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# Applications of total hip prosthesis to patients with coxarthrosis that has developed due to developmental hip dysplasia

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**Abstract**

The aim of this study was to evaluate the clinical and radiographic results of total hip arthroplasty (THA) for coxarthrosis secondary to developmental dysplasia of the hip (DDH). Examinations were made of 58 hips in 47 patients with DDH who were operated on between 1990-2000 (patients with anatomic centred hips with or without roof graft and/or femoral shortening). The patients were evaluated using the Modified Harris Hip Score pre- and postoperatively. The average Harris score increased from 47.7 preoperatively to 89.2 postoperatively. The average age of 43 female and 4 male patients was 48 years (24-65). All the patients presented with a limp, which was resolved after surgery in 34% and partially improved in others. The average medialization was 24 mm, and the average distal placement was 32 mm. A total of 28 (48%) complications were observed in 26 patients. Intraoperatively, fissures were detected in the proximal femur in 5, and were fixed with cerclage wiring. One patient with femoral shortening had hip dislocation one week later, so plate screw fixation was revised with open reduction. One patient had anterior thigh pain, heterotopic ossification was observed in three cases, and polyethylene wear in one case. All 20 patients who had superolateral acetabular grafting showed incorporation but there was observed to be resorption in a 20% section that was non-weight-bearing in 3 cases. THA is an effective treatment option for coxarthrosis in neglected DDH. Patients should be informed about the problems they may encounter after surgery and care should be taken in terms of complications such as dislocation, prosthesis infection, and vascular and nerve damage.

**Keywords:** developmental hip dysplasia, coxarthrosis, total hip arthroplasty, Harris hip score

## 1. Introduction

Early diagnosis and treatment are crucial for managing developmental dysplasia of the hip (DDH). In young patients who do not receive early diagnosis and treatment, interventions such as femoral and pelvic osteotomies, roof interventions, and hip arthrodesis are used as an alternative to total hip arthroplasty (THA). Compared to the normal adult population, the development of coxarthrosis is seen more in adult patients with DDH due to the prolonged exposure to body weight (1). Currently, THA is the option usually applied to these deformities.

As DDH patients are younger and have a wide range of anatomic abnormalities of the acetabulum and femur, this can present great challenges in THA. Complications such as limb length discrepancy, non-union in the osteotomy region, nerve damage, postoperative dislocation of the hip joint, valgus deformities in the knee, and aseptic loosening continue to be the main problems related to DDH (2).

The aim of this study was to review the clinical and radiographic results of THA applied to patients with Hartofilakadis type B and type C coxarthrosis, which had developed on the basis of DDH, and to evaluate the complications and their resolution.

## 2. Materials and Methods

A retrospective examination was made of patients with Hartofilakidis type B and type C dislocation who underwent THA in the 2nd Orthopaedics and Traumatology Clinic of Dışkapı Yıldırım Beyazıt Training and Research Hospital between 1990 and 2000. As the procedures related to THA in patients with Hartofilakidis type A were similar to those for primary coxarthrosis, these patients were not included in the study.

The study included 58 hips of 47 patients in which THA was reduced to the real acetabulum without grafting or shortening, those who underwent acetabular roof graft and those who underwent subtrochanteric femoral shortening. Of the cases, 43 (93%) were female and 4 (7%) were male. The average age at the time of surgery was 48 years, ranging from 24 to 65 years. The mean follow-up period was 37.6 months, with a range of 17 to 124 months (Table 1).

