

# Hinged Distraction of the Adolescent Arthritic Hip

Mihir M. Thacker, MD, David S. Feldman, MD, Sanjeev S. Madan, MD,  
Joseph J. Straight, MD, and David M. Scher, MD

**Abstract:** From 1996 to 2000, 11 adolescents with hip joint arthritis secondary to osteonecrosis or idiopathic chondrolysis were treated with articulated hinged distraction arthroplasty. Indications for surgery were severe pain and limited ambulation. Charts and radiographs were reviewed. Clinical status was assessed preoperatively and at latest follow-up (mean 4.8 years after surgery) using criteria of pain, range of motion, and ambulation level. Ten patients showed improved clinical status, with seven having an excellent outcome and three a good outcome. One patient failed distraction. Mean joint space was 2.6 mm before surgery and 4.8 mm at latest follow-up. Average duration of fixator use was 4.4 months. Four patients (36.4%) had complications. Articulated hip distraction was effective in eliminating pain, improving function, and preventing progressive degenerative changes in young patients' hips. It should be considered a salvage procedure for arthritic hips and an alternative to arthrodesis in this difficult-to-treat group of patients.

**Key Words:** arthrodiastasis, distraction arthroplasty, osteonecrosis, chondrolysis, hip

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A painful, stiff arthritic hip in an adolescent is a difficult therapeutic problem. Secondary arthritis due to osteonecrosis or idiopathic chondrolysis (IC) occurs at an early age. Total hip arthroplasty is an excellent treatment option in older patients with arthritic hips, but its use in the young population is associated with significant problems, including polyethylene wear, loosening, and the need for multiple revisions.<sup>24,27,33</sup> Hip fusion in these patients provides reliable pain relief<sup>4,22,25</sup> but at the cost of loss of motion and deleterious long-term consequences on surrounding joints.<sup>2,4,13,15,25,32</sup> Retaining the native hip joint with preservation of motion using various techniques has yielded mixed results.<sup>3,7,8,12,17,19,21,23,26,34</sup> Animal studies have shown the value of distraction and motion on the repair of articular cartilage.<sup>14,20</sup> This concept has been successfully used in the elbow and knee in human subjects.<sup>6,31</sup>

Articulated distraction arthroplasty unloads the joint and permits joint motion, which improves cartilage nourishment

and promotes repair. This has been observed both microscopically and macroscopically. Preservation of the joint and range of motion using an articulated hinged distractor, as an alternative to fusion, is a promising technique. The purpose of this study was to examine the effectiveness of the use of a hinged external fixator (EBI Inc, Parsippany, NJ) in alleviating the symptoms of secondary arthritis from osteonecrosis or IC in adolescent patients.

## MATERIALS AND METHODS

This was an IRB-approved, retrospective chart and radiographic review. Demographic details, etiologic diagnoses, and the duration of fixator use were recorded. Each patient's clinical status was assessed before and after surgery at the latest follow-up using criteria for pain, range of motion (ROM), and level of ambulation.

Pain was rated as 0 if the patient had no pain; 1 if pain occurred after exercise; and 2 if pain was constant. For ROM, 0 indicated that the patient had flexion to at least 80 degrees with 20 degrees of adduction-abduction and internal and external rotation; 1 indicated 40 to 80 degrees of flexion; and 2 indicated less than 40 degrees of flexion. Level of ambulation was scored as 0 if the patient was able to walk without an assistive device for more than 10 city blocks (a half-mile); 1 if able to walk without an assistive device for less than 10 city blocks; and 2 if able to walk with an assistive device and/or limited to walking at home or school. A score of 0 on all three criteria indicated an excellent result; a score of 1 or 2 on any of the three criteria indicated a good or poor result, respectively. Using radiographs, joint space was measured and containment was assessed before surgery and at latest follow-up.

## Operative Technique

The patient was placed on a radiolucent table. Under general anesthesia, using fluoroscopic guidance, the center of rotation of the hip joint was identified. A guide pin was placed through the skin such that its tip was over the center of the femoral head, both in the AP and lateral views. The hinge of the distractor was placed 1 inch away from the skin lateral to this point. Three pins were inserted in the supra-acetabular region and three pins were inserted in the femoral diaphysis with the hip held in as much abduction needed to seat the hip. The femoral and the supra-acetabular pins were placed parallel to each other and then connected to the articulated distractor. Additional pins, usually two, were inserted between the inner and outer tables of the iliac wing and connected to the supra-acetabular pins. The guide pin was removed and the range of motion of the hip was checked intraoperatively. The hip was then distracted using the proximal end of the distractor. If

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From Pediatric Orthopaedic Surgery, Center for Children, NYU Hospital for Joint Diseases, New York, New York.

