This study explored the surgical method and short-term clinical effect of a greater trochanter osteotomy along with cementless artificial total hip arthroplasty in the treatment of Crowe type IV developmental dysplasia of the hip. The authors conducted a retrospective analysis of 18 patients (22 hips) with Crowe type IV dysplasia who were seen between June 2008 and August 2010. After undergoing cementless artificial total hip arthroplasty using a posterolateral approach, a greater trochanter osteotomy was used to adjust the tension of the gluteal muscle, and an acetabular cup was placed.

Average preoperative length shortening of the affected limb was 4.5 cm (range, 3.4-6 cm), and average postoperative length increase was 4.0 cm (range, 3.2-4.8 cm). Average postoperative Harris Hip Score was 87 (range, 79-91), which was higher than the average preoperative score of 38 (range, 32-51). Intraoperatively, 3 hips (3 patients) sustained a proximal femur fracture. Due to the stability of the femoral prosthesis, either no treatment or wire fixation only was given; by 2 months postoperatively, radiographs indicated that all fractures had healed. One patient had symptoms of sciatic nerve paralysis that resolved 3 months postoperatively.

Performing a greater trochanter osteotomy after cementless artificial total hip arthroplasty is effective for the treatment of Crowe type IV dysplasia and can rebuild the complex biology and biomechanics of hip dysplasia without increasing the complication risk.
Crowe type IV developmental dysplasia of the hip is the most severe and complex type of hip dysplasia, corresponding with Hartofilakidis type III (high dislocation), which was reported in 1996.\textsuperscript{1,2} Its clinical manifestation includes complete femoral head dislocation, significant shortening of the affected extremity, serious hypogenesis, and deformation of the acetabulum and proximal femur.\textsuperscript{3} Artificial total hip arthroplasty (THA) is an effective treatment for advanced adult hip joint lesions.\textsuperscript{4} However, some risks remain, including a high incidence of complications, which may result in unsatisfactory surgical outcomes.\textsuperscript{5} The current authors conducted a retrospective study to analyze the clinical effect of using a greater trochanter osteotomy along with cementless THA to treat Crowe type IV dysplasia combined with osteoarthritis.

**MATERIALS AND METHODS**

This study was performed at the authors’ institution between August 2011 and April 2012. Eighteen patients (22 hips) with dysplasia were treated with THA between June 2008 and August 2010. One man and 17 women with an average age of 39.8 years (range, 27-49 years) were included in the study. Seven patients had moderate claudication and 11 had severe claudication. All patients received a cementless TKA, and a greater trochanter osteotomy was performed to adjust the gluteus medius strength.

**Inclusion Criteria**

Radiographs showed Crowe type IV dysplasia with some secondary symptoms of late-stage osteoarthritis, such as significant joint space narrowing, subchondral bone sclerosis, and cystic degeneration. Hip pain and dysfunction seriously affected the patients’ quality of life, making them eager to relieve their symptoms and improve function through surgical treatment.

**Materials**

The biotype congenital hip prosthesis (LINK, Hamburg, Germany) was used at the femur stem. The prosthesis is made using titanium alloys with MS HX coating and a ceramic head. The T.O.P. biotype cup (LINK) was used at the prosthetic acetabulum. The cup is made using titanium alloys with MS HX coating and a polymer polyethylene lining.

**Surgical Technique**

Preoperative examination was conducted. Preoperative radiographs included anteroposterior radiographs of the pelvis (Figure A), anteroposterior and lateral (Figure B) radiographs of the affected hips, and a full-length radiograph of the lower limbs. Preoperative templating using the radiographs was performed to determine the position, size, depth, and anteversion angle of the false and real acetabulum; the bone thickness surrounding the real acetabulum; the developmental condition of the proximal femoral bone; the width of the medial cavity and whether it was bent; and the difference in length between the lower limbs. Using the above measurements, a detailed surgical plan was made to guide the reconstruction of the acetabulum and proximal femur and the prosthesis selection. Digital templating has been reported to significantly improve the accuracy of cementless THA.\textsuperscript{6,7} Due to abnormal hip shapes, special implants with different geometries or modular stems may be needed for reconstruction, especially for patients with dysplasia without a false acetabulum, who are at a greater risk of dislocation.\textsuperscript{8}

