Original Article

# Cementless arthroplasty with a distal femoral shortening for the treatment of Crowe type IV developmental hip dysplasia

*Chang-Yong Guo, Bo-Wei Liang, Mo Sha, Liang-Qi Kang, Jiang-Ze Wang, Zhen-Qi Ding*


## Abstract

**Background:** Severe developmental dysplasia of the hip is a surgical challenge. The purpose of this study is to describe the cementless arthroplasty with a distal femoral shortening osteotomy for Crowe type IV developmental hip dysplasia and to report the results of this technique.

**Materials and Methods:** 12 patients (2 male and 10 female) of Crowe type IV developmental hip dysplasia operated between January 2005 and December 2010 were included in the study. All had undergone cementless arthroplasty with a distal femoral shortening osteotomy. Acetabular cup was placed at the level of the anatomical position in all the hips. The clinical outcomes were assessed and radiographs were reviewed to evaluate treatment effects.

**Results:** The mean followup for the 12 hips was 52 months (range 36-82 months). The mean Harris hip score improved from 41 points (range 28-54) preoperatively to 85 points (range 79-92) at the final followup. The mean length of bone removed was 30 mm (range 25-40 mm). All the osteotomies healed in a mean time of 13 weeks (range 10-16 weeks). There were no neurovascular injuries, pulmonary embolism or no infections.

**Conclusion:** Our study suggests that cementless arthroplasty with a distal femoral shortening is a safe and effective procedure for severe developmental dysplasia of the hip.


**Key words:** Developmental dysplasia hip, distal femoral shortening, total hip arthroplasty, cementless
**MeSH terms:** Hip dysplasia, congenital, hip dislocation, arthroplasty, replacement, hip

## Introduction

Despite advances in total hip arthroplasty (THA), severe developmental dysplasia of the hip continues to pose a challenge to the orthopedic community.[1-3] There are many anatomic deformities in a dysplastic hip, including increased proximal femoral anteversion, deficient acetabular bone, a small and narrow femoral canal, as well as soft tissue contracture.[4,5] It is generally recommended that the acetabular component should be placed in the true acetabulum for better biomechanics.[3,5-7] However, several studies have been published reporting that a leg lengthening of over 4 cm can result in sciatic nerve palsy.[3,8,9] Fortunately, evidence has shown that the risk of postoperative nerve palsy can be substantially reduced by femoral shortening.[10,11]

A variety of proximal femoral osteotomies have been described for the treatment of severe developmental dysplasia of the hip.[4,5,10,12-14] Multiple studies have shown relatively good clinical results when these techniques were used as part of the treatment protocol.[5,8,12,15] However, there are some problems and potential pitfalls associated with proximal femoral shortening such as nonunion, difficult surgical technique and is time consuming.[5,11] Consequently, the optimal osteotomy strategy for treating severely dysplastic hip remains controversial.

To overcome the above shortcomings at our institute, we have adopted cementless arthroplasty with a distal femoral shortening osteotomy. There are few reports concerning distal femoral shortening. Especially, midterm and long term clinical results of this technique have not been reported. The aim of this study was to describe the surgical technique, outline the advantages of the technique when compared

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| Quick Response Code: | Website: www.ijoonline.com |
| | DOI: 10.4103/0019-5413.159652 |

with proximal femoral shortening osteotomy, and to report our mid to long term clinical results.

## Materials and Methods

12 patients with Crowe type IV dysplasia underwent surgery at our institution in which cementless arthroplasty with a distal femoral shortening osteotomy is performed between January 2004 and December 2010. There were 2 men and 10 women. Mean age at the time of surgery was 47 years (range 30-75 years). Patients who had severe curvature of the proximal femur were excluded. No patient had any history of operative intervention for developmental dysplasia of the hip. Preoperative good quality radiographs were used to select appropriate prosthesis. All femoral component fixations were uncemented. All hips were managed with a proximally hydroxyapatite coated femoral component (Depuy, Warsaw, Indiana). Porous coated acetabular components with dome screws were used in all hips (Depuy, Warsaw, Indiana). Cups ranged from 40 to 42 mm in outer diameter. The main reason for THA in all patients was pain around the hip and abnormal gait. No patient was lost to followup.