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**Table 1**. Demographic and clinical data of patients

| | Early/mid-term |
|---|---|
| **N (hips) n,** | 58 |
| **Age (year)** | |
| **Mean±SD** | 48.01±21.12 |
| **Range** | 24-65 |
| **Sex F/M n (%)** | 43 (%91) / 4 (%9) |
| **Follow-up time (month)** | |
| **Mean±SD** | 37.6±29.16 |
| **Range** | 17-124 |
| **Side n (%)** | |
| **Right** | 7 (%15) |
| **Left** | 29 (%62) |
| **Bilateral** | 11 (%23) |
| **Hartofilakidis type B/C, n (%)** | 35 (%60) / 23 (%40) |
| **FSO (n)** | 7 |
| **AG (n)** | 20 |
| **Medialization distance of the hip (mm)** | |
| **Mean±SD** | 24,06±1.05 |
| **Range** | 14-36 |
| **True acetabular reduction distance of the hip (mm)** | |
| **Mean±SD** | 32,14±1.9 |
| **Range** | 25-55 |
| **Femoral osteotomy healing time (weeks)** | |
| **Mean±SD** | 12.06±3.9 |
| **Range** | 10-14 |
| **Modified Harris Hip Score** | |
| **Preoperative** | **Early/mid-term** |
| 44.73 ±11.3 | 89.28±8.3 |

SD: Standard deviation; M: Male; F: Female; FSO: Femoral shortening osteotomy; AG: Acetabular grafting

Of the 58 hips applied with THA, 35 (60%) were type B, and 23 (40%) were type C. Bilateral THA was performed on 11 (18.9%) patients. In 51 cases, THA was performed without shortening, reduction to the true acetabulum by making subtrochanteric osteotomy (STO) in 7 cases, and acetabular roof graft to 20 cases. In one 19-year-old case applied with subtrochanteric femoral shortening, Schanz osteotomy was performed in another centre (Fig. 1-3).

### 2.1. Preoperative Planning

Each case underwent clinical and radiographic preoperative evaluation focusing on abductor mechanism function, limb length discrepancy, hip centre migration, the potential need for shortening osteotomy, the choice of suitable implants, and the achievement of primary stability. Additionally, antibiotic, and deep vein thrombosis prophylaxis were administered.

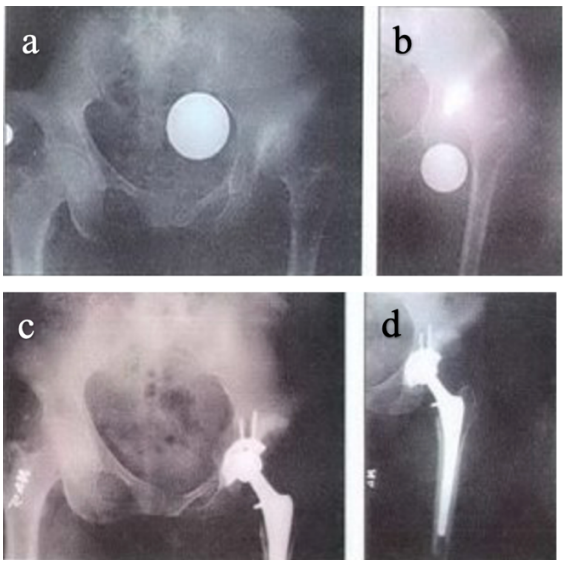


**Fig. 1.** A 49-year-old female patient with left coxarthrosis secondary to DDH, preoperative anteroposterior pelvic x-ray (a), anteroposterior left hip x-ray (b), and 26-month postoperative control pelvic x-ray (c) and anteroposterior left hip x-ray (d)

**Fig. 2**. 38-year-old female patient. Total hip arthroplasty was performed for bilateral coxarthrosis secondary to DDH. Preoperative anteroposterior pelvic radiograph (a), 6-month postoperative right hip radiograph (b) and 19-month postoperative left hip radiograph

