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Retrograde flexible intramedullary nailing in children's femoral fractures

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Abstract We treated 31 femoral shaft fractures in 28 children with a mean age of 6.7 (5–10) years with retrograde flexible intramedullary nailing. There were 16 isolated fractures, while 12 children had associated injuries. The average time for union was 10.5 weeks and there were no delayed unions. There was one broken nail requiring change of treatment, but no infection or refractures. At follow-up after a mean time lapse of 27 months there was no limb-length inequality exceeding 1 cm and no malunion. We feel that femoral fractures in patients aged 5–10 years can be safely treated with retrograde flexible intramedullary nailing with minimal risk of surgical complications.

Résumé Nous avons traité 31 fractures de la diaphyse fémorale chez 28 enfants avec un âge moyen de 6.7 (5–10) années par enclouage flexible centro-médullaire rétrograde. Il y avait 16 fractures isolées alors que 12 enfants avaient des lésions associées. Le temps moyen de consolidation était 10,5 semaines et il n'y a eu aucune retard de consolidation. Il y avait un clou cassé qui nécessita un changement de traitement, mais aucune infection ou fracture itérative. Au suivi moyen de 27 mois il n'y avait aucune inégalité de longueur qui dépasse 1 centimètre et aucun cal vicieux. Nous pensons que ces fractures fémorales dans la tranche d'âges de 5 à 10 ans peuvent être traitées par un enclouage flexible centro-médullaire rétrograde avec des risques minimes de complications chirurgicales.

Introduction

There is general agreement that femoral fractures in children up to 4 years of age must be treated conservatively [13] because of the rapid union and good remodeling potential. Additionally, in children over 10 years of age, a surgical approach is the generally accepted method of treatment because these patients have diminished growth potential and residual deformity may persist. However, there is no consensus on the treatment of choice in children between 5 and 10 years of age. Various authors [1, 12] believe that fractures of the femoral shaft in children do not always recover with conservative treatment when they are combined with multiple injuries. Even in isolated injuries several methods of surgical management are becoming well accepted with good results. The purpose of this paper is to evaluate the outcome of femoral shaft fractures treated by retrograde flexible intramedullary nailing.

Material and methods

We treated 31 femoral shaft fractures (including three bilateral fractures) with retrograde flexible intramedullary nailing between 1997 and 1999. Pathological fractures, supracondylar fractures, and fractures in patients with preexisting neuromuscular conditions were excluded. We recorded demographics, side and type of fracture, associated injuries, time to assisted and unassisted weight bearing, and complications. All procedures were performed on a radiolucent operating table. The standard technique is described as follows.

The fracture is partially reduced by manual traction guided by fluoroscopy. Prepared nails of stainless steel are 3.0 mm in diameter and 30 cm in length, with a blunt tip on the entry side. Nails are contoured with a long, C-shaped bend to facilitate insertion and positioning into the medullary canal. Small incisions are made in the skin and fascia over each side of the distal metaphysis, and the holes are made by a 4.0 mm drill bit at the level of 3 cm above the growth cartilage. Under fluoroscopic control the nail is pushed up the medullary canal and passes the fracture site up to the level of femoral neck. Two nails are used to stabilize the fracture. On the distal end of each nail a loop is made for easy removal and prevention of skin irritation, but no method of preventing them backing out is used (Fig. 1).

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Fig. 1a, b A 9-year-old boy had a proximal femoral fracture and the fracture was reduced with retrograde flexible intramedullary nailing. Union with some varus (6°) was gained at 11 weeks. Nail removal was done at 10 months (a). He had a minimal leg-length discrepancy and full range of motion in his knee (b)