All operations were performed by the same surgeons (Y.H., J.X.). Intraoperatively, a neurophysiologist monitored the electromyography, somatosensory evoked potential, and motor evoked potential of the lower limb nerves (mainly the sciatic nerve) using a Viking Select myoelectricity evoked potential machine (Nicolet, San Carlos, California).

After general anesthesia was administered, the superficial fascia was opened through the posterolateral approach. The gluteus maximus was separated to expose

![Figure: A 48-year-old patient with bilateral Crowe type IV developmental dysplasia of the hip underwent total hip arthroplasty of the right hip. Preoperative anteroposterior radiograph of the pelvis (A), preoperative lateral radiograph of the right hip (B), and postoperative anteroposterior (C) and lateral (D) radiographs of the right hip.](image-url)
the external rotation muscles and were cut out at the side clinging to the intertrochanteric ridge. The external rotation muscles were then lifted posteromedial. After resecting the joint capsule, fibrous scar, and osteophyte, part of the tensor fascia lata fascia was cut off, and then partial insertion of the gluteus maximus, rectus femoris, adductor, and iliopsoas were released in that order. The gluteus medius was not released but rather was only cut off part of the aponeurosis when necessary. The femoral head was then pulled out and cut off the greater trochanter with the gluteus medius. The femoral neck was exposed, cut off using a power saw, and removed, retaining 1 to 1.5 cm of the femoral calcar.

The authors identified the real acetabulum and resected the fiber and fat tissue in it. Small and large drills were used to shape the acetabulum with antversion of 15° and abduction of 45°, as guided by the preoperative templating results. If the defect of the acetabular wall was larger than 30% of the wall, a structural graft bone from the repaired, removed femoral head was applied to reconstruct the acetabulum. Then, the authors fixed the acetabulum with screws and put the acetabular prosthesis in place. For patients whose limb lengthening was greater than 3 to 4 cm, the sciatic nerve needed to be exposed and released up to the greater sciatic foramen and down to one-third of the thigh to determine the tension of the nerves. After sciatic nerve release, the authors performed traction.

When the osteotomy plane was down to the acetabular prosthesis plane and sciatic nerve tension was low, the femoral canal was reamed. For patients with high sciatic nerve tension, a subtrochanteric osteotomy was used. Intraoperatively, oppression of the sciatic nerve from prolonged traction should be avoided, and the knee should be placed in flexion during dislocation and reduction to keep the sciatic nerve in a relaxed state. An intramedullary broacher was used to ream the medullary cavity of the femur. The implant mold was then placed. If the reposition was satisfactory, the mold was removed and the medullary cavity was rinsed using physiological saline. After that, the femoral prosthesis was implanted and the hip joint was replaced.

The greater trochanter was then pulled downward and outward to overlap the lateral border of femoral shaft. Steel wire or a poly-para-dioxanone line was used to fix the gluteal muscles once they maintained a certain tension. No patient in this study received subtrochanteric shortening osteotomy. Finally, a drainage tube was placed and the incision was sutured.

**Postoperative Treatment**

Postoperatively, T shoes should be worn on the affected limb to keep the hip in neutral abduction. Intraoperatively, patients with femoral fractures were given hip spica cast plaster fixation. Patients with a simple femoral osteotomy could bear weight during ambulation beginning at 3 weeks postoperatively. Patients who received an acetabular bone graft (3 hips in 2 patients) and those with intraoperative femoral fractures (3 hips in 3 patients) were told to gradually begin weight-bearing ambulation by 2 months postoperatively, depending on the signs of bone healing seen on radiographs (Figures C, D). Radiograph examination was performed every 3 to 4 months for the first postoperative year, after which radiographic examination was only required annually.