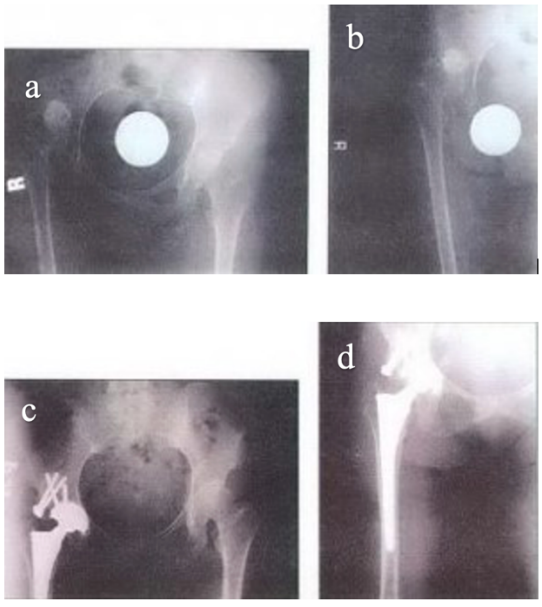


**Fig. 3**. A 49-year-old female patient with coxarthrosis secondary to DDH: preoperative anteroposterior pelvic x-ray (a), preoperative right hip x-ray (b), postoperative 24-month anteroposterior pelvic x-ray (c) and postoperative 24-month right hip x-ray (d)

### 2.2. Surgical Technique

All patients were positioned on their sides and posterolateral entry was made and the true acetabulum was prepared for the placement of the acetabular component. In the event that several tenotomies were necessary for reduction of the femur, adductor, iliopsoas tenotomy and loosening of the gluteus maximus from the linea aspera, as well as femur head-neck resection at the level of the trochanter minor were performed. Subsequently, the joint capsule was dissected to reach the true acetabulum. The hypertrophic capsule was completely excised in order to provide a wide view of the acetabulum. The proximal sections of the true acetabulum, including the pubic and ischial bones, were then exposed. The true acetabulum was widened and enlarged using small reamers (40-44 mm) to address the underdevelopment of the joint. The acetabulum was reamed gradually with hemispheric reamers until the medial wall of the true acetabulum was reached, with bleeding spongious bone. In uncemented cases, a porous-coated acetabular component was placed in the anatomic acetabular position using the press-fit technique, with the option of fixation with domed screws when necessary. In the event that acetabular bone was absent, autograft derived from the resected femoral head was employed to ensure adequate coverage of the acetabular component.

In the present study, subtrochanteric femoral shortening osteotomy was conducted on seven hips (15.9%) with a high dislocation incidence. When STO was performed, aggressive soft tissue loosening was not required. The degree of shortening was determined using preoperative radiographic measurements and intraoperative traction assessments. In one patient with a previous Schanz osteotomy, the shortening was combined with the correction of angulation from the prior procedure and adjustment of femoral anteversion. Following hip reduction, a 4-6-hole dynamic compression plate was positioned on the lateral femoral cortex, and unicortical screws were utilized for fixing the femoral osteotomy. Due to insufficient acetabular coverage in 20 (34.4%) hips, autografts from the femoral head were secured to the superolateral acetabulum using two spongious screws.

### 2.3. Implants and Fixation

Cemented prostheses were used in 3 (5%) hips, hybrid in 8 (14%), reverse hybrid in 3 (5%), and uncemented in 44 (76%). The external diameter of the acetabular cups varied between 40 mm and 54 mm. No supplementary rings, reconstruction cages, or special structure implants were used in any case.

The acetabular components used were acetabular component with screws (J&J, Aesculap, Zwei-Müller, Osteonisc) using domed screws (screw number varied between 0–3) in 52 cases. Cemented acetabular component (Exeter, Elite Plus) was used in 6 cases. Uncemented femoral component (AML, J&J, Aesculap, Zwei-Müller, Osteonisc, ABG, Medor) was used in 47 cases, and cemented femoral component (J&J ve Exeter) in 11 cases. Femoral head size was 28mm in 35 cases, 22mm in 21, and 32mm in 2.

### 2.4. Postoperative Care

Postoperatively, the patients were positioned supine, and a triangular pillow was placed between the legs to prevent hip adduction and internal rotation. Drain was removed after 24-48 hours, and the sutures were removed on the 15$^{th}$ day.

Prophylactic antibiotics were initiated one hour before surgery and were given twice daily for a duration of three days. Thromboembolism prophylaxis was administered as subcutaneous low-molecular weight heparin injection for 5 days, then 300 mg oral acetylsalicylic acid for 6 weeks. Active leg exercises were performed without the use of anti-embolic stockings.

