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# Intermediate-term results after uncemented total hip arthroplasty for the treatment of developmental dysplasia of the hip

## Gelişimsel kalça displazisi tedavisinde çimentosuz total kalça protezi uygulamalarımızın orta dönem sonuçları

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**Objectives:** We aim to evaluate the restoration of the hip and limb length in patients with osteoarthritis secondary to developmental dysplasia of the hip (DDH) using total hip arthroplasty (THA).

**Patients and methods:** Between February 1996 and September 2001, 65 hips in 55 patients (2 males, 53 females; mean age 48.6 years; range 37 to 60 years) with advanced osteoarthritis secondary to DDH underwent uncemented THA. According to the Hartofilakidis classification, 20, 27, and 18 hips were evaluated types I (dysplasia), II (subluxation), and III (dislocation), respectively. All of the acetabular cups were reconstructed in the original anatomic location. Structural autografts were used in seven hips to supplement the acetabular coverage. We evaluated all patients clinically and radiographically.

**Results:** All of the patients were followed up for 7-12 years. Preoperatively, the Harris score averaged 52.5, 48.41, and 45.28 in types I to III, respectively. At the final follow-up, the Harris score averaged 89.65, 87.44, and 83.28, respectively. The difference between the pre- and postoperative scores was significant (p=0.0001). Preoperatively, 26 patients (47.27%) had slight limps (length difference <1 cm), eight (14.55%) had moderate limps (length difference 1-3 cm), and 21 (38.18%) had severe limps (length difference >3 cm). At their final follow-up, four (7.27%) had severe limps. The limps of all of the patients improved significantly (McNemar's test p=0.0001). We observed aseptic loosening and subsidence in six hips. In seven hips, we used a femoral head autograft for the superior acetabular defect. We performed femoral shortening osteotomies only for two (3.07%) type III hips.

**Conclusion:** In addition to the standard procedure, structural bone autografting, medialization of the cup, and placing the acetabular component in the true acetabulum are important factors for successful intermediate-term results.

*Key words:* Developmental hip dysplasia; femoral head autograft; total hip arthroplasty.

**Amaç:** Gelişimsel kalça displazisi (GKD)'ne sekonder gelişen kalça osteoartritli hastaların, çimentosuz total kalça artroplastisi (TKA) ile tedavileri sonrası kalça restorasyonunun sonuçları ve ekstremite boyları değerlendirildi.

**Hastalar ve yöntemler:** Şubat 1996 ile Eylül 2001 tarihleri arasında 55 hastanın (2 erkek, 53 kadın; ort yaş 48.5 yıl; dağılım 37-60 yıl) 65 kalçasına GKD'ye sekonder gelişen koksartroz nedeniyle çimentosuz TKA uygulandı. Hartofilkidis sınıflamasına göre 20 kalça tip I (displazi), 27 kalça tip II (subluksasyon), 18 kalça tip III (dislokasyon) olarak değerlendirildi. Asetabuler komponentlerin tamamı orijinal anatomik bölgeye yerleştirildi. Yedi kalçaya asetabuler örtümü artırma amacıyla femur başı otogrefti kullanıldı. Hastalar klinik ve radyolojik olarak değerlendirildi.

**Bulgular:** Bütün hastalar 7-12 yıl takip edildi. Ameliyat öncesi ortalama Harris skoru tip I kalçalarda 52.5, tip 2 kalçalarda 48.41, tip III kalçalarda 45.28 idi. Son muayenede ortalama Harris skoru tip I kalçalarda 89.65, tip II kalçalarda 87.44 ve tip III kalçalarda 83.28 olarak hesaplandı. Ameliyat öncesi ve sonrası skorlamalar arasındaki fark anlamlı idi (p=0,0001). Ameliyat öncesi 26 hastada (%47.27) hafif aksama (uzunluk farkı <1 cm), sekiz hastada (%14.55) orta derecede aksama (uzunluk farkı 1-3 cm), 21 hastada (%38.18) ileri derecede aksama (uzunluk farkı >3 cm) vardı. Ameliyat sonrası ve son kontrolde dört hastada (%7.27) ileri derecede aksama vardı. Bütün hastaların aksama durumundaki bu düzelme anlamlı bulundu (McNemar's test p=0.0001). Altı kalçada aseptik gevşeme saptandı. Yedi hastada femur başı otogrefti superiyor asetabuler defekt için kullanıldı. Tip III kalçalardan sadece ikisine (%3.07) femoral kısaltma osteotomisi uygulandı.