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Reprints: David S. Feldman, MD, Chief, Pediatric Orthopaedic Surgery, Center for Children, NYU Hospital for Joint Diseases, 301 E. 17th Street, New York, NY 10003 (e-mail: david.feldman@med.nyu.edu).

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required, the hip was medialized. The hip was put through a range of motion to ensure that there was free movement at the hip joint.

Postoperatively the patients were placed on CPM and started on a vigorous ROM protocol. The duration of distractor use was estimated to be 3 to 4 months in patients with IC and 4 to 6 months in patients with osteonecrosis.

### RESULTS

From 1996 to 2000, 11 patients (8 boys, 3 girls) presenting with limited ambulation and significant hip pain and stiffness secondary to osteonecrosis or IC were treated with distraction arthroplasty using a hinged external fixator. The mean age was 13.9 years (range 9–17 years).

Four patients had idiopathic osteonecrosis with secondary collapse, two had osteonecrosis secondary to sickle cell disease, one had lupus and another had multiple epiphyseal dysplasia. These eight patients had grade IV osteonecrosis as per the classification of Ficat and Arlet.<sup>9–11</sup> Three patients had IC with secondary arthritis and joint spaces of 2 mm or less.

All patients had constant pain despite nonoperative treatment, consisting of activity modification, physical therapy, and use of nonsteroidal anti-inflammatory drugs. Three patients had surgical procedures performed prior to application of the distractor. One had hip flexor and adductor releases, one had a trapdoor procedure with elevation of the depressed portion of the femoral head and iliac crest bone grafting, and one with Perthes disease (idiopathic osteonecrosis) had an innominate osteotomy and a femoral varus derotation osteotomy.

The various diagnoses, preoperative clinical status, and latest follow-up clinical status at an average of 4.8 years (range 2–6.1 years) after surgery are shown in Table 1. A case of articulated hinged distraction of the hip in a 14-year-old boy with severe hip pain secondary to osteonecrosis is depicted in Figure 1.

Preoperatively, all patients had constant pain; eight had 40 to 80 degrees of flexion, while three had less than 40 degrees of motion; and eight walked without an assistive device for less than 10 city blocks, while three were dependent on an assistive device and/or were limited to walking at home or school. At latest follow-up, eight (73%) had no pain, while three had pain after exercise; all patients had at least 80 degrees of flexion with 20 degrees of adduction-abduction and rotation; and nine (82%) walked without an assistive device for more than 10 city blocks, one walked without an assistive device for less than 10 city blocks, and one was dependent on an assistive device. Overall, seven patients had an excellent clinical outcome, three had a good outcome, and one had a poor outcome. The latter patient failed hinged distraction and subsequently required adductor releases and a valgus femoral osteotomy.

The mean duration of fixator use was 4.4 months (range 3–7 months). Preoperatively, the mean amount of hip flexion was 60 degrees (range 25–75 degrees) and the mean joint space was 2.6 mm (range 2–3 mm). At latest follow-up, the mean amount of flexion had increased to 95 degrees (range 80–110 degrees) and the mean joint space to 4.8 mm (range 4–7 mm). Hip medialization was required in two patients. Containment was maintained in all cases.

Four out of 11 (36.4%) patients had complications. One patient developed a pin tract infection that was successfully treated with intravenous antibiotics. One patient developed a painful knee effusion that resolved with anti-inflammatory medication and physical therapy. Two patients had to return to the operating room for manipulation and placement of an epidural catheter for postoperative pain control.

### DISCUSSION

The concept of distraction arthroplasty (arthrodiastasis) is not a new one: it has been used in the hip, knee, elbow, and ankle joints. Judet and Judet<sup>14</sup> reported the use of a hinged

**TABLE 1.** Demographics, Diagnoses, and Clinical Status Before Surgery and at Latest Follow-up

Patient	Gender	Age (yrs)	Diagnosis	Preoperative			Latest Follow-up		
				Pain*	ROM†	AL‡	Pain	ROM	AL
1	M	17	IC	2	2	1	0	0	0
2	M	14	ON (SC)	2	1	1	0	0	0
3	F	16	IC	2	1	1	0	0	0
4	M	9	ON	2	2	1	1	0	2
5	M	14	ON	2	1	1	0	0	0
6	F	12	IC	2	1	2	0	0	0
7	F	16	ON (LE)	2	1	2	0	0	0
8	M	16	ON (SC)	2	1	1	1	0	0
9	M	13	ON	2	2	2	0	0	1
10	M	14	ON (MED)	2	1	1	0	0	0
11	M	12	ON	2	1	1	1	0	0

ON, osteonecrosis; IC, idiopathic chondrolysis; SC, sickle cell disease; LE, lupus erythematosus; MED, multiple epiphyseal dysplasia.

