

Hip Arthrodesis in Adolescents Using External Fixation

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Summary: Between 1994 and 1998, seven adolescents underwent hip arthrodesis with the use of an external fixator. Mean time of follow-up was 24.0 months after surgery. The duration of fixation and time to fusion were 6.6 months (range, 5–9.5 months) and 8.0 months (range, 5.2–15 months), respectively. At most recent follow-up, there was a significant improvement in the mean modified Harris hip score, in which the maximum score is 91 points after omitting 9 points for hip range of motion and deformity, from 25.7 before surgery to 66.7 after

surgery ($p < 0.01$). The advantages of this procedure include (i) the ease and accuracy of obtaining the proper position for fusion, (ii) the ability to lengthen the affected leg at the same time, (iii) the diminished likelihood of compromising future hip operations, and (iv) the ability to ambulate and bear weight throughout the treatment course. We recommend this method of hip arthrodesis with external fixation for patients with intractable hip pain necessitating this procedure. **Key Words:** Arthrodesis—External fixation—Fusion—Hip.

Painful conditions of the hip in children and adolescents present a challenging problem for the orthopaedic surgeon. Depending on the etiology, there are a variety of nonsurgical and surgical options to help minimize pain and improve function. However, when disorders of the hip result in severely disabling arthritis, the options become limited. For adults, total hip replacement is a successful operation resulting in excellent pain relief, but this is not a viable option for most children and adolescents because of the finite life span of joint replacements. Consequently, hip arthrodesis remains the best surgical option for this patient population (1,2,4,6,8).

Various methods of hip arthrodesis have been described with good results. In 1980, Price and Lovell reported their results using the Thompson arthrodesis which involves intraarticular and extraarticular arthrodesis with an intertrochanteric osteotomy (6). Subsequently, Mowery et al. described a modification of this procedure in which an intraarticular arthrodesis was performed using large cancellous screws along with a subtrochanteric osteotomy (5). Both of these techniques have yielded good intermediate-term results with excellent pain relief and function. There are, however, several

disadvantages to these methods, including the necessity of maintaining the patient in a spica cast to hold the position of the hip and the deformity created in the proximal femur, which poses a potential problem for future arthroplasty.

Schneider, in 1974, described the technique of hip fusion in adults using the cobra-head plate (7). Klemme et al. reported good results with this technique in children, despite pseudarthrosis in 36% of their patients (4). However, this technique is complicated by the necessity of compromising the abductor mechanism, which may interfere with the success of future hip arthroplasty. In addition, when fusing with a plate there is no option to make postoperative modifications in the position of the hip without additional surgery. This pitfall is important to recognize because it is often difficult to determine the position of the extremity with the patient supine on the operating table. Despite this technical challenge, placing the hip in a functional position for fusion, approximately 25° of flexion with neutral abduction and rotation, is crucial for a successful outcome.

To overcome some of the shortcomings of these other arthrodesis techniques, we have used an external fixator to effect the fusion. This device enables us to position the hip in the desired position, apply compression across the joint to assist in fusion, lengthen the femur if needed, and allow weight bearing during the entire postoperative period. The purpose of this article is to describe the technique of hip arthrodesis using an external fixator and to report our short-term results.

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METHODS

The clinical charts of seven adolescents who underwent unilateral hip arthrodesis between 1995 and 1998 were retrospectively reviewed. All procedures were performed at the Hospital for Joint Diseases Orthopaedic Institute by one of the authors. Data were obtained retrospectively by chart review as well as follow-up interviews, follow-up clinical examinations, and serial radiographs. Measurements, including the position of arthrodesis (i.e., flexion, rotation, and adduction) and true leg length discrepancies, were made clinically. A modified Harris hip score was obtained for the preoperative conditions and at most recent follow-up using the method described by Benaroch et al. (2,3). A 91-point scale was used, omitting 9 points for hip range of motion and deformity.

