The role of the small AO external fixator in supracondylar rotational femoral osteotomies

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Torsional problems of the femur have been traditionally treated by a proximal osteotomy with internal fixation. We elected to perform femoral derotational osteotomies distally. Between September 1994 and April 2001, supracondylar osteotomies were performed on 38 femora in 21 children with torsional and angular deformities. The average age was 9 years (range 5–15 years). Twenty-three femora had excessive anteversion and fifteen, retroversion. All osteotomies were maintained by the small AO external fixator. Bony union occurred at an average of 10 weeks. Distal femoral osteotomy is an effective site for correcting rotational and associated angular deformities. The small AO external fixator provides precise adjustability, solid stability, and avoids a second procedure for hardware removal. *J Pediatr Orthop B* **14:194–197**
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Introduction

Severe persistent femoral anteversion or retroversion presents both a functional and cosmetic problem. Surgical intervention is indicated in patients with severe anteversion without compensatory external tibial torsion that has not corrected by the age of 8 years [1]. Earlier intervention is warranted when the deformity interferes with normal gait. Correction is traditionally performed in the proximal femur using internal fixation to maintain the osteotomy [2]. This method requires significant exposure. A second procedure is subsequently needed for hardware removal.

We elected to perform corrective osteotomies of the femur distally. This location also permits concurrent correction of angular deformities, such as genu valgum.

Based on our experience with the small AO external fixator in other locations [3–7], this device would allow us to maintain an osteotomy with a rigid construct that is both precisely adjustable and light in weight. The exposure for the osteotomy is limited. In addition, the fixator and pins could be removed in the office setting, avoiding a second surgery. We therefore selected the small AO external fixator to maintain osteotomies in the distal femur.

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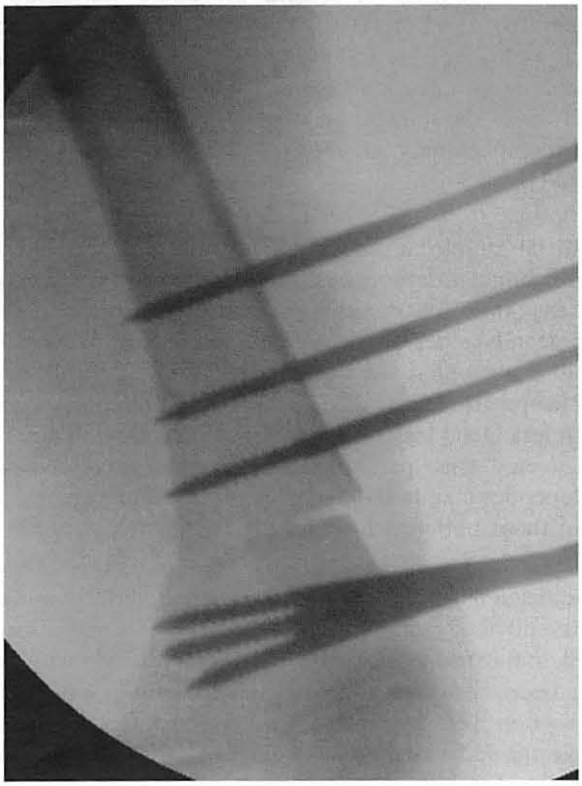
Methods

Between September 1994 and April 2001, 21 children presented at our institution with torsional deformities in 38 femora. Twelve children in this group also presented with angular malalignment in 23 femora. The average age was 9 years (range 5–15 years). There were nine boys and 12 girls. Sixteen patients had idiopathic torsional problems, one child had lumbosacral agenesis, one spina bifida, one spastic hemiplegia, one Roberts syndrome, and one 47, XXY karyotype. All patients were ambulatory and presented with gait difficulties, limiting activities. None of these patients had ipsilateral hip dysplasia.

We measured lower limb rotational and angular deformities. The patient was examined in the supine position. Internal and external rotations of the feet and patellae were recorded to obtain both total foot and total femoral rotations. Angular deformities and flexion contractures of the knees were also measured. Tibial torsion was assessed by examining the intermalleolar angle with the patient sitting with the knees flexed at 90°. Knee range of motion was also recorded preoperatively. Gait was assessed clinically for functional efficiency.

Twenty-three femora demonstrated excessive anteversion and 15 demonstrated significant retroversion. The femora that were excessively anteverted had an average of 50° more internal than external rotation of the patellae. The retroverted group averaged 50° more external rotation than internal rotation. None of these patients had compensatory tibial torsion. In addition, 18 femora were associated with genu valgum, and five with fixed knee

Fig. 1



Radiograph demonstrating the supracondylar osteotomy maintained by the small AO external fixator.

Fig. 2

The small AO external fixator is used to hold a supracondylar femoral osteotomy.

flexion contractures. In each case, gait was directly affected by torsional malalignment of the femur.

After informed consent was obtained, supracondylar femoral osteotomy was performed. The patient was positioned supine with both lower extremities draped free with the anterior superior iliac spine exposed. Three 4.0 mm end-threaded Schanz pins were placed laterally, 1 cm above and parallel to the distal growth plate. Three similar pins were inserted more proximally in line with the femoral shaft. A sterile tourniquet placed around the upper thigh was inflated for the osteotomy only. A transverse osteotomy was performed through a limited lateral approach, close to the distal pins. Derotation of the femur was followed by angular correction, when required (Fig. 1). Each pin was linked to all others by clamps and carbon fiber rods (Fig. 2). Construct stability was achieved by three pin clusters proximally and distally, a minimum of three rods crossing the osteotomy site, and by interconnecting all pins within a cluster. Before final tightening of the cross-clamps, rotational correction was checked by examining the total foot and total femur rotations of the extremity and comparing them with the contralateral limb. Angular correction was checked and mechanical axis alignment was assessed from the center of the femoral head to the center of the ankle.

