Articulated distraction or arthrodiatasis is a new method of treatment of Legg-Calvé-Perthes disease (LCPD). The term arthrodiatasis is derived from the Greek words arthro (joint), dia (through), and taxis (to stretch out). The method has been used to treat a variety of hip conditions, such as avascular necrosis, osteoarthritis, chondrolysis, neglected hip dislocation, unstable capital femoral epiphysis, and the adolescent arthritic hip.

**RATIONALE**

The aim of treatment of LCPD is to prevent the residual hip deformity, which can lead to early degenerative arthritis. During the stage of revascularization, the bone of the femoral head is biologically weak. When this weak bone is subjected to weight-bearing stresses across the edge of the acetabulum, the femoral head can become irreversibly deformed. Even when the hip is not bearing weight, muscular contraction can generate forces across the joint that may exceed the body weight; these forces can cause the femoral head to deform. Joint distraction attempts to neutralize muscular and weight-bearing forces on the femoral epiphysis, induce neovascularization, and prevent femoral head deformation.

One advantage of distraction is that it does not change the anatomy of the proximal femur. Besides, it can be employed even when the hip is very stiff, when other methods of surgical containment are contraindicated.

**METHODS**

Articulated hip distraction can be applied with either a monolateral fixator or a circular external fixator. If fixed adduction or flexion deformities are present, tenotomies of the adductors and the psoas tendons are first performed.

Whatever the type of external fixator, it should be aligned such that its rotating axis is in line with the flexion–extension axis of the hip joint. This step is crucial. If alignment of the center of rotation is not accurate, limitation of movement and even painful loosening of the pins may occur. A guidewire is inserted from the lateral side through the center of rotation of the hip joint under image-intensifier control while the lower limb is kept in 15° abduction, neutral rotation, and 0° flexion. This position is used so that the guidewire is perpendicular to the femoral shaft. The hinge of the monolateral articulated distraction device is aligned with this guidewire (Fig. 1). Two half pins (5 or 6 mm) are inserted in the supraacetabular area using the image intensifier for avoiding too-deep penetration. The author prefers the use of hydroxyapatite-coated pins. Another 2 or 3 pins are applied to the shaft of the femur in the midsagittal plane. The guide pin is removed and the range of motion of the hip is checked. A circular external fixator can be applied with the same principles as the monolateral hinged fixator. Schanz pins are introduced in a convergent manner into the iliac crest, the supraacetabular area, or both, and fixed to a pelvic arch. Another arch or a complete ring is applied to the femur by wires or pins. The connection between the two parts is built using rods and hinges, ensuring that the level of the hinge is at the center of hip rotation as previously described. In cases with flexion hip deformity, an extension rod can be applied for a temporary period to correct the deformity and restrict all movements.

The author has nothing to disclose.

Department of Orthopaedics, Benha Faculty of Medicine, Benha University, 53 Misr Helwan Street, Maadi, Cairo, Egypt

E-mail address: gamalahosny@yahoo.com

doi:10.1016/j.ocl.2011.04.010

0030-5898/11/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
POSTOPERATIVE PROTOCOL

Patients are allowed to walk with partial weight bearing with crutches on the second day after the operation. A day later, distraction is started at a rate of 1 mm/d. Distraction is continued until the Shenton line is overcorrected by 5 to 10 mm (Fig. 2). Physiotherapy is performed daily to maintain hip flexion and extension. The end point of distraction is when adequate ossification of the lateral pillar is seen because no further collapse of the epiphysis is expected beyond this stage of the disease. This result would normally take 4 or 5 months in the fixator. After fixator removal, the child has daily hydrotherapy and physiotherapy with passive continuous and active assisted movements. Non–weight-bearing activity is recommended for 2 months.12,13

COMPLICATIONS

1. Pin-track infection is the most frequent complication. Usually, it responds to frequent dressing and oral or parenteral antibiotics. However, premature removal of the fixator has been reported because of severe pin-track infection. There is a remote possibility of infection in cases where hip arthroplasty would be required in the future.

2. Pin breakage has been reported in obese patients.7

3. Mechanical failure of the fixator during distraction has been reported.13,14 The surgeon must be aware of mechanical failure as a potential cause for lack of anticipated joint distraction during arthrodiatasis.

