We evaluated total hip arthroplasty in patients with neglected developmental dislocation of the hip with regard to surgical method and modifications, problems encountered during surgery, and follow-up results. A total of 25 hips (Hartofilakidis type 3, high dislocation) of 22 patients (22 women; mean age 44 years; range 28-61 years) who underwent total hip arthroplasty were clinically and radiologically evaluated. In all cases, cementless acetabular components were placed in the true acetabulum. Only one acetabula required structural autograft. Cementless stems were used on the femoral side. A subtrochanteric osteotomy was performed in 23 hips. The mean follow-up period was five years (range 2 to 10 years). The scale of Merle d’Aubigne and Postel, as modified by Charnley was used to evaluate the clinical results. Pain improved from a mean of 2.3 preoperatively to 5.7 postoperatively. Function improved from 2.3 to 4.5 and mobility from 2.3 to 4.4 at the final follow-up evaluation. No acetabular autograft resorption or non-union were observed. Intraoperatively: femoral fissure occurred in 3 cases. One sciatic nerve palsy occurred. Brooker type IV heterotopic ossification was observed in one case. Three polyethylene wear, 1 DVT, 2 osteolysis were observed during the follow-up. Total hip arthroplasty proved successful in neglected developmental dislocation of the hip.

Key Words: Total Hip Arthroplasty, High Dislocation, Hip, Shortening Osteotomy
intramedullary cavity of the femur (4). Good technical solutions have been developed for all stages of the disease and good or excellent results can achieved in most cases (2-20). The surgical technique of a simple acetabular dysplasia is different from that of a high riding dislocation of the hip. Femoral shortening osteotomy that is not needed for simple acetabular dysplasia or low dislocation is mostly inevitable in high dislocation. There is no consensus on reporting the clinical and radiological results because of the great variety in the surgical techniques.

We aim to report the results of the total hip arthroplasties on a series of patients with developmental high dislocation of the hip managed with the same technique, and the problems encountered during the procedures are discussed.

Patients and Methods
The adult hip dislocations and dysplasias have been classified by Eftekhar (21), Crowe et al.(2), Hartofilakidis et al.(8), Kerboul et al.(22) and Mendes et al.(23). The most practical and convenient one is the Hartofilakidis and associates classification (HC). For this reason, we favor this classification system over the others. According to this classification (8), Type 1 is the dysplastic hip and the femoral head remains in the true acetabulum. Type 2 is the low dislocation and the femoral head is in the false acetabulum, but the inferior part of the head is in contact with the true acetabulum. In type 3, also known as high dislocation, the head is completely in the false acetabulum, but the inferior part of the head is in contact with the true acetabulum. Type 3 is also known as high dislocation, the head is completely in the false acetabulum and there is no contact with the true acetabulum. While HC Type 1 corresponds to Crowe Type I and II, HC Type 2 to Crowe Type III and HC Type 3 to Crowe Type IV.

To 25 hips of 22 patients with developmental high dislocation of the hip, total hip replacements (THR) were performed (Table 1). All total hip replacements procedures were performed at the Ibn Sina Hospital from 1992 through 2000. The indications for arthroplasty were severe hip pain, with considerable difficulty in walking and in performing activities of daily living. All of the patients had Hartofilakidis type 3 (high dislocation) preoperatively. Patients with dysplasia were not included in this study. In five cases Schanz osteotomy had been performed previously on the same hip. All the patients were women and the average age at the time of the operation was forty-four years (range, twenty-eight to sixty-one years). Each patient was evaluated with the hip-rating system of Merle d'Aubigne and Postel, as modified by Charnley (24). Trendelenburg's sign of pelvic instability was also recorded. Preoperatively and postoperatively radiographs were taken in standing antero-posterior and in the frog-leg lateral positions. The follow-up radiographs were evaluated for the change in component position, radiolucencies at the implant-bone interface and screw breakage. We referenced the location of the center of the femoral head to a line drawn through the teardrops (25). The vertical height was measured perpendicular to this reference line. The horizontal displacement of the center of the femoral head was measured along this line as the distance from the teardrop. Prophylactic antibiotic therapy was given one hour before operation and continued for 48 hours. Thromboembolic prophylaxis included low molecular weight heparin (subcutan, approximately 15 days), early mobilization, encouragement of active leg movement and anti-embolic stockings.