Operative technique

Patients were placed supine with a bolster under the affected hip on a radiolucent table. A Smith-Petersen approach was used to expose the hip joint. The hip was dislocated and the femoral head and acetabulum denuded of cartilage. Cancellous iliac crest bone graft was packed around the fusion site. In some patients, a portion of the anterior superior iliac spine with attached sartorius was also placed into the proximal femur at the fusion site and secured with a screw to add a vascular graft. An EBI external fixator (EBI Medical Systems, Parsippang, NJ) was then applied, placing three self-tapping cortical 6.0-mm pins perpendicular to the mechanical axis of the femur and three supraacetabular self-tapping cortical 6.0-mm pins perpendicular to the femur in a transverse fashion (Fig. 1A-B). The proximal pins were placed through the inner and outer tables of the ilium. A standard EBI fixator frame was then attached with a transverse clamp placed proximally and a longitudinal rail distally. In two patients, two additional transiliac cortical pins were placed and connected to the proximal transverse clamp with rods to triangulate the construct. While holding the hip in the desired position of 25° of flexion and neutral abduction/adduction, the fixator was tightened. The pa-

tient was then placed supine and final modifications of the fixator were made as necessary. Then, in the early postoperative period, standardized standing lower extremity films were obtained and additional adjustments of the fixator were made if the position was found to be incorrect.

After surgery, patients were allowed to bear weight as tolerated immediately. Routine pin care was performed. The fixator was left in place with a bridging bar across the joint until there was radiographic evidence of fusion. As necessary, adjustments were made on the external fixator in routine office visits to produce the desired position of fusion.

RESULTS

The results are summarized in Table 1. Clinical follow-up ranged from 21 to 59 months, with a mean follow-up of 34.6 months. The ages of the patients ranged from 10 to 16 years, with a mean age of 11.2 years. Mean duration of external fixation and mean time to fusion were 6.6 ± 1.4 months and 8.0 ± 3.4 months, respectively, with all patients achieving solid bony fusion by radiographic evaluation (Fig. 1C). Only patient no. 4 experienced delayed union. Although there was no motion at the fusion site, percutaneous pin fixation was performed at 7 months after removal of the fixator. This patient had radiographic evidence of fusion at 15 months. One patient (patient no. 3) underwent an ipsilateral femoral lengthening procedure at the time of the initial procedure and subsequently experienced uncomplicated bony fusion at approximately 7 months (Figs. 2A-B). The mean position of hip fusion was 25.7° flexion, 0° abduction, and 1° external rotation. Four patients underwent adjustments of the fixator in the first several days after surgery to refine the position of fusion. All adjustments were made in the office and without the need for general anesthesia.

A modified Harris hip score was used that evaluated pain and function but excluded deformity and range of motion. Thus, the maximum possible hip score was 91,

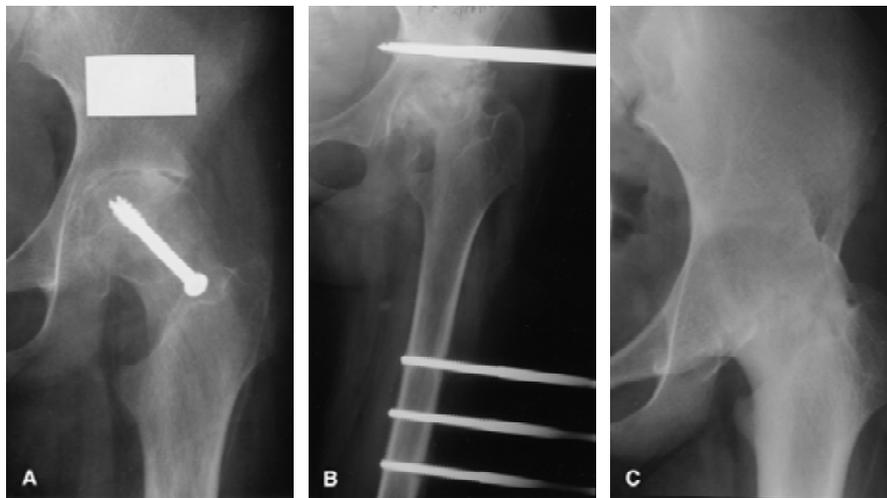


FIG. 1. **A:** Preoperative anteroposterior radiograph of a patient's left hip demonstrating severe chondrolysis. **B:** Anteroposterior radiograph of the same patient's left hip demonstrating placement of self-tapping 6.0-mm cortical pins for application of the external fixator. **C:** Postoperative anteroposterior radiograph of the same patient's left hip at 5 months demonstrating evidence of bony fusion.