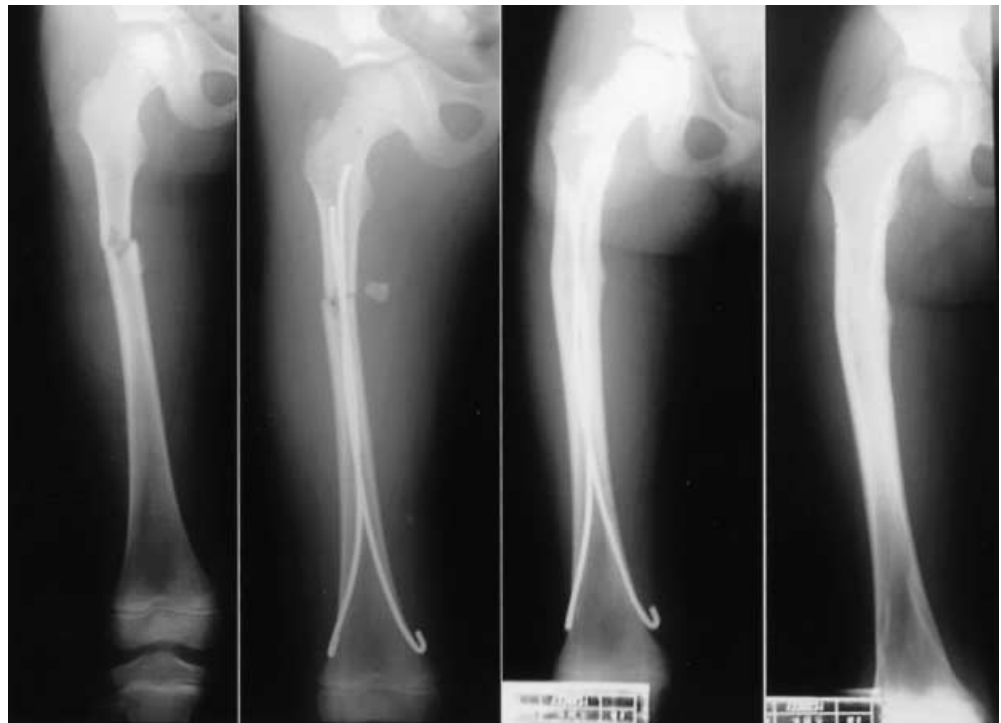


Table 1 Results of retrograde flexible intramedullary nailing

	Excellent	Satisfactory	Poor
Leg-length inequality	<1 cm: 31	<2 cm: –	>2 cm: –
Malalignment	<5°: 28	<10°: 3	>10°: –
Complications	None: 24	Minor, resolved: 3 ^a	Major, lasting: 1 ^b
Overall result	24	6	1

^a Skin irritation

^b Broken nail

After operation a long-leg splint is applied for about 2 weeks then mobilization is allowed. However, two children had spica casting as we were concerned about uncontrolled movements due to head injury.

Postoperative examinations included assessment of knee motion, limb-length inequality, and limb rotation and alignment. Radiographs were evaluated for alignment and change in nail position, and scanograms were performed in all patients except those with bilateral fractures. Cases were followed up to their clinical endpoint of fracture union and return to full activity.

Results

Ages at injury ranged from 5 to 10 (mean 6.7) years, and the average follow-up period was 27 (18–40) months. Associated injuries were present in 11 patients: three had head injuries, seven had other limb fractures (including three bilateral fractures), and one had a chest injury. The most common level was midshaft (22 cases); eight were proximal and one was distal. Twenty fractures were transverse, seven oblique, and two comminuted. Patients who sustained an isolated femoral fracture walked with a crutch by an average of 5.5 (4–8) weeks, and without assisted devices by an average of 9.7 (6–16) weeks. All fractures healed within 12 weeks (mean 10.5 weeks) without delayed union.

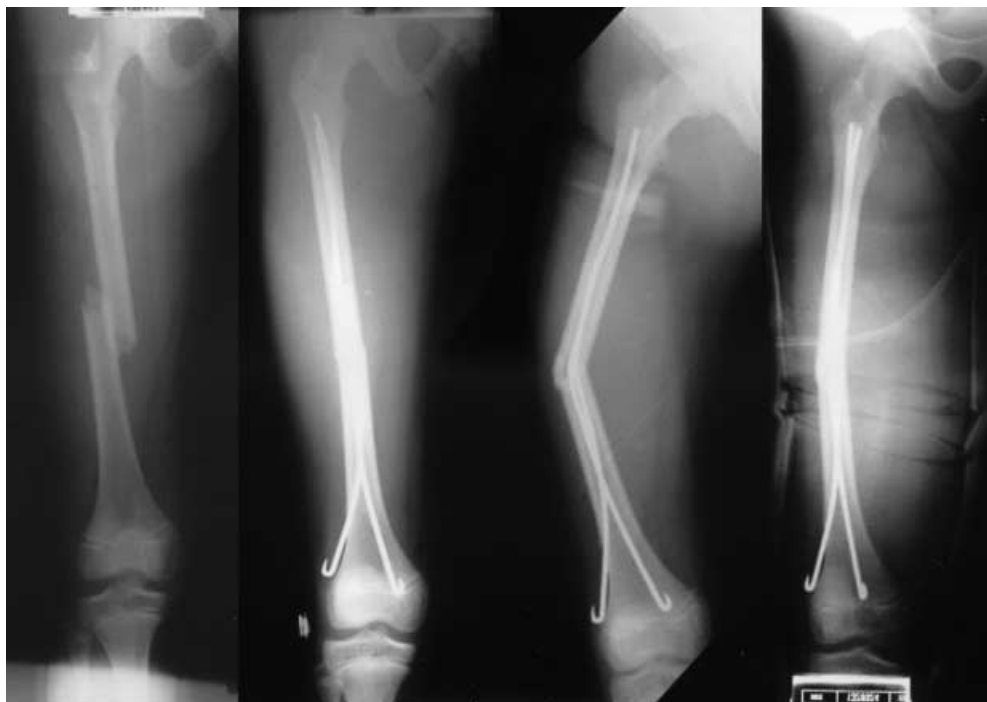
Three fractures healed with more than 5° of varus deformity, but an angular deformity over 10° or rotational malalignment was not seen at the final follow-up. Leg-length discrepancy averaged 1.1 mm in overgrowth (range: from 6 mm of shortening to 7 mm of lengthening). Only four patients had a moderate leg-length discrepancy of more than 5 mm; however, clinically significant leg-length discrepancy over 10 mm did not occur in any patient. Fracture patterns or ages had no influence on the result of leg-length discrepancy. None of the children had any abnormal gait, and all returned to previous levels of participation in sports and recreational activities.