### Operative procedure

Patients were placed in the supine position. An incision centered over the greater trochanter was made. After resection of the femoral head, all fibrous scar tissue and osteophytes covering the true acetabulum were excised to facilitate proper placement of the acetabular component. Dissection of the inferior part of the elongated capsule permitted exposure of the true acetabulum. Soft tissue releases were performed as needed for the reduction of the hip. The adductors and parts of the iliotibial tract were split, if necessary, the iliopsoas was released. In addition, the attachments of the rectus femoris could be transected in some cases. The acetabulum was reamed carefully with curved gouges. The direction of reaming was in a medial and posterior wall. Frequent checks of the depth of reaming was made to ensure that the medial wall was not violated. After the acetabular component had been inserted in the true acetabulum, the process of femoral intramedullary reaming was started. Graduated sized reamers were used to enlarge the canal sufficiently. If the proximal femoral cortex was thin, a cerclage wire was placed around the proximal femur to prevent an inadvertent fracture. Next, an appropriate size femoral component was inserted. The precise degree of anteversion determined by the broach was reproduced. Manual traction was applied to the extremity with the hip in slight flexion. If it was difficult to reduce, it was checked for soft tissue or neurovascular tension. A transverse osteotomy was performed at the distal metaphysis until the tension was tight. The lateral aspect of the femur was exposed through a standard straight incision, starting distally to the epicondyle and extending the incision about 10 cm proximally. A retractor was placed under the posterior aspect of the femoral metaphysis to protect the vessels and to fully expose the femur so as to place the plate in the desired position. It was noteworthy that the osteotomy performed parallel to the landmark, the exact site of the osteotomy varied on the basis of the patient's anatomy, but it was generally four finger breadth above the lateral epicondyle. The corresponding length of bone was excised from the distal femur to allow reduction of the hip [Figure 1]. While performing the osteotomy, it was important to regularly check progress to ensure the direction of the cut. The bone block of resected femur was longitudinally divided into two pieces, of which one was used as an osteotomy site graft [Figure 2]. Later, the plate was positioned on the lateral femoral cortex and stabilized with screw under radiographic control. Finally, with the hip reduced, range of motion and stability was confirmed. The wound was closed in layers over a suction drain [Figure 3].

Postoperatively, prophylactic antibiotics (1.5 g of cefazoline) were administered intravenously 3 times a day for the first 24 h, low-molecular-weight heparin (enoxaparin 40 mg/day) was given prophylactically for 5 days. Immediately after the surgery, passive motion exercises were begun to keep the joint mobile until active motion of the joint as possible. The patients were mobilized with partial weight bearing on two crutches for 8 weeks postoperative until radiological signs of healing were seen.

Clinical and radiographic followup examinations were evaluated preoperatively, at 6 weeks, 3 months, 6 months, and 1 year postoperatively; and annually thereafter until the latest followup. The Harris hip score was used to determine the functional level and evaluate pain.[16] Trendelenburg

**Figure 1:** Intraoperative photograph showing traction being applied to the extremity and the corresponding length of bone was excised from the distal femur