TABLE 1. Results of hip arthrodesis

Patient no.	Diagnosis	Duration fixation (mos)	Time to fusion (mos)	Preop Harris score	Postop Harris score	Position fusion (degrees flexion)	Leg-length discrep (cm)	Clinical follow-up (mos)	Complication
1	Chondrolysis (s/p SCFE pin)	7	7	10	71	25	2.1	23	
2	AVN (Idiopathic)	6	6	22	68	30	2.5	17	Knee pain
3	AVN (s/p fracture/dislocation)	7	7	31	66	25	3.5	11	Pin tract infection knee pain
4	AVN (untreated SCFE)	5	15	13	69	40	2.5	46	Delayed union
5	AVN (Idiopathic)	6	6	47	58	0	2.0	12	
6	Post-traumatic osteoarthritis	6	5.2	32	67	30	3.5	48	Back pain
7	AVN (DDH)	9.5	9.5	25	68	30	5	11	
Mean		6.6	8.0	25.7	66.7	25.7	3.0	24.0	
SD		1.4	3.4	12.5	4.2	12.4	1.1	16.3	

AVN, avascular necrosis; DDH, developmental dysplasia of the hip; SCFE, slipped capital femoral epiphysis; SD, standard deviation.

not 100 points. The mean preoperative Harris hip score was 25.7 ± 12.5 , with all patients reporting disabling pain. All patients reported marked dysfunction, including inability to ambulate without a cane or crutches and inability to use stairs. The mean postoperative Harris hip score was 66.7 ± 4.2 . This was a significant difference from the preoperative score ($p < 0.01$). All patients experienced significant relief of pain and restoration of function. Six of seven patients reported no hip or groin pain after the procedure. One patient reported occasional pain with no compromise in activities. Moreover, all patients were also able to ambulate without the use of a cane or crutch and were able to use stairs.

At the time of the most recent clinical evaluation, the average limb length discrepancy was 3.0 ± 1.1 cm. Two

patients required additional procedures to correct the leg length discrepancy. Patient no. 2 underwent a contralateral distal femoral epiphysiodesis. Patient no. 4 underwent a contralateral femoral shortening to correct a leg length discrepancy. Patient no. 3 underwent an ipsilateral femoral lengthening concurrent with the arthrodesis.

Two patients complained of mild ipsilateral knee pain, whereas one patient reported mild back pain. One patient contracted a superficial pin tract infection around one of the transiliac pins, requiring removal of the pins and oral antibiotics. This infection resolved completely without any untoward consequences.

DISCUSSION

Our short-term results suggest that arthrodesis of the hip using an external fixator reliably results in successful fusion. Six of seven patients were fused in a functional position with excellent pain relief from their hip disease and a significant improvement in their hip score.

In addition, they were able to remain ambulatory throughout the course of their treatment, despite its somewhat long duration. With regard to the position of hip fusion, we found that the external fixator produced acceptable results. However, one patient was fused in approximately 10° more flexion than is deemed normal.

Another significant advantage of this procedure is the ability to modify the position of fusion after surgery if it is noted to be unsuitable. The adjustments are simple and can be made easily in the office without the need for anesthesia or sedation. Because of lumbar lordosis, pelvic mobility, and difficulty in accurately determining the position of the opposite hip during the operative procedure, assessing the proper flexion and abduction/adduction during surgery can be challenging. Benaroch et al. have reported that one advantage of their described method of fusion, which includes subtrochanteric osteotomy and spica casting, is that the spica cast can be wedged up to 4 weeks after surgery to alter the position of the limb (2).