Discomfort of the soft tissue near the knee because of the nail tip occurred in three cases without leading to infection. One patient had moderate loss of knee flexion at 6 months following operation, but it improved to the level of the uninjured side after nail removal.

In all cases nails were routinely removed when the fracture line was no longer visible – approximately 6–12 months after injury. No complications were associated with the nail removal procedure, and no refractures occurred.

According to the criteria of Flynn et al. [12], 24 cases had an excellent result and six had a satisfactory result

Fig. 2 Two flexible nails were used for stabilization of a mid-shaft fracture in a 7-year-old girl with cerebral contusion. Severe uncontrolled rigidity made the nails break with loss of reduction. A hip spica cast with correction of the angulation was applied for 8 weeks



(Table 1). There was one poor result: A 7-year-old girl with a cerebral contusion had a reduction loss with a broken nail due to uncontrolled rigidity after 1 week of nailing. Spica casting was added for 8 weeks (Fig. 2).

Discussion

Conservative treatment for femoral shaft fractures in children can increase hospitalization, rehabilitation time, incidence of fracture malunion, and even psychoses [7, 11, 15]. Therefore, there have been many surgical efforts to decrease these problems, including external fixation [1, 4, 9], antegrade locked nailing, and flexible intramedullary nailing [5, 10, 18], which are methods of minimal surgical dissection in contrast to plating. External fixation, mainly useful for open fractures and patients with polytrauma, has been shown to be effective for closed and isolated fractures [8, 16], but many authors have documented complications such as refracture, loss of fixation, and pin tract infection [20]. Solid antegrade intramedullary nailing has limited indications in children under 10 years of age because of the diameter of the femoral marrow and possible avascular necrosis of the femoral head [3, 20, 21].

A simple, load-sharing internal splint, either an Ender nail or a titanium elastic nail (TEN), is the ideal device to treat pediatric femur fractures. Flynn et al. [12] used TENs and reported excellent results with no significant complications in 58 children. Unfortunately, TENs are still not available in Korea. Stainless steel implants, such as Ender nails, are readily available and used in many centers. In agreement with other authors have reported [2, 14], we also had satisfactory results with flexible

stainless steel nailing. Even though titanium has better elasticity and biocompatibility than stainless steel, we think that the differences may be negligible in pediatric femoral fractures.

Ligier et al. [17] reported 10% of skin ulceration caused by the prominent extraosseous portion of the nail at the insertion site. To avoid this complication and to facilitate removal, we made a loop at the nail tip so we needed to leave only a small amount outside the distal cortex. Irritation of soft tissue was present in three of 31 cases but no cases of deep infection or osteomyelitis occurred.

While some authors recommend that nails be locked in the distal area to prevent nails from backing out [6], we performed no such procedure; there were no radiological signs or clinical cases of nails moving in the femur.

Many different types of immobilization have been described in several reports [12, 19], but we think that the stability of flexible nailing is relatively weaker than external fixation or rigid nailing, as our case of the broken nail. Therefore, long-leg splinting during the postoperative 2 weeks adds stability and limits pain.

Leg-length discrepancy was not a major problem, as in other reports [12, 17], and no patient in this series had more than 1 cm of inequality. However, longer follow-up is needed to determine the incidence of permanent leg-length discrepancy.

Although this series is small, we found retrograde flexible intramedullary nailing allowed rapid mobilization with few complications and satisfactory results in most cases. It may prove to be an ideal method to stabilize pediatric femur fractures, avoiding the prolonged immobilization of conservative treatments and reducing the complications of other surgical methods.

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