Surgical Technique
The operative procedure was carried out through a direct lateral approach (26) with the patient in supine position. In the type 3 (high dislocation) cases no difficulty was encountered while dislocating the head, as the femoral head was already in the false acetabulum. The location of the true acetabulum was difficult to determine in many cases, but following the elongated and attenuated capsule was often helpful. The true acetabulum was narrow and shallow and thus required careful exposure. The anterior wall generally was thin and deficient, and room could be gained by curetting toward the thicker posterior wall. The hypoplastic true acetabulum was enlarged and deepened with the use small reamers (forty to forty-two and four diameters). In the type 3 hip, the inferior wall of the false...
Preoperative radiograph.

Immediate postoperative radiograph after a subtrochanteric shortening step cut osteotomy. An unemente hydroxyapatite coated stem will provide fixation of both proximal and distal segments.

Preoperative anteroposterior radiograph of the pelvis and hips.

Bilateral total hip arthroplasties were performed for disabling pain. Both acetabulae were reconstructed with unemente hydroxyapatite coated shells. The acetabular cups had been placed in the true acetabulum. Bilaterally, transverse subtrochanteric osteotomies were performed and a cementless femoral components were used. Five years postoperatively, the patient had good clinical and radiographic results, with union of the femoral osteotomies.

A 38-year-old woman with high developmental hip dislocation bilaterally. Right and left hips treated by Schanz osteotomy 13 years previously.
acetabulum is the superior wall of the true acetabulum. There are two main points that are crucial in the procedure; one of them is to protect the bone bridge between the two acetabuli; and the other is to ream the posterior portion of the acetabulum more than the anterior so that the insufficient anterior wall will be protected during the preparation. The acetabular component was placed true acetabulum in all patients. In one case more than 70% of the cup remained uncovered and thus the femoral head was used as a graft and fixed with two screws. The largest uncemented cup possible should be used. The most suitable cup sizes for type 3 dislocated hips was usually 40-42-44 or 46 mm. As the bone quality is mostly rather bad, cups permitting screw fixation are generally more advantageous regardless of the primary stability. The diameter of the cup is usually small; therefore, a 22 mm head should be used to leave room for a liner of satisfactory width. In case of using a system permitting metal-to-metal articulation, a 28 mm head can be used. Thirty-two-millimeter heads were used in 2 of the cases, 28 mm heads were used in 12 (3 of these were metasul) and 22 mm heads were used in 11 cases.

If a subtrochanteric osteotomy was planned preoperatively, it is best to perform the osteotomy at the beginning of the operation, so that the entrance to the acetabular inlet at the level of the trochanter minor would be easier. After the placement of the acetabular component the femoral component is inserted into the proximal part of the femoral bone and the hip is reduced. The amount of shortening required can then be determined by overlapping the proximal and the distal fragments of the femur and appropriate amount of bone is resected from the distal segment. A subtrochanteric osteotomy was performed in 23 hips. If an osteotomy such as a Schanz osteotomy had been performed formerly, both shortening and correction can be achieved by the procedure. In our series, a step-cut osteotomy was performed in 3 hips and a transverse osteotomy in all of the rest. Fixation and rotational stability can be achieved by screw and metal plates, tension band technique or by using a long-stem prosthesis. We used the tension band technique for two of the transverse osteotomies and screw and plates for another. We relied on the femoral stem for stability of the rest. Uncemented components were used for all of the femoral side (Table 1). Soft tissue release was done only by sectioning the linea asperea. Aggressive tissue release should be avoided in cases that a shortening osteotomy is performed. After the operation the patients were ambulated without bearing weight. Partial weight bearing was allowed at six weeks and full weight bearing at 12 weeks.

