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Cementless Total Hip Arthroplasty Involving Trochanteric Osteotomy without Subtrochanteric Shortening for High Hip Dislocation

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Background: Total hip arthroplasty with subtrochanteric shortening osteotomy is widely performed for high hip dislocation. However, suboptimal leg length discrepancy correction and nonunion of the osteotomy site remain concerns. Although total hip arthroplasty using trochanteric osteotomy without subtrochanteric osteotomy was introduced, cemented implants have been more commonly used than contemporary cementless implants in this procedure. We evaluated the long-term results of cementless total hip arthroplasty with trochanteric osteotomy without subtrochanteric osteotomy for high hip dislocation.

Methods: From 1990 to 2002, 27 cementless total hip arthroplasties using trochanteric osteotomy without subtrochanteric osteotomy were performed in 26 patients with Crowe III or IV high hip dislocation and a mean age of 36.4 ± 12.9 years. Seven ceramic-on-ceramic, 8 ceramic-on-polyethylene, 10 metal-on-polyethylene, and 2 metal-on-metal bearings were inserted. Mean follow-up was 15.1 ± 3.7 years. We retrospectively reviewed medical records and radiographic data and evaluated the clinical and radiological results including the Harris hip score, implant survival, correction of leg length discrepancy, and occurrence of complications.

Results: The mean Harris hip score and leg length discrepancy improved significantly from 73.3 to 94.9 points and from 4.3 cm to 1.0 cm, respectively. With revision for loosening set as the end point, implant survival rates at 10 and 15 years postoperatively were 96.0% and 90.9% for stems and 74.1% and 52.3% for cups. In 8 of 10 hips with the metal-on-polyethylene bearing and 4 of 8 hips with the ceramic-on-polyethylene bearing, revision surgery was performed for aseptic loosening. However, no revision was performed in hips with the ceramic-on-ceramic bearing or the metal-on-metal bearing. Implant survival was significantly different by the type of bearing surface. Two permanent neurologic complications occurred in patients with a limb lengthening over 3.5 cm.

Conclusions: With proper selection of the bearing surface coupled with adjustment of lengthening, cementless total hip arthroplasty using trochanteric osteotomy without subtrochanteric osteotomy might be a favorable treatment option for high hip dislocation.

Keywords: *Congenital hip dislocation, Hip replacement, Dislocations, Osteotomy, Leg length inequality*

High hip dislocation, caused by sequelae of dysplasia or infection of the hip joint can be accompanied by anatomical deformities, soft tissue contracture, and limb length discrepancy (LLD) (Fig. 1A).[1,2] Anatomical deformities and LLD cause technical difficulties during total hip arthroplasty (THA).[3] Traditionally, subtrochanteric shortening osteotomy (STO) has been widely performed in THA for high hip dislocation, and favorable results have been reported.[2,4,5] However, the procedure is technically demanding and time-consuming.[4] In addition, LLD restoration might be suboptimal and concerns about nonunion at the osteotomy site remain.[6,7] Hartofilakidis et al.[8] introduced a THA method involving trochanteric osteotomy