Unlike the arthrodesis using cobra-head plate fixation, as described by Klemme et al., this procedure has a lesser

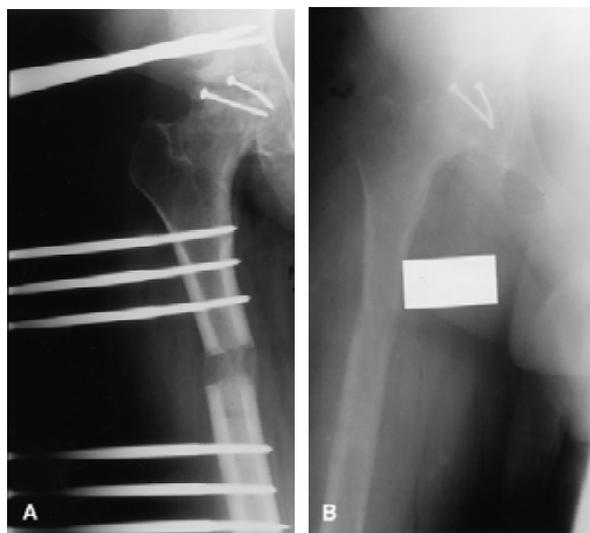


FIG. 2. **A:** Anteroposterior radiograph of a patient's right hip demonstrating an ipsilateral femoral lengthening procedure accompanying the placement of the external fixator. In this patient, a portion of the anterior superior iliac spine with attached sartorius also was placed at the fusion site and secured with a screw to add a vascular graft. **B:** Anteroposterior radiograph of the same patient's right hip demonstrating uncomplicated bony fusion at approximately 7 months.

chance of complicating future total hip replacement (4). Their method involves stripping of the abductor musculature, detachment followed by reattachment of the greater trochanter, and implantation of a plate spanning from the ilium to the subtrochanteric femur. Arthrodesis with the external fixator results in minimal retained hardware around the hip, if any is used at all. There is no need to remove any internal fixation at the end of treatment or at the time of an eventual total hip arthroplasty. Furthermore, the abductor musculature is left untouched and there is no deformity of the proximal femur, both of which may prove advantageous at the time of a total hip arthroplasty.

There are four notable shortcomings of this procedure that deserve mention. First is the duration of fixation and the time to fusion, 6.6 and 8.0 months, respectively. The prospect of wearing this cumbersome apparatus for over 6 months is not appealing to some patients. Second is the potential risk for pin tract infections. Only one of our seven patients in this series had this complication, which was subsequently treated with a short course of oral antibiotics. It is our experience that this complication not only can be easily managed with oral or intravenous antibiotics, but can be avoided with meticulous pin tract care and regular follow-up. We do not believe a pin tract infection would jeopardize a future total hip replacement if treated early and aggressively. Third is the possibility of a late femur fracture resulting from the stress riser created from the removal of the femoral shaft pins. Although this is a potential risk, we have not experienced such a complication in our series, which includes at least three obese adolescents. Fourth is that the use of the external fixator demands close attention to hip position during frequent postoperative visits to perform adjustments of the fixator. One patient drifted into a position of 40° of hip flexion when she did not return for her follow-up. Another patient's final position of fusion was 0°, which we believe to be suboptimal.

The results of our study are comparable with those previously reported on different methods of hip arthrodesis in children. Price and Lovell found excellent results in 14 children who were all pain free and had returned to normal activities at a mean of 4.5 years (6). Klemme et al. reported solid fusions in 7 of 11 adolescents at a mean interval of 7.4 months, but noted that all patients who failed to fuse were beyond the 90th percentile for their weight (4). Of those patients who did achieve fusion, one

reported requiring the use of an ambulatory aid. A similar procedure has recently been described using a modular fixator, with solid fusions obtained in the three cases reported (9).

Intermediate follow-up of hip fusions in adolescents by Benaroch et al. reveals that more than half of the patients in their series have back and knee pain (2). They also noted a progressive drift into adduction averaging 7°. They were able to correlate certain factors with a positive outcome, including hip position in 20° of flexion and 0° of abduction, as well as maintaining limb length discrepancy at less than 2 cm. Although we had less back and knee pain and no notable change in the position of fusion, perhaps a longer follow-up will yield different results.

We recommend external fixation for hip arthrodesis in those adolescents with intractable hip pain necessitating this procedure. Using this method, we have been able reliably to accomplish fusion in the desired position with a tolerable postoperative period for the patient without the use of either spica casting or internal fixation, and with preservation of the periosteum and soft tissues, in particular the abductor musculature. There are certain risks and disadvantages associated with external fixation; however, in the appropriate patients (8), we believe the external fixator offers distinct advantages.

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