Results
The average duration of follow-up was five years (range, two to ten years). The scale of Merle d'Aubigne and Postel, as modified by Charnley was used to evaluate the clinical results. Pain, function and mobility were assessed separately. Pain improved from a mean of 2.3 preoperatively to 5.7 postoperatively. Function improved from 2.3 to 4.5 and mobility from 2.3 to 4.4 at the final follow-up evaluation. All patients had a typical Trendelenburg limp before the arthroplasty. Postoperatively, Trendelenburg limp was moderate in nine (36 %) and slight in sixteen hips (64%). The center of the femoral head was moved inferiorly and medially at the time of the operation. The average horizontal displacement decreased fifty-five millimeters (range, thirty-nine to seventy-eight millimeters) preoperatively to twenty-six millimeters (range, twenty to sixty-five millimeters) postoperatively. The average height of the center of the femoral head decreased from seventy-two millimeters (range, forty-nine to 107 millimeters) preoperatively to forty-six millimeters (range, thirty-five to sixty-nine millimeters) postoperatively.

Intraoperatively, during the insertion of the acetabular component an acetabular medial wall fracture occurred in one of the cases. The medial wall was grafted with the femoral head. On postoperative radiographic evaluation the cup was seen to be seated more vertical than should be. At the postoperative eighty months polyethylene wear was encountered. A second case of premature polyethylene wear happened at the postoperative seventy-two months. The
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PEW** Polyethylene Wear
FR** Full Recovered
HO*** Heterotopic Ossification
IV**** Femoral Fracture
third case having polyethylene wear needed a revision surgery. Femoral fissure occurred in 3 cases and was fixated using cerclage wire in 2. Heterotopic ossification was seen in only one patient and resulted in moderate limited hip motion. Peroneal nerve paralysis, which completely resolved in twenty-eight months, was observed in one case. Osteolysis (in all zones) developed in 2 hips. In one case deep venous thrombosis developed at the third week and completely responded to treatment. There was no infection, or abductor contracture.

Discussion

Total hip arthroplasty is a difficult procedure to perform on high hip dislocations. The main problems and the complications should be well known before performing a THA. One of the most important issues is where and how the acetabular component should be placed. Charnley and Feagin (1) therefore believe that total hip replacement is contraindicated in these patients, while Justy et al. (19) prefer to place the cup in the false acetabulum. Although the true acetabulum is hypoplastic and shallow, it still is much better, considering its bone stock, than the false acetabulum. Placing the cup into the true acetabulum is the most accepted technique regarding the literature (1,4,21,23). Obtaining satisfactory acetabular cup coverage is the key step. For most cases, this necessitates only deeper reaming and use a small diameter (forty, forty-two) acetabular component that is porous-coated. The small components can be covered completely in most patients. Because the components are initially stabilized with screws, small portions of the components can be left uncovered and nonstructural bone graft can be added to fill the uncovered areas. The reason for preferring uncemented cups is that there is a possibility of screw fixation other than primary fixation. We believed that 70% of the cup should be covered with intact host bone (18,27). If more than 30% of the cup is uncovered, consideration should be given to use of bulk autograft or allograft. The femoral head was applied as an autogenous graft in one case using the method of Harris et al. (7) to compensate for the severe superolaterale wall deficiency of the true acetabulum. This technique was very successful for the short term and allowed total hip replacements even in patients with severe congenital hip dislocation (7). However, long-term results have shown unacceptably high loosening rates of the acetabular components with structural autografting and allografting (6,19,27).