**Sonuç:** Standart kalça artroplasti tekniklerine ek olarak, GKD'li hastalarda; yapısal kemik otogrefti kullanımı, asetabuler komponentin medializasyonu ve gerçek asetabuluma yerleştirilmesi başarılı orta dönem sonuçlar için önemli faktörlerdir.

*Anahtar sözcükler:* Gelişimsel kalça displazisi; femur başı otogrefti; total kalça artroplastisi.

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The surgical treatment of arthritis secondary to developmental dysplasia of the hip (DDH) is controversial. Periacetabular osteotomies should be considered in early-stage arthritis and young patients. When the arthritis is severe and the pain worsens, total hip arthroplasty (THA) is the preferred treatment.

Arthroplasty in DDH raises technical problems related to the anatomy and patient age. Both bone and soft tissue problems arise, and morphological bony differences in dysplastic hips exist not only on the acetabular side, but also on the femoral side. These differences make surgery difficult. Many studies have reported on the surgical techniques and prosthesis designs for osteoarthritis secondary to DDH. In this retrospective study, we evaluated the restoration of hip and limb length in patients with osteoarthritis secondary to DDH using cementless THA.

## PATIENTS AND METHODS

The study included 65 total hip replacements performed between February 1996 and September 2001 in 55 consecutive patients (2 males, 53 females; mean age 48.6 years; range 37 to 60 years) with osteoarthritis secondary to DDH in our hospital. Two patients had undergone surgery during childhood (open reduction and open reduction with iliac osteotomy). The main complaints were pain and limping.

A standard imaging protocol was performed for all patients, including the anteroposterior (AP) pelvis, AP and lateral views of the healthy and pathological hips, and AP and lateral views of the pathological femur. The preoperative plan was based on these X-rays and the type of deformity.

Based on the radiographic classification of Hartofilakidis, 20, 27, and 18 hips were type I (dysplasia), II (subluxation), and III (dislocation), respectively.

We used the standard lateral Harding approach. All of the acetabular cups were inserted in the original anatomic location. Structural autografts were used in seven hips to supplement the acetabular coverage. We performed femoral shortening osteotomies for two hips only.

### Type I acetabulum

The superior wall defect is not significant and the anterior wall is often thin. The posterior and medial walls are essentially normal. Consequently, when reaming the acetabulum, we focused on the anterior wall, as it can be damaged and fractured easily. More bone was resected from the posterior wall than from the anterior one. Usually, we used 46-48 mm acetabular cups with press-fit fixation.

### Type II acetabulum

If the femoral head has subluxed and migrated proximally, the acetabulum is oblong and its roof is eroded. Both the anterior and superior walls are dysplastic. The inferior wall should be exposed. Usually, the iliopsoas tendon was released, a capsulectomy performed, and the tissues dissected inferiorly to visualize the inferior wall, which was the landmark we used to prepare the acetabulum. With a 38-40 mm reamer in 90 degrees of abduction, we reamed the medial wall to gain sufficient superior coverage. Then, 42-44 mm reamers were used in 45 degrees of abduction and 10-15 degrees of anteversion, i.e., the acetabular cup position.

After reaming the acetabulum, if we gained sufficient acetabular containment and coverage, we inserted the acetabular cup with press-fit fixation. We used structural femoral head autografts to restore the acetabulum and to support the acetabular cup in seven hips that had a significant deficit of the acetabular roof exceeding 40% of the acetabular cup. Grafts were prepared for the deficit size and shape and fixed with two or three cancellous screws. The acetabulum was reamed after graft fixation.

In three cases, we fractured the medial wall and inserted the acetabular cup medially to gain more superior coverage.

