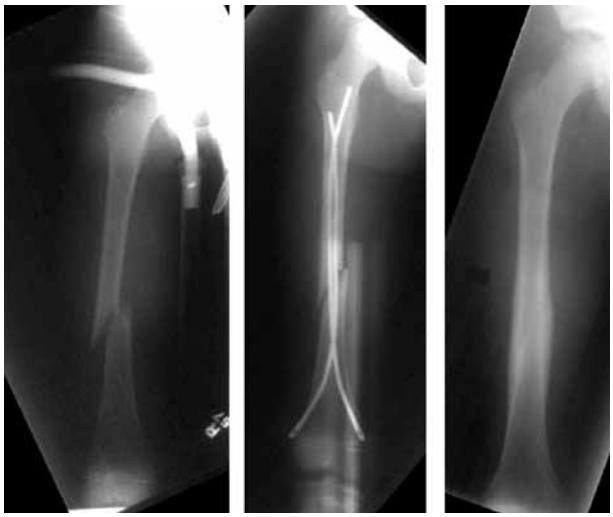

Fig. 2. — Fracture of the right femoral diaphysis in an 11-year-old boy, treated with retrograde flexible nails. The picture on the right shows the femur after fracture healing and removal of the nails.

From the 40 fractures, the first half was treated by external fixation and the last half with flexible intramedullary nails. We used a unilateral monotube system with 4 half pins in the external fixator group (AO External Fixator, Mathys Medical Ltd, Bettlach, Switzerland), stainless steel elastic nails in 12 (Ender Nail, Smith & Nephew, Hull, UK) and titanium elastic nails in 8 fractures (Métaizeau/Nancy Nail, Synthes, Welwyn Garden, UK) for flexible intramedullary nailing. Fixator pins were placed through a lateral transverse stab incision, using a manual drill. The points of entry for flexible intramedullary nails were according to the location of fractures. It was lateral and proximal for the proximal-third fractures, distal with lateral and medial entry points for mid or distal-third fractures. For any entry point, 2-3 cm incisions were used.

The operations were performed on a fracture table under fluoroscopic control. We recorded the patient details, mechanism of fracture, associated injuries

Table I. — Distribution of fractures according to location

Location	Oblique	Spiral	Transverse	Comminuted	Total
Proximal	0	2	1	1	4 (10.0%)
Midshaft	5	11	10	6	32 (80.0%)
Distal	2	1	1	0	4 (10.0%)
Total	7	14	12	7	40

Table II. — Associated injuries

Injuries	Numbers
Isolated	28
Closed Head Trauma	6
Chest Trauma	0
Closed Abdominal Trauma	1
Spinal Injuries	0
Pelvic Fractures	2
Other Extremity Fractures	3

Table III. — Comparison of Complications

Complications	External Fixator	Flexible Intramedullay Nailing
Infection	7	3
Superficial	6	3
Deep	1	0
Refracture	2	0
Neurology (Foot drop)	0	1
Post op loss of movement	6	0
Knee Joint	5	0
Hip Joint	1	0
Malalignment 5-10°	4	0
Recurvatum/Antecurvatum	1	0
Varus/Valgus	3	0
Limb length discrepancy at final review(up to 1cm)	2	0
Pain on fractured leg at final review	3	0
Avascular necrosis at final review	0	0
Patient satisfaction at final review	79%	100%

(table II), the location of fracture with its configuration and the time from injury to operation. Records were also made of the duration of surgery and fluoroscopy, the surgical technique and complications (table III). After the operation, a note was made of the period in hospital, the course of rehabilitation, fracture healing, removal of the device, the outcome and parental satisfaction.

RESULTS

The average age of the flexible nailing group was 9.2 years (range : 6.8 to 14.1) and of the external fixator group 8.2 years (range : 5.4 to 12.3). The most common cause of fractures (73.17%) was a road traffic accident : 14 patients in the external fixator group and 16 patients in the flexible nailing group were involved in accidents and the remainder either fell or acquired sports injuries. There were 4 open fractures, 2 Gustilo grade I and 2 Gustilo grade II ; 28 patients (68.29%) had isolated femoral shaft fractures and the remaining had associated injuries. If the associated injuries required surgical intervention, then two teams carried out the procedures at the same time.