Partial weight-bearing with underarm crutches was permitted for the first 6 weeks postoperatively, and in the subsequent weeks full weight-bearing was allowed. Patients who underwent acetabular grafting and shortening were permitted partial weight-bearing in the 6$^{th}$ week and full weight-bearing was reached gradually after 12 weeks.

Patients were discharged from hospital at mean 5 days (range, 4-8 days) and were then called for follow-up at 1.5 months, 3, 6, and 12 months postoperatively, and annually thereafter.

### 2.5. Clinical Evaluation

At the preoperative and postoperative examinations, all the patients were evaluated according to the modified Harris Hip Score (3) (Table 1). The strength of the abduction was evaluated using the Trendelenburg test.

### 2.6. Radiographic Assessment

Anterior-posterior (AP) and lateral radiographs of all the hips were taken preoperatively and postoperatively. On the AP radiographs, a line was drawn from the teardrops and the vertical distance of the centre of the femoral head from this reference line was compared (4). Horizontal migration was determined as the distance of the centre of the femoral head from the teardrop along this line. Acetabular inclination was measured on AP radiographs and recorded.

Evidence of loosening was evaluated according to the radiological follow-up parameters of Callaghan on the AP pelvis radiographs taken postoperatively and at the follow-up examinations. Radiolucent lines and sclerotic lines were evaluated in the areas explained by Gruen (5), and by Delee (6) and Charnley (7) for the acetabulum. The radiological Brooker classification was used in the classification of heterotopic ossification (8).

### 2.7. Statistical Analysis

Data obtained in the study were analysed statistically using SPSS software. Preoperative and postoperative continuous data were analysed using the two-sided, matched Student's t-test. Data were presented as mean and range values. A value of $p<0.05$ was accepted as statistically significant.

## 3. Results

The mean modified HHS increased from 44.73 preoperatively to 89.28 postoperatively (Table 1). The mean amount of medialization of the centre of hip rotation was 24.06 mm, and the mean distal placement was measured as 32.14 mm. Union was observed in all the structural grafts taken from the femoral head to support the acetabulum, and the STOs healed at mean 12 weeks (range, 10-14 weeks). The complaint of limping was present in all the patients preoperatively, and this complaint was completely resolved after surgery in 34% and partially improved in the others. The acetabular cup size used varied between 40 and 52 mm (mean 44mm). The mean inclination of the acetabular cup was measured as 48.23° (range, 37°-58°).

### 3.1. Complications

A total of 28 (48%) complications were observed in 22 patients (Table 2). These complications developed during the operation in 7 (12%) cases and postoperatively in 21 (36%). Femoral fissures occurred in 5 cases intraoperatively, which were addressed with cerclage wiring and patients were not permitted to bear weight for 6 weeks. Union was observed in all the cases during follow up. During reaming of the acetabulum in one patient, a medial wall fracture developed, so autogenous grafting was applied. Union of the fracture was observed during follow up and there was not seen to be any problem with the acetabular component.

**Table 2**. Complications

| | Early/mid-term n (%) |
|---|---|
| **Infection** | 1 (%1.7) |
| **Deep Vein Thrombosis** | 1 (%1.7) |
| **Intraoperative Fracture** | 6 (%10.3) |
| **Polyethylene wear** | 1 (%1.7) |
| **Hip Dislocation** | 3 (%5.17) |
| **Lower Limb Length Discrepancy** | 4 (%6.9) |
| **Sciatic nerve injury** | 1 (%1.7) |
| **Anterior thigh pain** | 1 (%1.7) |
| **Heterotopic ossification** | 4 (%6.9) |

Lengthening of the leg on the side to which THA was applied was seen to be 2cm in two patients, 3cm in one, and 4cm in one. Postoperatively, a lesion developed in the peroneal branch of the sciatic nerve in the patient with 4cm lengthening. This partially recovered in the 20-month follow-up period. The patients with limb length discrepancy of ≥2cm were given a boot to eliminate the shortness.