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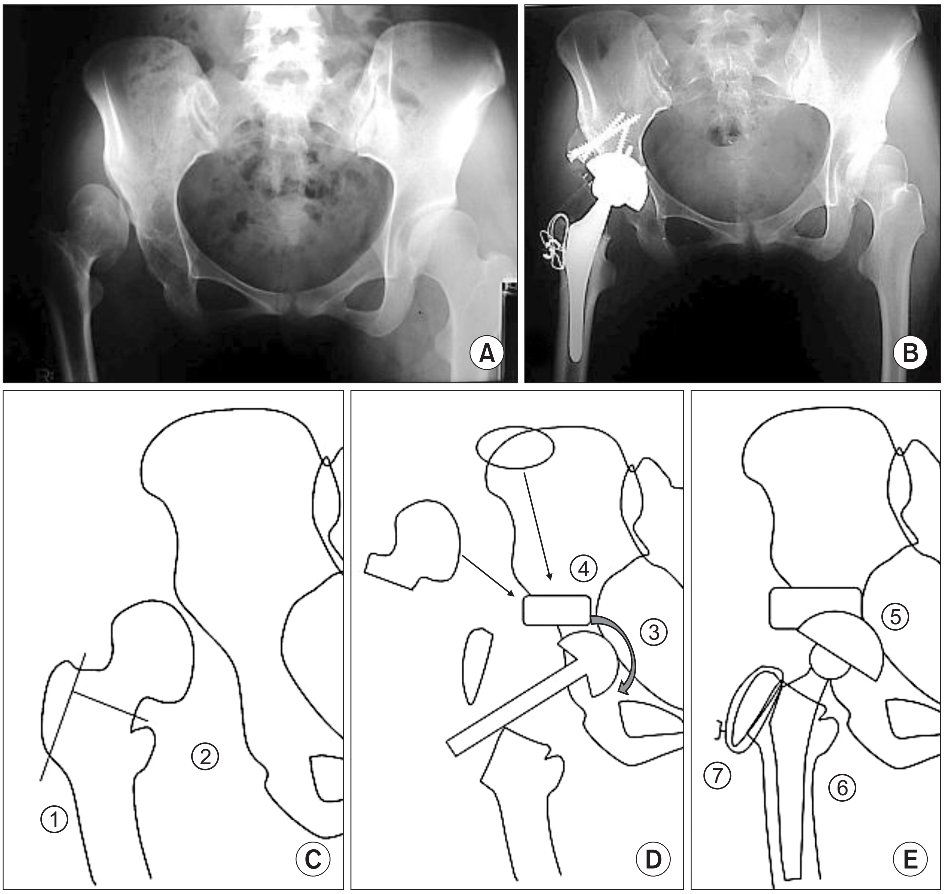

Fig. 1. Preoperative and postoperative radiographs and schematics of the operative technique. (A) The preoperative radiograph of a patient with Crowe type III high hip dislocation caused by developmental dysplasia shows a limb shortening of 3.5 cm. (B) The postoperative radiograph shows improved limb shortening to 1.4 cm. (C) Trochanteric osteotomy ① is performed and proximal femoral osteotomy ② is performed at the level between the upper border of the lesser trochanter and 1 cm proximal to the lesser trochanter. (D) Acetabular reaming ③ is performed and the structural bone graft for deficient acetabulum is obtained from the resected proximal femur or iliac crest and placed in the deficient acetabulum ④. (E) The cup ⑤ and stem ⑥ are inserted, and the greater trochanter is reattached with wire ⑦.

(TO) without STO. With TO, acetabular exposure was facilitated and LLD was improved; however, cemented or hybrid THA was performed in the majority of cases rather than contemporary cementless THA.[9)]

Contemporary cementless stems have shown excellent implant survival, regardless of morphology of the stem and location of bone ingrowth surface.[10)] However, to our knowledge, there has been no report on the long-term results of cementless THA using TO without STO. Patients with high hip dislocation have femoral deformity and the proximal femoral geometry might further deteriorate during TO.[4)] Since deformed proximal femurs after TO may lack secure purchase with cementless stems, cemented stem THA with TO or cementless stem THA with STO, which preserves a more proximal femoral geometry, has been recommended for high hip dislocation.[4)]

In this study, we evaluated long term results of cementless THA using TO without STO for high hip dislocation in terms of clinical and radiological outcomes, implant survival, LLD correction, and occurrence of complications. In addition, we analyzed the related factors for implant survival, such as the type of bearing surface, type of implant, and etiology of high hip dislocation.

METHODS

From 1990 to 2002, 45 cementless THAs with TO without STO were performed on 44 consecutive patients with high hip dislocation (Fig. 1B). All patients were informed that their medical data could be used in a scientific study. During follow-up, 15 patients were lost to contact or died, 1 patient immigrated abroad, and 2 patients refused to visit the clinic because of poor medical conditions unrelated to THA. Follow-up of theses 18 patients could not be carried out for 10 years and thus they were excluded from the study. The remaining 26 patients (27 hips) were included in this study with a mean 15.1 ± 3.7 years (range, 10.0 to 24.2 years) of follow-up. After approval of the Seoul National University College of Medicine/Seoul National University Hospital Institutional Review Board (IRB No. H-1407-077-594), the medical records and radiological data were retrospectively reviewed.