### Type III acetabulum

In high and intermediate dislocations, the impingement of the femoral head on the ilium leads to the formation of a false acetabulum, which is usually not deep or wide enough to contain the cup. The true acetabulum tends to be small and shallow, and the shallow recesses are filled with fat pad or bone. The iliopsoas tendon should be released and the dissection continued inferiorly to visualize the inferior wall. The cross-section of the ischium and pubic ramus were landmarks. After removing the fat pad or thin bone layer, we exposed the depth of

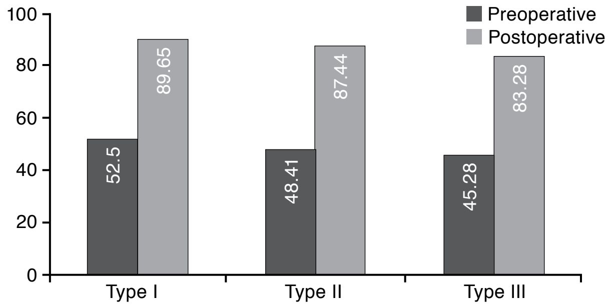


**Figure 1.** The difference between preoperative and postoperative Harris hip scores were significant (p=0.0001).

the cotyloid fossa and the medial wall of the acetabulum, which allowed us to determine the amount of medialization that could be accomplished safely by reaming. This should be started with very small reamers, e.g., 38-40 mm. We created a hemispherical recess 40, 42, or 44 mm in diameter, fully containing the cementless acetabular component. If this could be achieved in the optimal position, we fixed the acetabular component with screws. In two hips, we used additional screws to stabilize the cup position.

**Femur**

The femoral head is small and deformed, and the femoral neck is typically narrow and short, often with marked anteversion. The greater trochanter is usually small and often located posteriorly. The anterior bowing of the proximal third of the femur is increased. We placed the femoral component in a neutral position relative to the transverse axis of the femoral condyles. In types I and II dysplasia, we did not need to perform a femoral osteotomy. In type III dysplasia, we used femoral derotation and a shortening osteotomy for two hips, using the subtrochanteric transverse femoral osteotomy technique. The femoral component was used for intramedullary fixation.

The method of limb length restoration included careful preoperative planning and intraoperative soft tissue release. The patients were followed three, six and 12 months postoperatively and then annually thereafter. The rotation center of the hip and limb length were assessed radiographically. The Harris hip score (HHS) was used for clinical evaluation. The limb lengths were measured both pre- and postoperatively. Preoperatively, 26 (47.27%) patients had slight limps (length difference <1 cm), eight (14.55%) had moderate limps (length difference 1-3 cm), and 21 (38.18%) had severe limps (length difference >3 cm).

Standard cementless prostheses were used in all cases. No custom-designed prostheses were used. Bulk autografts were necessary to reconstruct the deficiency in the acetabular roof in seven hips.

**Statistical analysis**

Statistical calculations were performed with the program NCSS 2007 for Windows (NCSS Inc., Utah, USA). In addition to standard descriptive statistics (mean and standard deviation), the unpaired t-test was used to compare groups, the paired t-test was used to compare the pre- and post-treatment values, and the Chi-square and McNemar's tests were performed to evaluate qualitative data. Statistical significance was established at p<0.05.

## RESULTS

All of the patients were followed up for 7-12 years (average 9.3 years). The HHS was used for the clinical evaluation. For type I hips, the preoperative mean HHS was 52.5 (range 49-55), and it increased to 89.6 (range 83-95). In type II hips, the preoperative average HHS was 48.4 (range 43-53), and it increased to 87.4 (76-100). In type III hips, the HHS was 45.2 (range 41-49) and increased to 83.3 (range 71-94).

**TABLE I**

Haris hip scores of all patients that have been grouped according to their type of dysplasia were significantly increased postoperatively and these results were statisticaly meaningful (p=0.0001)

| Type of dysplasia | Preoperative HHS | Postoperative HHS | t | *p* |
|---|---|---|---|---|
| Type I | 52.5±3 | 89.65±6.33 | –27.68 | 0.0001 |
| Type II | 48.41±4.99 | 87.44±12.56 | –16.12 | 0.0001 |
| Type III | 45.28±3.71 | 83.28±11.45 | –14.27 | 0.0001 |

HHS: Harris hip score.

Six (9.23%) hips required revision surgery: two of these six hips required revision after major trauma (one patient fell downstairs and fractured the femur at the femoral osteotomy level); another two had aseptic loosening of the acetabular cup; and the remaining two required revision for loosening of an acetabular cup that had been grafted superiorly. In seven hips, we used femoral head autografts for the superior acetabular defect. Of these seven, two hips (28%) required revision, which is concordant with the literature. Three hips showed radiographic evidence suggestive of aseptic loosening (two stems and one cup), but the clinical results remain satisfactory.

We did not see any infection, dislocation, nonunion of the femur or greater trochanter, breakage of wires, or heterotopic ossification.