Dislocation developed in 3 patients. Closed reduction was performed in the case that developed dislocation in the 6$^{th}$ postoperative week. In one patient who underwent femoral shortening, left-side dislocation occurred after 7 days, and revision was performed with open reduction and plate-screw fixation. This patient developed acute renal failure after the operation, then recovered after 3 cycles of hemodialysis.

There was anterior thigh pain in one patient and this complaint decreased by the end of the first year. Heterotopic ossification was determined as Brooker grade 1 in one patient, and grade 2 in three patients. As movement was not restricted to the extent that would prevent daily activities no surgical treatment was performed.

In one patient followed up without pain, polyethylene wear was determined by the 10$^{th}$ year. In all 20 cases that underwent superolateral grafting of the acetabulum, union was obtained and there was observed to be resorption in a 20% section that was non-weight-bearing in 3 cases.

Two-stage revision was recommended for one patient with infection determined in the 6$^{th}$ postoperative month, but the patient refused this treatment. Deep vein thrombosis was determined in one patient in the 3$^{rd}$ week after surgery, and this was treated appropriately.

## 4. Discussion

In the preoperative and postoperative clinical evaluations of the patients in this study, the most significant improvement was in pain. The results obtained confirmed that hip-origin pain is the primary indication for the application of THA to patients with DDH.

Trochanteric overgrowth may result from avascular necrosis, which occurs when the femoral head fails to grow properly. This can be caused by impaired growth or previous treatments in patients with developmental dysplasia of the hip (DDH) (9). In such cases, the trochanter major moves superior to the centre of the femoral head. In this situation, the neck length of the femoral component can be adjusted to raise the femoral head to a higher level. An increase in offset of the femoral component can help to improve abductor arm function (10,11).

In instances of high dislocations, notable anatomical changes may be observed on either the acetabular or femoral side. The acetabulum is typically shallow and underdeveloped, accompanied by a heightened acetabular anteversion angle and diminished anterosuperior bone stock. Additionally, the femoral head is smaller, and the neck is shorter. The femoral canal is narrow and straight, and the trochanter major is situated posteriorly. These structural abnormalities, along with a high hip centre, cause complications such as abductor muscle failure in the adjacent soft tissues, capsular thickening, and the shortening of neurovascular structures, resulting in improper placement (12). Femoral shortening addresses these issues by protecting neurovascular structures, correcting excessive femoral anteversion, and properly positioning the abductor arm laterally (8,13–17).

For patients with DDH, the acetabular component should be positioned in the true acetabulum where the bone stock is optimal (7,16–18). Hartofilakidis et al. (19) found that placing the acetabular component in the false acetabulum causes the moment arm of the body's center of weight to be longer than that of the abductor mechanism. This results in a reduction of strength in the abductor arm and increased loading on the hip. In the current study, due to the positive effects on the abductor mechanism of taking the centre of hip rotation medial and

inferior, the acetabular component was placed in the true acetabulum, at mean 32 mm distal and 24mm medialised.

In the long-term follow up of 129 dysplastic hips applied with THA, Linde et al. (20) reported loosening at the rate of 13% in components placed in the true acetabulum, and at the rate of 42% in components placed in the false acetabulum. In the current study, the acetabular component was placed in the true acetabulum in all the cases.

Garvin et al. concluded that to reduce exposure of the graft to stress and provide sufficient bone support to the prosthesis, it is necessary to use a small acetabular component and to achieve medial placement of the acetabular component (21). To be able to have sufficient acetabular coverage, 80% of the acetabular component must be covered with intact bone (22,23). The remaining section is grafted with femoral head autograft (the spongious part of the graft to come to the subchondral bone). In cases where femoral head autograft is used, grafting is made from bone preferably taken from the femoral neck if the head is cystic. Iano and Matsuno stated that corticocancellous graft taken from the femoral neck is superior to femoral head graft (24). In the current study, as acetabular coverage was insufficient in 20 (34.5%) cases, autograft taken from the femoral head was fixed with two spongious screws to the superolateral of the acetabulum. The autografts used supported a 30-40% section of the acetabular component. Although radiological signs of graft union emerge in 2-4 months, a period of 4 years is required for complete fixation (24,25). During the radiological follow up, there may be resorption in the weight-bearing region of the graft (25). In the current study, resorption was observed at the rate of 20% in the non-weight-bearing section of the graft in 3 (5.17%) cases.