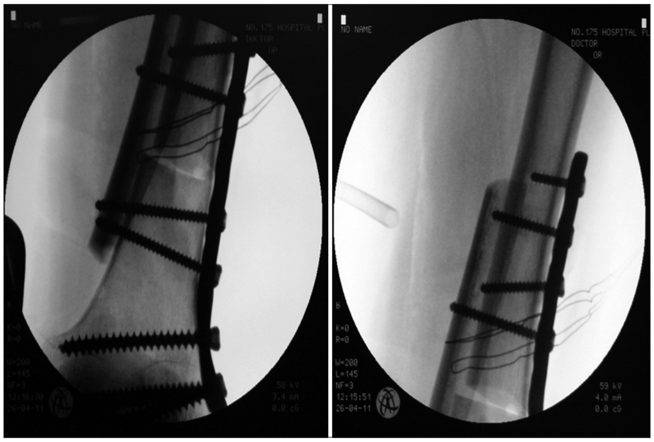

**Figure 2:** Fluoroscopic views taken intraoperatively showing placement of medial bone block

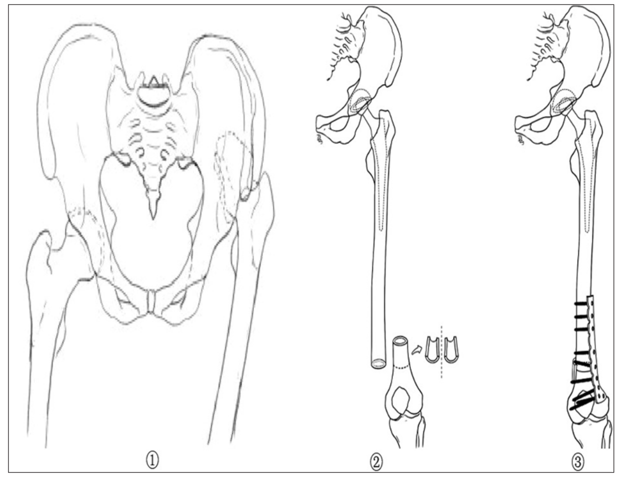


**Figure 3:** Illustration demonstrating the process of cementless arthroplasty with a distal femoral shortening osteotomy

sign was used to measure abduction strength. Leg lengths were also measured before and after the surgery. Standard anteroposterior (AP) and lateral radiographs were taken routinely. Healing of the osteotomy site was assessed, radiological union was considered to have occurred when osteotomy line was no longer visible on both the AP and the lateral views. The radiographs were also examined for acetabular and the femoral components. On the acetabular side, radiolucent lines around the implant and the stability of the acetabular components were assessed according to the criteria of DeLee and Charnley.[17] On the femoral side, the stability of the femoral component was assessed by the criteria of Engh *et al*.[18]

## Results

The mean followup was 52 months (range 36-82 months). The average Harris hip score improved from 41 (range 28-54) preoperatively to 85 (range 79-92) at the final followup. The mean preoperative pain component of the Harris hip score was 20.2 (range 10-40). The mean postoperative pain score was 42.5 (range 18-44). At last followup, all patients reported significant pain relief and functional improvement. The average length of bone removed was 30 mm (range 25-40 mm). A Trendelenburg gait was present in all patients preoperatively. Postoperatively, this gait disappeared in seven and persisted in five. The abduction strength of 7 (58.3%) of the 12 hips was graded as good or slightly decreased.

Radiologically, the mean lengthening discrepancy decreased from 38 mm (range 28-52 mm) at the time of surgery to 12 mm (range 6-20 mm) at the last review. The mean leg lengthening achieved was 32 mm (range 24-42 mm).There was no evidence of acetabular component migration or loosening. All the femoral components showed radiographic evidence of bone ingrowth at the last followup evaluation. All osteotomies healed without any complication. The average time to union at the osteotomy site was 13 weeks (range, 10-16 weeks). No patient had a revision of the acetabular or femoral component.

Intraoperative fracture of the proximal fragment occurred in one patient, which was successfully stabilized by wiring. Postoperative complication was early dislocation in one case. Closed reduction was successful in this patient. There were no further dislocations at followup. There were no neurovascular injuries, pulmonary embolism or infections.