## DISCUSSION

Arthroplasty in developmental dysplasia of the hip joint raises technical problems related to the anatomy and age of the patient. Both bone and soft tissue problems arise, and morphological bony differences in dysplastic hips exist not only on the acetabular side, but also on the femoral side. These differences make the surgery difficult. Operative strategies to overcome these anatomical anomalies remain controversial. For preoperative planning, we used the simple, practical classification method of Hartofilakidis.

Hartofilakidis et al.[1] described three distinct types of congenital hip disease in adults. The first type is dysplasia, in which the femoral head is contained within the original true acetabulum. The second type is low dislocation, in which the femoral head articulates with a false acetabulum, the inferior lip of which contacts or overlaps the superior lip of the true acetabulum, giving the appearance of two overlapping acetabula. The third type is high dislocation, in which the femoral head has migrated superoposteriorly and there is no contact between the true and false acetabulum.

Decking et al.[2] compared the inter- and intra-observer reliability of the Hartofilakidis classification system with other systems and found it useful.

The most common problem associated with dysplasia is insufficient acetabular bone coverage, which can compromise the durability of component fixation. Acetabular reconstruction of dysplastic hips in total hip arthroplasty is reported to be difficult due to the deficient acetabular bone coverage.[3]

Placement of the cup depends on the amount of available bone stock and the magnitude of the limb-length discrepancy. The cup can be placed at the correct or nearly correct level with or without a bone graft. For type I hips, we did not need to use any acetabular reconstruction technique. Only anterior wall dysplasia was observed, and this wall was thin, so we reamed the posterior wall more to gain sufficient acetabulum.[4] By contrast, in type II and III hips, when the anterior, posterior, and superior aspects of the acetabular component could not be covered during total hip arthroplasty because of a deficient acetabulum, we performed acetabuloplasty techniques that involved medial advancement of the acetabular floor by creating a controlled comminuted fracture of the medial wall, autogenous bone grafting, and implantation of a small acetabular component.[5,6]

**TABLE II**

Differences between pre- and postoperative HHS are nearly equal (p=0.558) in all these three groups

| | | Difference between pre- and postoperative HHS |
|---|---|---|
| | n | % |
| Type I | 20 | 41.22±4.63 |
| Type II | 27 | 43.07±12.88 |
| Type III | 18 | 44.67±8.6 |
| F | | 0.59 |
| *p* | | 0.558 |

HHS: Harris hip score.

**TABLE III**

Limb lengths were determined pre- and postoperatively. Twenty-one limbs were 3 cm shorter than their contralateral limbs preoperatively. After surgery only four (7.27%) limbs had shortness greater that 3 cm

| Difference in limb lengths | Preoperative | | Postoperative | |
|---|---|---|---|---|
| | n | % | n | % |
| (–) 0-1 cm | 26 | 47.27 | 34 | 61.82 |
| (+) 1-3 cm | 8 | 14.55 | 17 | 30.91 |
| (++) >3 cm | 21 | 38.18 | 4 | 7.27 |
| Mc Nemar's | | 0.0001 | | |

**TABLE IV**

Trandelenburg signs of most of the patients were dissappeared. In type II and type III hips trandelenburg sign and shortness improved significantly and it was statistically meaningful (p=0.0001). In type I hips there were not any difference between pre- and postoperative limping results

| | Shortness | Preoperative | | Postoperative | | Mc.Nemar's |
|---|---|---|---|---|---|---|
| | | n | % | n | % | |
| Type I | (–) | 17 | 94.4 | 17 | 94.4 | – |
| | (+) | 1 | 5.6 | 1 | 5.6 | |
| Type II | (–) | 7 | 30.4 | 13 | 56.5 | 0.0001 |
| | (+) | 7 | 30.4 | 8 | 34.8 | |
| | (++) | 9 | 39.1 | 2 | 8.7 | |
| Type III | (–) | 2 | 14.3 | 4 | 28.6 | 0.0001 |
| | (+) | – | – | 8 | 57.1 | |
| | (++) | 12 | 85.7 | 2 | 14.3 | |