**Evaluation Criteria**

The affected limb length (from the anterior superior iliac spine to the medial malleolus) was separately measured preoperatively and postoperatively. Harris Hip Score was referenced to evaluate the function of the affected hip. Main observational index is the pre- and postoperative Harris Hip Score. SPSS version 17.0 statistical software (SPSS, Inc, Chicago, Illinois) was used to conduct the t test for statistical analysis.**

**RESULTS**

Eighteen patients (22 hips) were included in this study. All patients were followed for 10 to 38 months (average, 22.5 months). Average preoperative shortening length of the affected limb was 4.5 cm (range, 3.4-6 cm), and average postoperative prolonging length of the affected limb was 4.0 cm (range, 3.2-4.8 cm). One patient had symptoms of sciatic nerve paralysis that resolved 3 months postoperatively. Intraoperatively, 3 patients sustained a proximal femur fracture and depending on the stability of the femoral prosthesis, wire fixation or no treatment was provided; radiographs indicated that the fractures had healed by 2 months postoperatively. Three months postoperatively, radiographs for all patients showed that the position of the osteotomy had healed well without postoperative hip dislocation, prosthesis loosening, infection, and clinical manifestations of deep vein thrombosis. The prosthesis’ bony covering was satisfactory in patients (3 hips in 2 patients) who received acetabular structural bone graft reconstruction. The plant bone mass fit well with the prosthesis and the graft bed, with no acetabular prosthesis loosening or obvious plant bone mass absorption.

Claudication was significantly improved postoperatively. Average preoperative Harris Hip Score was 87 (range, 79-91), which was significantly greater than the postoperative average score of 38 (range, 32-51) (P<.01).

**DISCUSSION**

**Processing of the Acetabular Reconstruction**

Positioning of the cup remains disputable. All cups were put in the true acetabulum in the current study, and most authors support this method.9-11 In 1988, a total of 129 patients with hip dysplasia underwent THA, and a 15-year follow-up showed that the mechanical loosening rate for patients with acetabular component placement in the true acetabulum was 13%...
compared with 42% for patients with acetabular component placement proximal to the roof of the true acetabulum. One possible explanation for the high loosening rate was that the false acetabulum was not physiological and a prosthesis placed in the false acetabulum might decompose in a short time. On the contrary, the prosthesis placed in the real acetabulum was conducive to long-term functional improvement. Repositioning to the real acetabulum could lengthen the limbs and the force arm of the hip joint and improve the power of its surrounding muscles. In most patients, false acetabulums were difficult to polish to the appropriate depth and angle due to the poor bone condition, which led to a high rate of loosening postoperatively. For patients with unilateral Crowe type IV dysplasia, placement of the prosthesis in the real acetabulum can reduce the loosening rate and is conducive to the recovery of bilateral hips to the same height, as well as the normal gait.

Excessive bone loss of the acetabular edge or the acetabular bottom would lead to early loosening or wear of the acetabular bottom by the prosthesis. Most reports recommend using the structural graft bone that came from the trimmed resected femoral head to reconstruct the acetabulum on its edge. One study showed that reconstruction of the acetabulum using a cementless acetabular prosthesis combined with a structural graft bone to treat dysplasia had a satisfactory 11-year survival rate.

For 4 patients with a large acetabular bed defect, the healthy parts of the femoral head were cut into an appropriate shape and temporarily fixed by a Kirschner wire. Then, the authors used a drill to polish it and temporarily fixed by a Kirschner wire. The later review the Kirschner wire was replaced by a cannula screw to fix it. The later review showed that the graft bone fit well with the prosthesis and bone bed with no acetabular prosthesis loosening or significant absorption of the graft bone.