The complication rate following THA applied to patients with DDH is higher than that of cases with primary osteoarthritis (26–28). In a study by Ferguson, the revision and complication rates were found to be higher in patients who had previously undergone femoral osteotomy (29). There is a high risk of fracture forming in the femur during placement of the prosthesis or in the reaming procedures associated with femoral deformities in dysplastic hips. In fractures including the proximal third of the femur, the fracture region is opened, anatomic reduction is performed, and cerclage is applied (30,31). A fracture that did not pass the trochanter minor developed in 3 (6.81%) of the current study cases, all of whom were treated with cerclage following reduction.

Nerve lesions following THA have been reported at the rate of 0.5-2%, and this rate has been reported as 3-15% in patients with dysplasia (32–38). Lesions in the peroneal branch of the sciatic nerve constitute 80% of all nerve lesions. When lowering the acetabulum to the true level, femoral shortening may be necessary to reduce the risk of sciatic nerve lesion. To avoid increasing the risk of sciatic nerve lesion, the femur should generally not be lengthened by more than 4 cm (14,21,35). In one case in the current study, a lesion developed in the peroneal branch of the sciatic nerve, and this showed improvement in the 20-month follow-up period.

Femoral shortening is not limited to the protection of neurovascular structures, but also provides correction of excessive femoral anteversion and lateral placement of the abductor arm (14,15). By removing the thin femur segment seen in some cases and good fixation, subtrochanteric osteotomy provides easier placement of the femoral component. In 7 patients with Hartofilakidis Type C in the current study, transverse subtrochanteric femoral shortening osteotomy was performed and fixed with plate-screws.

The dislocation rate after THA in dysplastic hips has been reported to be 5-11% (38–40). The accepted mean incidence for dislocation in all THAs is 2.7%. Yetkin et al. reported that the main determinants of hip dislocation after THA in patients with DDH are previous hip surgery, a high hip centre and a more vertical acetabular inclination, and stated that the surgical approach does not affect the dislocation rate (41). In the current study, dislocation was seen in 3 (5.17%) cases.

Deep vein thrombosis (DVT) is the most frequently seen complication in patients not administered prophylaxis, at a frequency of 50-70%. The rate of pulmonary emboli as a result of DVT is 6-19%, and the rate of deaths due to pulmonary emboli is 1-3%. Mechanical and pharmacological methods are used in thromboembolism prophylaxis. The most common pharmacological prophylaxes are acetyl salicylic acid and low-molecular weight heparin (LMWH). The period of greatest risk for thromboembolism has been reported to be the postoperative second and third weeks (41). In our clinic, LMWH was administered as prophylaxis throughout the hospital stay (mean 5 days), followed by 300 mg acetyl salicylic acid for six weeks after discharge.

Limitations of this study can be said to be the retrospective design and that the cases, the surgical techniques applied, and the implants used were not homogenous.

Despite the technical difficulties and high complication rates, the aim of THA is to reduce pain and for patients to regain the activities and social life that have been restricted.

Patients must be informed in detail preoperatively about problems that may be encountered such as shortening osteotomy and limb length discrepancy, and care must be taken in respect of the main complications such as dislocation, prosthesis infection, and vascular and nerve damage.

In patients with coxarthrosis that has developed on the basis of DDH, THA seems to be an effective treatment option.

**Conflict of interest**
The authors declared no conflict of interest.

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**Authors' contributions**

Concept: H.G., F.İ.P., Design: H.G., A.A., F.İ.P., Data Collection or Processing: A.A., Analysis or Interpretation: H.G., A.A., Literature Search: H.G., Writing: H.G., A.C.B., F.İ.P.

**Ethical Statement**

Approval was obtained from Ondokuz Mayıs University Clinical Research Ethics Committee, the study started. The ethics committee decision date is 31/01/2024 and the number of ethical committee decisions is 2024/39.

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