There were 6 men and 20 women with a mean age of 36.4 ± 12.9 years (range, 18.7 to 63.6 years). On preoperative radiographs, all hips were highly dislocated to meet the criteria of Crowe type III (15 hips) or IV (12 hips).[3)] Except for 1 patient with bilateral dislocation, all hips were dislocated unilaterally. High hip dislocation occurred as a sequela of dysplasia (8 hips) or infectious arthritis (19 hips). The etiology of infectious arthritis was tuberculosis in 5 hips and pyogenic septic arthritis in 14 hips.

All THAs were performed *via* the direct lateral approach with TO. After TO, neck cutting was performed at the level between the upper border of the lesser trochanter and 1 cm proximal to the lesser trochanter (Fig. 1C). Then, the acetabulum was exposed and reamed in a medial direction with a small diameter reamer. To enhance cup coverage, the medial acetabular wall was perforated carefully in 14 cases. The non-contact area between the cup and host bone by the perforated medial wall was limited to less than 30% of the cup surface. For 16 hips with insufficient host bone contact with the cup, structural bone graft was obtained from the resected proximal femur (9 hips) or the iliac crest (7 hips) and fixed with a screw in the deficient area (Fig. 1D). Eventually, a cementless cup was placed and fixed with screws. For the femoral side, soft tissue around the proximal femur was released circumferentially including the rectus femoris, adductors, and iliopsoas. In 5 hips, additional soft tissue was released due to severe limb shortening with soft tissue tightness at the level of the abductor muscle, psoas, or gluteus maximus tendon. Then, the proximal femur was prepared. With a trial stem inserted, reduction was attempted. In the event of difficult reduction, the trial stem was removed and the proximal femur was resected at a more distal location until reduction became possible. Finally, a cementless stem was inserted and reduction was performed after insertion of the head and a liner. Osteotomized trochanters were reattached to the proximal femur using wires (Fig. 1E). In 6 hips, adductor tenotomy was performed in a supine position after wound closure. The mean operation time was 160 ± 36 minutes (range, 110 to 240 minutes) from incision to closure of wound including adductor tenotomy.

During THA, various types of stems and cups were implanted (Tables 1 and 2). Regarding the bearing surface, 4 types of bearing surfaces of metal-on-polyethylene (MoP), metal-on-metal (MoM), ceramic-on-polyethylene (CoP), and ceramic-on-ceramic (CoC) were used (Table 3). Tables 1, 2, and 3 show the features of various types of cups, stems, and bearing surfaces. The mean cup size was 47.1 ± 2.5 mm (range, 44 to 52 mm). The head size was 28 mm in all except for 2 hips with 22-mm metal heads.

Clinical evaluation was performed using the Harris hip score (HHS). Also, the patient was asked about clinical symptoms such as pain or limping. Neurological examination was performed. The occurrence of complications was recorded.

Table 1. The Features of Stems and Results of Total Hip Arthroplasty for High Hip Dislocation

Type and name of stem	No.	Bearing (no.)	Osteolysis	Loosening	Revision (no revision/for loosening/ for bearing change to CoC)
Anatomical stem with HA coating					
ABG-1 (Howmedica, Rutherford, NJ, USA)	1	CoP (1)	0	0	1/0/0
Proximal Double wedged stem with HA coating					
Omnifit-HA (Osteonics, Allendale, NJ, USA)	9	CoP (2), MoP (7)	5	2	5/2/2
Custom-made tapered stem with HA coating					
Xpress Rapid (DePuy, Leeds, UK)	1	MoP (1)	1	0	0/0/1
Ribbed conical tapered stem with grit-blasting					
Cone prosthesis (Protek, Berne, Switzerland)	2	MoM (2)	0	0	2/0/0
Rectangular tapered stem with plasma coating					
BiCONTACT (Aesculap AG, Tuttlingen, Germany)	8	CoP (1), CoC (7)	0	0	8/0/0
Modular type stem					
S-ROM (Joint Medical Products, Stamford, CT, USA)	6	CoP (4), MoP (2)	2	0	5/0/1
Total	27	CoP (8), MoP (10), CoC (7), MoM (2)	8	2	21/2/4

CoC: ceramic-on-ceramic bearing, HA: hydroxyapatite, CoP: ceramic-on-polyethylene bearing, MoP: metal-on-polyethylene bearing, MoM: metal-on-metal.