4. Subluxation after fixator removal had been reported in a few cases.10,15 However, the coverage of the femoral head improved with longer follow-up.

5. Chondrodiatasis of the growth plate developed in 1 case with resultant femoral neck lengthening instead of arthrodiatasis. The accumulating tension during distraction was conveyed to the femoral epiphysis instead of the hip joint, probably because of marked intraarticular adhesions.15

Psychological intolerance that required fixator removal has not been reported.11

DISCUSSION

Only a few reports of arthrodiatasis in LCPD have appeared in the literature and not many centers advocate this form of treatment.16 A review of the published results describing this method of treatment of LCPD1,10,11,13,15,17,18 is summarized in Table 1. Most of these reports share the same limitations: small number of patients, absence of a control group, relatively short follow-up, and diversity of indications.
Table 1
Comparison of the 6 articles of hip arthrodiatasis in LCPD

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>11</td>
<td>15</td>
<td>23</td>
<td>8</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>Age</td>
<td>5–10 y</td>
<td>7.1–12.5 y</td>
<td>5–8 y</td>
<td>6–10 y</td>
<td>&gt;9 y</td>
<td>&gt;8 y</td>
</tr>
<tr>
<td>Lat pillar classification</td>
<td>B4, C7</td>
<td>A1, B14</td>
<td>B9, C14</td>
<td>B&amp;C</td>
<td>Out of 16 cases in 2004 B1</td>
<td>B5, C24</td>
</tr>
<tr>
<td>Follow-up period</td>
<td>24–50 mo</td>
<td>15.8–56.6 mo</td>
<td>52–104 mo</td>
<td>13–69 mo</td>
<td>4.3–7.8 y</td>
<td>2.9–11.0 y</td>
</tr>
<tr>
<td>Complications</td>
<td>Pin-track infection in 7 cases</td>
<td>Pin-track infection in most of the cases</td>
<td>Pin-track infection in 1 case</td>
<td>Pin-track infection in most of the cases</td>
<td>Restriction of the hip Joint movement in 1 case</td>
<td>Reported before Segev et al, 13, 2004 Pin-track infection in 13 cases (out of 16) Broken clamp</td>
</tr>
<tr>
<td></td>
<td>Translocation of the ring on the iliac crest</td>
<td>Fracture pin in 2 cases</td>
<td>Stiffness of the hip in 2 cases</td>
<td></td>
<td></td>
<td>Pin-track infection in 22 cases Chondrodiatasis instead of arthrodiatasis in 1 case Hip subluxation in 1 case</td>
</tr>
<tr>
<td></td>
<td>Self disassembly of the device</td>
<td>Subluxation in 2 cases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stulburg classification II 3</td>
<td>Not applied in this study</td>
<td>Not applied in this study</td>
<td>II 4 cases</td>
<td>III 3 cases</td>
<td>IV 7 cases</td>
</tr>
<tr>
<td></td>
<td>III 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification for 21 cases only II 9 cases III 7 cases IV 4 cases V 1 case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of distraction</td>
<td>9 cases nonarticulated</td>
<td>Articulated</td>
<td>Articulated and Soft-tissue release</td>
<td>Articulated</td>
<td>Articulated and Soft-tissue release</td>
<td>Nonarticulated No soft-tissue release</td>
</tr>
<tr>
<td></td>
<td>2 cases articulated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soft-tissue release in some cases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group</td>
<td>None</td>
<td>Yes</td>
<td>Yes</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Although Aly and Amin\(^1\) used the technique in children aged younger than 8 years as the primary method of containment, most investigators have used this method more frequently as a salvage procedure in the older child, or in children who present with severe forms of the disease and marked limitation of hip motion. Arthrodiastasis has also been advocated as a preliminary step before surgical containment in late-onset cases with increasing pain and decreased range of motion.\(^7\)

The reported outcomes have varied a great deal. When articulated distraction was applied to hips with minimal collapse, the short-term results revealed preservation of the epiphyseal height.\(^{17}\) However, long-term results have not been as encouraging; Segev and colleagues\(^{16}\) reported that 7 of 10 cases had Stulberg class IV hips at final follow-up and the remaining 3 hips were graded as Stulberg class III hips. One clear benefit of articulated hip distraction noted by most investigators is improvement of joint stiffness.\(^{12,13,15}\)

**REFERENCES**