The interval between injury and surgery was between 2 hours and ten days. The average duration of the operation for the external fixator was 52 minutes, with a mean 1.5 minutes of fluoroscopy. The average duration of the operation for the flexible intra-medullary nailing was 70 minutes with a mean fluoroscopy time of 2.4 minutes. One fracture had to be exposed to allow engagement of the distal fragment ; the remaining nailings were performed closed. One patient in the external fixator group had flexible nailing of the opposite tibia. Excluding the patients with multiple injuries, mobilisation to a chair took place in 1-3 days and walking between 3-7 days after surgery in both groups. The external fixator group was allowed partial to full weight-bearing but the flexible nailing group was either non-weight bearing or partial weight bearing, depending on the stability of the fracture. Children in the external fixator group left hospital after an average of 10 days compared with 6 days for the flexible nailing group. The external fixator group was able to full weight bear in an average of 8 weeks (range : 4 to 17) ; 28.6% of them had reduced movement of the knee until the fixator was removed but all regained normal knee movements in an average of 16 weeks (range : 7 to 32) and returned to school within 12 weeks (range : 3 to 12). External fixators were removed in the outpatient consultation at an average of 2.4 months. By comparison, children in the flexible nail group were able to full weight bear in an average of 7 weeks (range : 3 to 10), to carry out full movements in 9 weeks (range : 6 to 12) and they returned to school in an average of 5 weeks (range : 2 to 12). One patient had foot drop which recovered in six weeks. One nail which was inserted retrograde

from the lateral aspect of the femur migrated proximally and required early removal and a spica cast. Nails were removed at an average of 7.1 months as a day procedure under general anaesthesia.

At final review, parents of children in both groups were questioned regarding satisfaction about treatment : five parents in the external fixator group and one parent in the flexible nail group would choose non-surgical treatment if faced with the same decision again.

DISCUSSION

Fractures of the femur in children are generally managed nonoperatively. Hip spica produces excellent results between 0-4 years of age and continues to be the treatment of choice. Femoral shaft fractures in children aged 5-15 have traditionally been treated with several weeks of traction followed by spica casting (*1*).

Surgical treatment for these fractures used to be reserved for patients with head or multiple injuries or patients with severe soft tissue damage (*2, 20, 21*) but indications have widened to include some isolated fractures of the femoral shaft (*8, 9*). We treat all patients with multiple injuries and with open or severely comminuted fractures surgically.

The external fixator (*2, 6, 10, 17*) involves no soft tissue dissection, a short operating time, little scarring, good stability, early mobilisation and above all, surgeons already have considerable technical experience for the use of this device. Unfortunately, the external fixator may stress-shield the fracture leading to delayed union, minimal callus response and the risk of refractures after removal of the external fixator (*10*). In addition, a high infection rate has been reported at the site of the pins (*6*) and knee stiffness occurs in many children when the external fixator is in place but resolves in the majority of cases once the fixator has been removed.

Flexible intra-medullary nailing combines the advantages of external fixation without its complications (*12, 13*). It is difficult to have elasticity and stability in one construct (*16*). However, working from the concept of three point fixation used with a single Rush nail (*18*), surgeons are able to improve stability significantly by using two pre-tensioned nails inserted from opposite sides of the bone (*12, 13*). Rotational stability was also better than had previously been experienced, although this is to remain the weakest point of the technique (*15*). There are also risks of avascular necrosis in antegrade nailing, soft tissue infection at the insertion site and the necessity of general anaesthetic to remove the nails (*11, 14*).

Our study included the flexible intra-medullary nailing performed at our hospitals and compared the results with the external fixator group whose fixators were applied before nailing was introduced. Despite this, we still have limited experience with flexible intra-medullary nails even though we have significantly better results in the nail group than in the external fixator group. The longer surgical and fluoroscopy times for the nail group may reflect our learning curve ; our time for the last five flexible nails averaged 56 minutes, almost equal to the external fixator group.

The advantages shown in the nailing group were even greater for healing and rehabilitation, with abundant callus attributed to the non rigid fixation. The improved rehabilitation was due to earlier healing of the fracture, the lack of transfixation of the lateral muscles and less apprehension with no external fixation device. Early return to school and cost effectiveness also favour its use.

CONCLUSION

We recommend the use of flexible intramedullary nailing for most paediatric fractures of the femoral shaft between 5-15 years age which require surgery, as it is a safe procedure and produces reliable results. External fixation should be reserved for severely comminuted femoral fractures.

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