Table 2. The Features of Cups and Results of Total Hip Arthroplasty for High Hip Dislocation

Type and name of cup	No.	Bearing (no.)	Osteolysis	Loosening	Revision (no revision/cup revision/liner exchange with cup retention)
Hemispherical HA-coated cup					
ABG-1 (Osteonics, Allendale, NJ, USA)	1	CoP (1)	1	1	0/1/0
Omnifit Acetabular shell (Osteonics)	8	CoP (3), MoP (5)	4	5	3/5/0
Dual geometry hemispherical HA-coated cup					
Omnifit Dual Radius (Osteonics)	3	MoP (3)	2	2	1/2/0
Expansion type HA-coated cup					
Medinov (Medinov, Roanne, France)	1	CoP (1)	1	1	0/1/0
Hemispherical porous-coated cup					
Arthropor (Joint Medical Products, Stamford, CT, USA)	3	CoP (2), MoP (1)	1	1	1/1/1
Duraloc (DePuy, Leeds, UK)	1	MoP (1)	1	1	0/1/0
Plasma (Aesculap AG, Tuttlingen, Germany)	8	CoP (1), CoC (7)	0	0	8/0/0
Hemispherical grit-blasted cup					
Standard (Protek AG, Berne, Switzerland)	2	MoM (2)	0	0	2/0/0
Total	27	CoP (8), MoP (10), CoC (7), MoM (2)	10	11	15/11/1

HA: hydroxyapatite, CoP: ceramic-on-polyethylene bearing, MoP: metal-on-polyethylene bearing, CoC: ceramic-on-ceramic bearing, MoM: metal-on-metal.

Table 3. The Features of Bearing Surfaces and the Results of Total Hip Arthroplasty for High Hip Dislocation

Bearing surface	No.	Follow-up (yr)	Size of cup (mm)	Leg-length discrepancy change (cm)	Osteolysis (femur/acetabulum)	Loosening (stem/cup)	10-Year survival rate (%)
Ceramic-on-ceramic*	7	12.7 ± 1.7	46.3 ± 2.7	3.2 ± 1.1	0/0	0/0	100
Ceramic-on-polyethylene	8†	16.5 ± 3.0	48.4 ± 2.0	3.1 ± 0.8	2/3	1/3	75.0 ± 15.3
Metal-on-polyethylene	10	16.7 ± 4.0	47.0 ± 2.2	3.2 ± 0.8	6/7	1/8	50.0 ± 15.8
Metal-on-metal‡	2	10.4 ± 0.1	45.0 ± 1.4	5.1 ± 0.8	0/0	0/0	100

*BIOLOX Forte Alumina bearing (CeramTec AG, Plochingen, Germany). †Zirconia head (7)/alumina head (1). ‡Cobalt-chrome Metasul bearing (Protek AG, Berne, Switzerland).

High hip dislocation on the preoperative anteroposterior (AP) radiograph was classified according to the Crowe's original method, which was based on the ratio of the vertical distance measured from the inter-teardrop line and the head-neck junction to the vertical pelvic height measured from the iliac crest to the ischial tuberosity in a dislocated hip.[3] On preoperative and postoperative standing AP radiographs, LLD was measured by comparing the vertical distance of each side from the inter-teardrop line to the lesser trochanter. Postoperatively, cup inclination and coverage of acetabular component were measured. The presence of osteolysis or loosening was evaluated.[11-14] Radiological union of the TO was classified into union, fibrous union, or nonunion by gap at the osteotomy site.[15] Also, union of the structural bone graft was evaluated.

Statistical analysis was performed with IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA). Kaplan-Meier survival analysis was performed to evaluate the survival of implant. Log rank test was performed to compare survival by the type of bearing or implant. Paired *t*-test was performed to compare pre- and postoperative LLD and HHS. Mann-Whitney test was performed to compare the postoperative LLD and changes in LLD between patients with limping and those without limping. Kruskal-Wallis test was performed to compare the mean age at operation, length of follow-up, size of the cup and LLD changes according to the type of bearing surface and etiology of high hip dislocation. A p-values less than 0.05 were considered significant.