Another technique is the high hip center technique (28). This is a convenient technique based on the principle of placing a small sized uncemented cup without using a graft. On the other hand, the main disadvantage of the technique is that the loosening of the cup is encountered more than with other methods and the possibility of dislocation is much higher (29,30). When this cup is placed, lengthening can be performed on the femoral component. As the bone stock is not generally restored in these procedures, it may cause difficulty in future surgeries. Despite all these disadvantages, the method can be used in patients who have enough bone stock and when the difference between the length of the two legs is 2-3 cm. In selected cases, this technique has been used in our other series.

We have no experience in the treatment of high dislocation of the hip with a third technique, which is the centralization of the cup that is also named as cotyloplasty (4,5,20). Fifteen of 17 hips were found to have an excellent results after a relatively short-term follow-up (mean,37 months) (5). Hartofilakidis et al. (20) reported the results at a mean of seven years (2 to 15 years) after cotyloplasty in 86 hips in 66 patients. Eight-one of the 86 hips (94%) had a good or excellent results, and only 2 acetabular components had to be revised during the study period.

Alternatives include the use of cement to augment the acetabulum (13), and the use of a reinforcement ring (30). Bipolar prostheses have also used in patients with dysplastic acetabulum but may lead to high rates of femoral loosening and acetabular erosions (31).

The difference in length is an important problem encountered especially in unilateral
high dislocation of the hip. This brings the question of how much lengthening can be achieved. First of all, the patient should be acknowledged about the amount of lengthening that can be done. Maximal amount of safe lengthening is 4 cm (18,32). If a lengthening more than 2 cm is to be done during the operation, the trial prosthesis should be placed and the tension on the sural nerve should be tested. Brutal dissection exposing too much of the nerve and causing devascularization should be avoided, especially if a posterior incision is being used. An alternative method is the wake-up test, but the patient should be informed preceding the operation. The dorsiflexion of the first toe is more reliable than its plantar flexion. In more complicated cases SSEP should be preferred. If the tension on the nerve is too much there are two choices. The acetabular cup can be placed higher or a subtrochanteric osteotomy can be performed. This points out to the importance of preoperative planning. In our department, if more than 4 cm of lengthening will be needed, we have a consensus of performing a subtrochanteric osteotomy at the beginning of the operation. The main aim of the operation is to place the acetabulum at its true, original level; therefore, instead of releasing all of the tissues, we believe that performing a shortening osteotomy and minimizing the tension on the nerve is a better method. If aggressive releasing is conducted, as the lengthening amount will be significant, and the risk of nerve injury will increase. Nerve palsy has occurred in one of our cases that had undergone a shortening procedure. Full recovery occurred in 28 months.

The subtrochanteric osteotomy can be done in different ways (14,33,34). It can be transverse or step-cut in order to achieve rotational stability, it can be oblique or chevron shaped. However, the other methods are technically more difficult than the transverse osteotomy. The stability can be achieved by screws, metal plates, tension band technique, cortical onlay grafts or by long stem prostheses (16,17). The most important problems are rotational stability and nonunion. In this series, tension band technique was used for 2 patients and plate and screws in another. The remaining distal femoral medulla after the shortening osteotomy is narrow and in most cases the femoral stem inserts tightly and in satisfactory length abolish the need for extra fixation techniques (14,17,19).

In the evaluation of hip arthroplasty in dislocated hips is the function of the hip abductor muscles. In this series, all the patients had a preoperative Trendelenburg limp. Postoperatively, Trendelenburg sign was moderate in nine hips (36 %) and slight in sixteen hips (64%). The tension of the muscle was then increased, and we assume that the restoration of the biomechanics of the gluteus medius is the explanation for the slightly appearance of the Trendelenburg limp in the most cases (14). In this patients still had insufficient of the abductor muscles, but none needed external support.

As a conclusion it can be stated that, although technically difficult, THA gives successful results in the treatment of high hip dislocations. The placement of the cup into the true acetabulum, lengthening the extremity being careful to tightness of the nerve, because the disease is a problem of a relatively younger group, preferring uncemented components, and a good preoperative planning are important in achieving successful results.
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