\*Pain: 0 = no pain; 1 = pain after exercise; 2 = constant pain.

†ROM, range of motion: 0 = flexion to at least 80 degrees with 20 degrees of adduction-abduction and internal and external rotation; 1 = flexion of 40–80 degrees; 2 = flexion of <40 degrees.

‡AL, ambulation level: 0 = walking without an assistive device for >10 city blocks; 1 = walking without an assistive device for <10 city blocks; 2 = walking with an assistive device and/or limited to home or school.



**FIGURE 1.** A 14-year-old boy with severe hip pain secondary to osteonecrosis. A, AP view of the right hip showing osteonecrosis at the time of diagnosis. B, AP view of the right hip at the time of distraction. C, Application of hinged distractor with hip flexed. D, Application of hinged distractor with hip extended. E, AP view of the right hip after surgery. F, AP view of the right hip 5 months after surgery. G, AP view of the right hip 4 years after removal of the distractor.

distraction device that permits joint motion after surgical arthrolysis or arthroplasty in the knee, ankle, or elbow joints of 38 patients. Morrey<sup>18</sup> described the rationale, technique, and application of its use in the elbow.

Any condition that involves the loss of articular cartilage leads to pain and stiffness due to increased friction and decreased lubrication. Irregularity of the joint surfaces results in decreased surface area and increased contact stresses across

the joint. Through the symmetric reconstitution of the joint surface, distraction arthroplasty permits repair of the articular cartilage<sup>14,20</sup> and restoration of ligament balance and the joint axis. This maintains the physiologic muscle action force across the joint. The passive and active motion nourishes the articular chondrocytes by even distribution of the synovial fluid. After the fixator is removed, the stretched ligaments maintain the joint balance and allow an increase in joint motion.

The exact mechanisms by which joint distraction results in clinical improvement have not been fully elucidated. Van Valburg et al<sup>28-30</sup> reported a decrease in the secondary inflammation of the synovial tissue after joint distraction. They also found that during ankle distraction, joint loading resulted in an intermittent hydrostatic pressure within the joint. Intermittent hydrostatic pressure in vitro stimulated the formation of cartilage matrix in osteoarthritic articular cartilage. They postulated that this intermittent fluid pressure along with the absence of mechanical stress due to joint distraction with the fixator may lead to articular cartilage repair.

Only limited success of this concept has been found in the hip joint. Aldegheri et al<sup>1</sup> reported 71% good results in 59 patients less than 45 years of age with articulated distraction arthroplasty of the hip with a minimum follow-up of 5 years. Canadell et al<sup>5</sup> used a unilateral fixator to treat nine patients, average age of 14 years, who presented with stiff hips, pain, limp, and shortening of the leg due to Perthes disease, epiphyseolysis, congenital dysplasia, tuberculosis, and idiopathic chondrolysis. The average range of movement increased from 20 to 65 degrees and the articular space was widened by an average of 2.8 mm. Only three patients had pain on follow-up.

Similarly, clinical and radiographic improvements were found in our series of comparably aged adolescents. Pain was markedly reduced from all patients having constant pain preoperatively to 73% having no pain and the remainder having pain only after exercise. At follow-up, all patients had a minimum of 80 degrees of flexion and all except one patient were ambulating without assistive devices. Joint space had increased by an average of 2.2 mm.

Kocaoglu et al<sup>16</sup> used an Ilizarov external fixator to distract the hips of 11 patients with Perthes disease. Using the criterion of the formation of a lateral pillar, the fixator was removed an average of 99 days after application. The device was used to maintain containment in six of the patients, but containment was lost in two of these six subsequent to fixator removal. The authors attributed this to inadequate time in the fixator. In the present series of patients, the average duration of fixator use was 132 days (4.4 months) and loss of containment was not encountered.

Articulated distraction arthroplasty is a minimally invasive procedure and usually has a high success rate in young patients. Correct application of the device and the hinge is critical. Adequate distraction, patient compliance, and supervised rehabilitation are important determinants of outcome. Hip motion with minimum distraction of 5 mm at the joint surface is important for fibrocartilaginous repair of hyaline articular cartilage and soft tissue balance.

Hinged hip distraction was an effective treatment in eliminating pain, restoring joint space, and improving function in adolescents with degenerative arthritis secondary to osteonec-

rosis and chondrolysis. Hinged hip distraction should be considered a salvage procedure and an alternative to hip fusion in this young and difficult-to-treat group of patients.

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