Postoperatively, pin sites were cleaned twice daily with a 50/50 solution of normal saline/hydrogen peroxide applied by a spray bottle. The pin sites were not manipulated. After 1 week, daily showering substituted for one daily pin care session. This protocol was taught to the patient's family before discharge. Half dose cephalosporin (cephalexin, 25 mg/kg, divided three times daily) was given orally while the pins were *in situ*. Physical therapy was started immediately. This protocol consisted of continuous passive motion of the knee, progressing to active knee motion, and quadriceps and hamstring strengthening. The patient was initially kept non-weightbearing.

Postoperative radiographs were taken in the office. Dynamization of the construct was performed when early callus was seen radiographically, usually at 4 weeks. This consisted of removal of one pin from each cluster and at least one carbon rod crossing the osteotomy site. Full weightbearing was then commenced.

Results

Supracondylar femoral osteotomies were performed on 38 femora. There were no intraoperative complications. Following derotation, the difference in internal and external femoral rotation was less than 10° in both the anteverted and retroverted groups. In this series, 18 femora also underwent correction into varus and five underwent correction into extension.

All osteotomies were correctly aligned postoperatively, except for one, which required remanipulation of the external fixator. This girl underwent a combined external rotation and varus correction for femoral anteversion and knee valgus. At 3 weeks following surgery, it was felt that the angular correction was inadequate. Under sedation, the osteotomy site was manipulated. The correction was subsequently maintained.

Postoperatively, four children had pin tract infections. Three were treated as outpatients with full strength oral antibiotics. One child presented with a significant pin tract infection 30 days after his surgery. He was admitted for a 3-day course of intravenous cephazolin. The infected pin was removed at the bedside. Bony healing and correction was not affected by any of these infections.

The external fixator was well-tolerated by all patients. With the pins *in situ*, knee flexion was limited to 100°, presumably due to tethering of the iliotibial band. All osteotomies healed uneventfully. The fixator was removed at an average of 10 weeks. Within 6 months of removal, all patients regained their preoperative arc of motion. No residual quadriceps or iliotibial band tethering was noted. None of the patients exhibited patello-femoral maltracking or anterior knee pain at an average follow-up of 5 years (range 3–9 years). Correction was maintained in all patients following fixator removal. All walked with their feet ahead. No postoperative femur fractures occurred. At final follow-up, relapse did not occur in any patient. No growth disturbances were seen in the distal femoral physis. One child underwent elective scar revision at the pin sites. All other patients found their scars acceptable.

Discussion

Femoral anteversion in the infant averages 39°. Although it is claimed to correct by 16 years of age to between 16° and 21° [8], Staheli [1] recommends surgical derotation by 8 years of age in children with severe anteversion. In selected cases, when function is compromised, earlier intervention is warranted. Retroversion usually does not spontaneously correct [8], and should be considered for surgery if the deformity is significant and affects gait.

Torsional problems of the femur are typically assessed by the rotational arcs of the tibiae with the child in the prone position [8]. We chose to assess rotations with the child in the supine position [9] because it is easily reproduced in the operating room setting.

Femoral derotation has been typically performed by an osteotomy at the intertrochanteric level. Fixation can be achieved with an internal fixation device [10] or with Steinmann pins incorporated into a hip spica cast [1]. Varus correction for hip dysplasia can also be performed at the time of surgery. A significant exposure of the proximal femur is required. A second procedure for hardware removal is recommended when internal fixation devices such as hip screws and blade plates are used. Furthermore, deep infection, femoral fracture, and avascular necrosis of the femoral head are potential well-documented complications of internal fixation in this region [10,11].

A distal supracondylar osteotomy offers several advantages. Angular deformities of the knee can be addressed at the time of derotation. Cancellous bone in the supracondylar region is particularly broad and allows for rapid bony union. According to Pirpiris and colleagues [12], operating in this region is faster and is associated with less blood loss than a proximal procedure. They also discovered that patients with cerebral palsy achieved independent ambulation faster after distal osteotomies than those performed proximally [12].

The distal osteotomy can be maintained with Steinmann pins and cast immobilization [13,14], internal fixation [12], and external fixation [15]. Immobilization with pins has been criticized for potential loosening and loss of correction [2]. Internal fixation requires a significant exposure and has no adjustability. As with the proximal devices, distal internal fixation usually requires hardware removal.

The small AO external fixator is an attractive alternative. The procedure is performed through a small incision. Pin placement is percutaneous. Fixation with 4.0 mm rods and pins has been demonstrated by this series to be sufficiently stable to prevent loss of correction. A major advantage of this technique is that it does not require parallel pin placement, as is needed by other external fixators [15]. The osteotomy may be manipulated and precisely changed by adjustments to the external fixator. Once bony union has occurred, removal of pins may be done in the office setting, without a second surgery.

Pin tract infections can be minimized with proper pin care. The incidence of pin tract infections in external fixators in pediatric femoral shaft fractures may be as high as 72% [16]. Most cases are mild and respond to antibiotics [16]. We report a 10% incidence of pin tract infections, with only one case requiring early pin removal.

Osteotomy at the distal femur has the advantage of correcting both torsional and angular deformities. The small AO external fixator provides precise control of the osteotomy and allows for subsequent adjustability. The exposure required is limited. This method effectively controls supracondylar osteotomies and avoids a second procedure for hardware removal.

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