In this study, our success depended on using porous-coated acetabular components with medialization of the cup to avoid a superior defect and using bulk femoral head grafts. In addition, this technique reduces the operating time and facilitates rehabilitation by permitting earlier weight-bearing of the hip. To obtain maximum coverage, we deepened the acetabular cavity medially.[7] Dunn and Hess[8] recommended that the medial wall of a dysplastic acetabulum be perforated on purpose to permit coverage of the acetabular component without bone-graft support. In 1978, after an average of three years follow-up, they reported that none of the acetabular components had migrated.[8] Recently, Hartofilakidis et al.[1] followed 86 hips for an average of seven years after inserting a Charnley cup with the use of a medial protrusion technique and cement. At the time of follow-up, two of these cups had been revised, and another two showed progressive radiolucent lines. Dunn and Hess[8] recommended controlled fracture of the medial acetabular wall with an osteotome, and Hartofilakidis et al.[1] perforated the wall with a reamer. We used the Dorr technique without cement. We always used screw fixation to maximize the contact with the host bone.[9]

After medialization of the cup, if a superolateral wall defect covered small portions of the component (less than 40% of the cup), we used bone graft chips to improve the bone stock of the acetabulum. If the defect exceeded 40%, we used a structural femoral head autograft.

Structural bone grafting with femoral head autografting to the dysplastic acetabulum and cementing acetabular components into the graft provide satisfactory short-term results, but longer-term follow-up data show high acetabular component failure rates. After a mean follow-up period of seven years, 20% of the components were loose, and after a mean follow-up period of 12 years, 46%

**TABLE V**

Limb lengths were same in type I dysplasia, there were not any change between pre- and postoperative results. In type II hips 56.53% patients limb lengths were increased, in type III hips 71.4% patients limb lengths were increased, and it was statistically meaningful (p=0.0001)

| Limb length | Type I | | Type II | | Type III | | |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Same | 18 | 100.0 | 10 | 43.47 | 4 | 28.6 | $\chi^2$:20.51 |
| Increased | 0 | 0.0 | 13 | 56.53 | 10 | 71.4 | p=0.0001 |

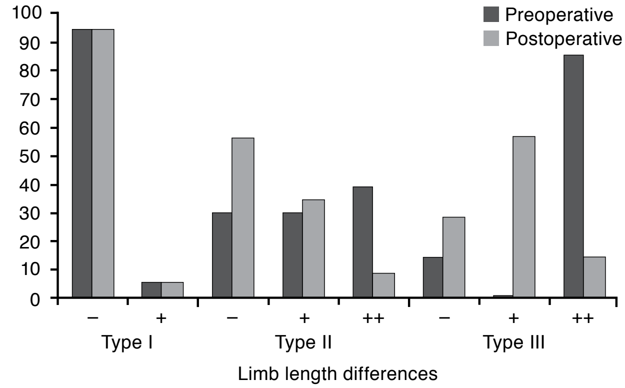


**Figure 2.** All the patients limping status were improved and it was significant (McNemar's: 0.0001).

were loose.[7] However, Kobayashi et al.[10] followed 37 patients for 10 to 26 years (mean 19 years); their patients had acetabular roof defects secondary to developmental dysplasia of the hip, and these were reconstructed with a bulk femoral head autograft at the time of total hip arthroplasties performed using the Charnley technique and prosthesis. They found that total hip arthroplasty performed using cement and a bulk autograft to reconstruct an acetabulum with severe bone deficiency secondary to DDH enabled long-term success in patients 48 years of age and older when coverage of the socket by the graft did not exceed 50%. According to Papachristou et al.,[11] who reviewed 38 hip replacements and used bulk femoral head autografts, all grafts were united, but minor graft resorption was noticed in 24 hips, moderate graft resorption in two hips, and major graft resorption in one hip.

Hendrich et al.[12] performed 55 total hip arthroplasties for DDH with a structural graft and a cementless cup. All patients were followed for 11 years. Four implants had been revised (8.4%) and two had radiographic evidence of loosening (4.2%).

Revision of an acetabular component that has failed after a total hip arthroplasty in which a bulk femoral head autogenous graft was used as a structural graft for acetabular reconstruction is an uncommon, but complex and challenging, procedure. Many studies have examined the treatment of DDH with cemented total hip arthroplasty and structural femoral head allografts, and their results differ. In addition, the literature does not include the revision results for these studies. Since our patients were young and active, we decided to use uncemented components. The healed bulk graft provides valuable additional bone stock for supporting an acetabular component that is inserted without cement.[13,14]