Greater Trochanter Osteotomy and Dispose of the Femur

All patients underwent greater trochanter osteotomy and femoral neck osteotomy by the lesser trochanter. Then, the greater trochanter was pulled downward and outward to overlap the lateral border of the femoral shaft. Finally, it was fixed with a poly-para-dioxanone line or steel wire. The osteotomy incision site healed within 1 to 2 months. This method is simple and effective, resulting in no subtrochanteric femoral shortening or nonunion after osteotomy. Moreover, it can safely expose the acetabulum and femur, effectively extend the shortening limb, and successfully install and reset the prosthesis. Furthermore, the strength of the gluteus medius can be better preserved postoperatively. Therefore, no need exists to adopt subtrochanteric shortening osteotomy, and many authors support this method.

This method is feasible based on the actual verification. The reasons to support this method are as follows: (1) the greater trochanter and proximal femur can be moved down after loosening the tissue surrounding the hip; (2) oblique oriented fibers in the gluteus medius can be stretched to be vertically oriented and prolonged; (3) because the osteotomy surface of the greater trochanter is long and oblique, it can be partly fixed with the femoral shaft and extend the limb after moving down; and (4) abducting the affected limb can effectively shorten the moving down distance of the greater trochanter by approximately 1 to 2 cm, and patients can gradually adduct the affected limb after 2 weeks postoperatively.

Injury to the sciatic and femoral nerves should be considered. Nerve damage can be minimized or avoided by using correct surgical techniques and postoperative care. One study reported that in 56 adult patients with Crowe type IV dysplasia, postoperative average extension of the affected limb was 4.6 cm (with the longest extension 5.5 cm), and no patient showed sciatic or femoral nerve palsy. In the current study, 1 patient had a sciatic nerve palsy and recovered 3 months postoperatively. Lai et al and Faldini et al recommended choosing a small straight or customized femoral prosthesis and paying attention to the torsion of the medullary cavity when reamed. After intraoperative femoral fracture, 3 patients were fixed with either steel wire (2 patients) or given no special treatment (1 patient) and were told to stay in bed for 4 weeks postoperatively so the fracture healed, and then they could begin partial weight-bearing exercises.

Treatment of the Tissues Surrounding the Hip

For patients with Crowe type IV dysplasia, long-term hip dislocation leads to the contracture of the periarticular tissue, which limits the femoral head back to the real acetabulum. Thus, the soft tissue should be released intraoperatively. The correct release of tissues surrounding the hip can help expose the real acetabulum, which is conducive for the prosthetic femoral head to reset in the real acetabulum and improve limb length. The surrounding hip tissue in patients with dysplasia had different degrees of lesions; as a result, extensive release was needed. The current release method is as follows: after resecting the joint capsule, fibrous scar, and osteophyte, the authors cut off part of the tensor fascia lata fascia and released part stop points of the gluteus maximus, rectus femoris, adductor, and iliopsoas. The gluteus medius is the main driving force of the hip abductor muscle and the decisive factor of hip stability and gait; as a result, the authors did not release it but only cut off part of the aponeurosis when necessary.

A follow-up study of 508 patients showed that sciatic nerve injury after THA might be associated with several factors, such as surgical history, proximal
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femur deformity, and severe hip flexion and contracture, but not with the limb lengthening, which is consistent with the current and other studies. The current authors recommend that intraoperative oppression of the sciatic nerve from prolonged traction should be avoided and that the knee should be placed in flexion during dislocation and reduction to keep the sciatic nerve in a relaxed state. For patients with a history of hip surgery whose sciatic nerve often adheres to the surrounding scar tissue, careful dissection is necessary to avoid direct injury to the sciatic nerve.

**CONCLUSION**

The short-term effect of greater trochanter osteotomy with cementless artificial THA is effective for the treatment of Crowe type IV dysplasia, which can rebuild the complex biology and biomechanics of hip dysplasia without increasing the complication risk. The middle- and long-term clinical results need further follow-up evaluation.

**REFERENCES**