## Discussion

Different osteotomy techniques[4,14,19] have been described to treat severe developmental dysplasia of the hip. However, most of these focuses on the proximal femur. It has been suggested that several challenges in the presence of proximal osteotomy. The transverse osteotomy is relatively technically simple, but nonunion of the osteotomy is the major complication because of inherent instability.[2,8] Masonis *et al*., in a study of 21 hips treated with subtrochanteric transverse osteotomy, reported that 2 hips required revision surgery because of nonunion. Furthermore, Krych *et al*.[8] have reported on 28 patients with Crowe type IV developmental dysplasia who underwent a transverse osteotomy. Osteotomy nonunion occurred in two cases. A step-cut or oblique osteotomy may increase the overall contact area between the two fragments. However, accurate reduction is extremely difficult. Double chevron osteotomy could enhance bony healing through improving stability. Unfortunately, this technique is both complex and time consuming.[2] Hence, there is still controversy concerning the best method of osteotomy in such cases.

To address the above problems, we perform metaphyseal segmental osteotomy in the distal femur. Recently, Koulouvaris *et al.*[19] showed a similar technique. In a study of 24 patients with this technique that combines THA with a distal femoral shortening in severely deformed hips, there was one delayed union. However, they performed transverse osteotomy in the middle femoral shaft. Compared to the femur shaft shorting, metaphysis has a rich blood supply and can provide better biomechanical stability, enhancing the rate of osteotomy site healing and minimizing the risk of nonunion. Furthermore, we insert the osteotomy gap with bone from the resected bone block, which can provide good mechanical support and increase the bone mass in the osteotomy gap [Figure 4]. In this study, the time of the union of the osteotomy site ranged from 10 to 16 weeks and there were no cases of postoperative nonunion.

There are several advantages of using a distal femur osteotomy over a proximal femur osteotomy. First, It is relative easier to do particularly the intraoperative rotational adjustments between osteotomy sites, which is difficult to perform in a proximal femoral osteotomy.[11] In addition, the distal osteotomy avoids requiring an extensive dissection in the proximal soft tissues, which may increase the risk of muscle weakness and subsequent hip instability.[20,21] Moreover, it preserves the proximal bone stock, whereas proximal femur osteotomy has been established to be associated with bone loss.[5] Although our is a retrospective case series, we observed satisfactory functional outcomes in Crowe type IV developmental hip dysplasia after a mean of 52 months followup.

This technique has some disadvantages. First, it is difficult to correct anteversion of the femoral component in the presence of excessive anteversion deformity, which has been mentioned in literature. However, we only used a femoral component with a straight stem, the appropriate version could be achieved in all hips. In our analysis, preservation of proximal bone stock allows intraoperative adjustment while fitting the stem. If the offset and anteversion are not satisfactory, a modular stem can be selected. Several studies have revealed that the use of the modular stem could provide an appropriate version.[15,22] We have had no loosening or revisions in these 12 patients with mid to long term followup. Second, an extra incision is needed in this technique. Finally, knee stiffness is a potential complication after distal femur osteotomy. As a result, early activity is important to counteract the effects of the osteotomy.

The limitations of this study are first, it is not a comparative study, so we cannot draw conclusions regarding the outcomes of this osteotomy technique when compared with other osteotomies. Secondly, our sample size is relatively small, which limits the statistical power of our results. However, the indication for this procedure is uncommon and it is difficult to obtain a larger series from a single center.

In summary, on the basis of the encouraging outcomes in the current study, we believe that this osteotomy technique is an option in the treatment of severe developmental dysplasia of hip.


**Figure 4:** X-ray anteroposterior view of left hip joint in a 36 years old male showing high dislocation of hip (b) anteroposterior and lateral radiographs immediately after surgery showing distal femoral shortening osteotomy and uncemented THR

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**How to cite this article:** Guo CY, Liang BW, Sha M, Kang LQ, Wang JZ, Ding ZQ. Cementless arthroplasty with a distal femoral shortening for the treatment of Crowe type IV developmental hip dysplasia. Indian J Orthop 2015;49:442-6.

**Source of Support:** Nil, **Conflict of Interest:** None.