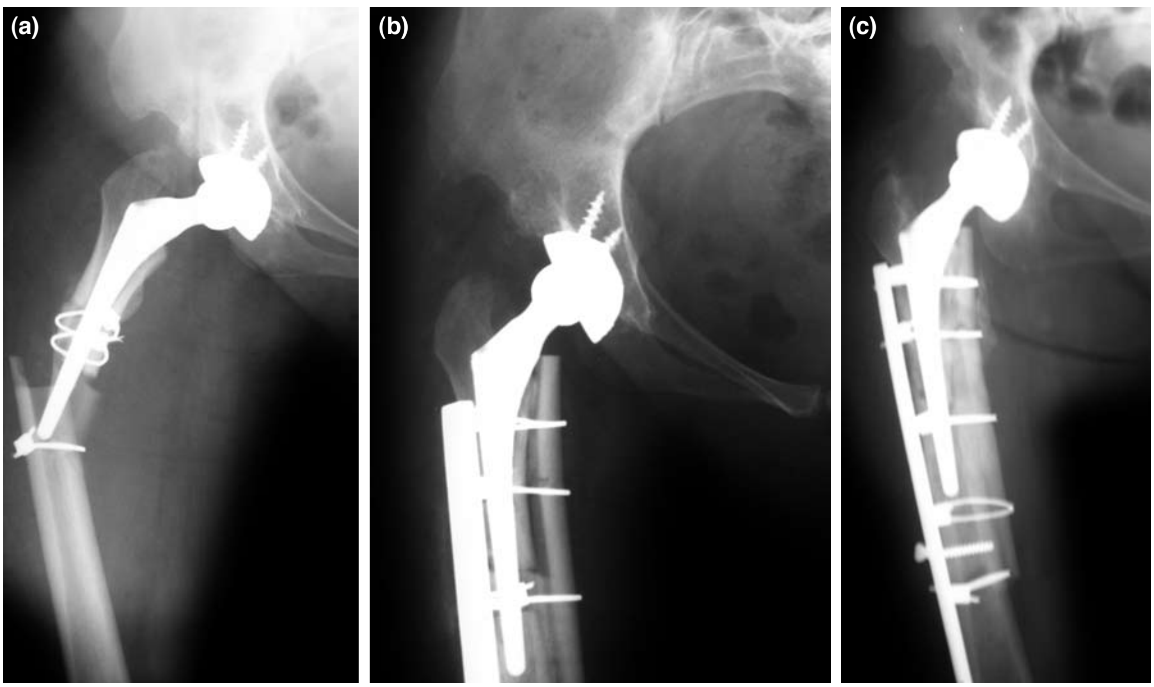


**Figure 3. (a)** Periprosthetic femoral fracture at the femoral osteotomy level. **(b)** Open reduction and internal fixation with plate and strut graft. **(c)** Seven years later after open reduction internal fixation.

Dealing with limb-length discrepancy is an important part of the surgical treatment of unilateral type II (low) and III (high) dislocation. The limb can be lengthened at the time of surgery by as much as 4 cm. If the soft tissues limit the femoral translation distally and the femoral head is more than 4 cm above the acetabulum, a shortening osteotomy is required. Step-cut, oblique, or chevron osteotomies can be used to obtain rotational stability, or cortical struts or a plate can be used with a subtrochanteric osteotomy to stabilize the osteotomy site.[15] A transverse subtrochanteric osteotomy is easier and decreases the operating time when compared with the other techniques.[16,17] Resected bone from the femur is used as a strut graft around the osteotomy site. We needed to perform a femoral osteotomy in two patients only (3.07%). The other type II and III hips were reduced with forceful traction. In addition, we controlled the sciatic nerve immediately after the patients woke up. We did not see any postoperative paralysis or loss of sensation in this group.

After inserting the femoral component in the transverse axis of the femoral condyle, we did not see any significant impingement between the greater trochanter and posterior wall of the acetabulum that reduced the external rotation or increased the risk of dislocation. The greater trochanter is usually small and often located posteriorly. Although many studies recommend a derotation osteotomy to increase the rotational movement of the hip, we did not perform a femoral osteotomy in type I hips. If we found any impingement between the greater trochanter and posterior wall of the acetabulum, we osteotomized the acetabular bone that ran over the cup posteriorly to increase the range of external rotation movement. In type II and III hips, the true acetabulum was small and osteophyte formation was observed around the false acetabulum, especially inferiorly. After reduction, no significant impingement posteriorly was observed. Consequently, we did not need to perform a derotational osteotomy with or without shortening.

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