RESULTS

Clinically, HHS improved significantly from 73.3 ± 10.4 points to 94.9 ± 9.3 points (p = 0.006) after THA. Twenty-one patients had no complaints of pain. Five patients complained of mild pain. Three patients complained of mild limping. One patient complained of discomfort by recurrent posterior hip dislocation. LLD improved significantly from 4.3 ± 1.0 cm (range, 2.9 to 6.8 cm) to 1.0 ± 1.0 cm (range, 0 to 2.6 cm) after THA (p < 0.001). The mean postoperative LLD of patients who complained of limping gait was severer than that of patients without limping gait, but the differences were not statistically significant. (1.7 cm vs. 0.9 cm, p = 0.155). The mean change in LLD showed no difference according to the presence of limping, type of bearing surface, or etiology of high hip dislocation (Tables 3 and 4). The mean postoperative cup inclination was 43.4° ± 8.3° (range, 28.1° to 60.6°). The mean coverage of acetabular components was 89.2% ± 13.5%. The site of the TO showed radiologic signs of union in all cases except one. One patient showed a radiologic sign of fibrous union with a 7-mm gap between fragments. He had no complaint of pain, limping, or dislocation except mild tenderness. All structural bone grafts showed radiological signs of union at the last follow-up. Osteolysis was observed around 10 cups (37.0%) and 8 stems (29.6%) during follow-up. All 10 cups with osteolysis and 2 of the 8 stems with osteolysis showed radiologic evidence of loosening. One cup showed early loosening without osteolysis at postoperative 2 years due to failed initial fixation. The remaining 16 cups and 19 stems showed stable fixation without evidence of loosening or osteolysis (Tables 1–3).

In 11 patients with loosening of components and one patient with severe liner wear, revision THA was performed at a mean 7.2 ± 4.5 years after primary THA (Fig. 2). With the end point set as revision THA due to loosening of components, survival rates of cups at postoperative 5, 10, and 15 years were 96.3% ± 3.6%, 74.1% ± 8.4%, and 52.3% ± 19.6%, respectively. Survival rates of stems at postoperative 5, 10, and 15 years were 100%, 96.0% ± 3.9%, and 90.9% ± 6.2%, respectively. Fig. 3 shows the survival curves of cups and stems (Fig. 3). In 8 of the 10 hips with the MoP bearing and in 4 of the 8 hips with the CoP bearing, revision THAs were performed. In contrast, there was no revision THA for hips with the CoC and MoM bearings (Table 3, Fig. 4). Overall, the Kaplan-Meier survival analysis showed significant differences (p = 0.017) according to the type of bearing surface. CoC bearings had significantly

Table 4. The Etiology of High Hip Dislocation and the Results of Total Hip Arthroplasty

Etiology	Developmental dysplasia	Pyogenic hip arthritis	Tuberculosis
No.	8	14	5
Follow-up (yr)	17.4 ± 4.7	14.1 ± 2.6	14.3 ± 4.0
Bearing (no.)	CoC (1), CoP (2), MoP (4), MoM (1)	CoC (4), CoP (5), MoP (4), MoM (1)	CoC (2), CoP (1), MoP (2)
Additional procedure (no.)	Roof BG (6), additional soft tissue release (1)	Roof BG (6), AT (5), additional soft tissue release (3)	Roof BG (4), AT (1), additional soft tissue release (1)
Operation time (min)	161 ± 26	154 ± 34	176 ± 46
LLD change (cm)	3.2 ± 1.0	3.4 ± 1.0	3.3 ± 1.1
Femoral osteolysis	4	2	2
Acetabular osteolysis	5	4	1
Stem loosening	1	1	0
Cup loosening	5	5	1
10-Year survival rate (%)	62.5 ± 17.1	71.4 ± 12.1	80.0 ± 21.7

CoC: ceramic-on-ceramic bearing, CoP: ceramic-on-polyethylene bearing, MoP: metal-on-polyethylene bearing, MoM: metal-on-metal, BG: bone graft, AT: adductor tenotomy, LLD: leg length discrepancy.

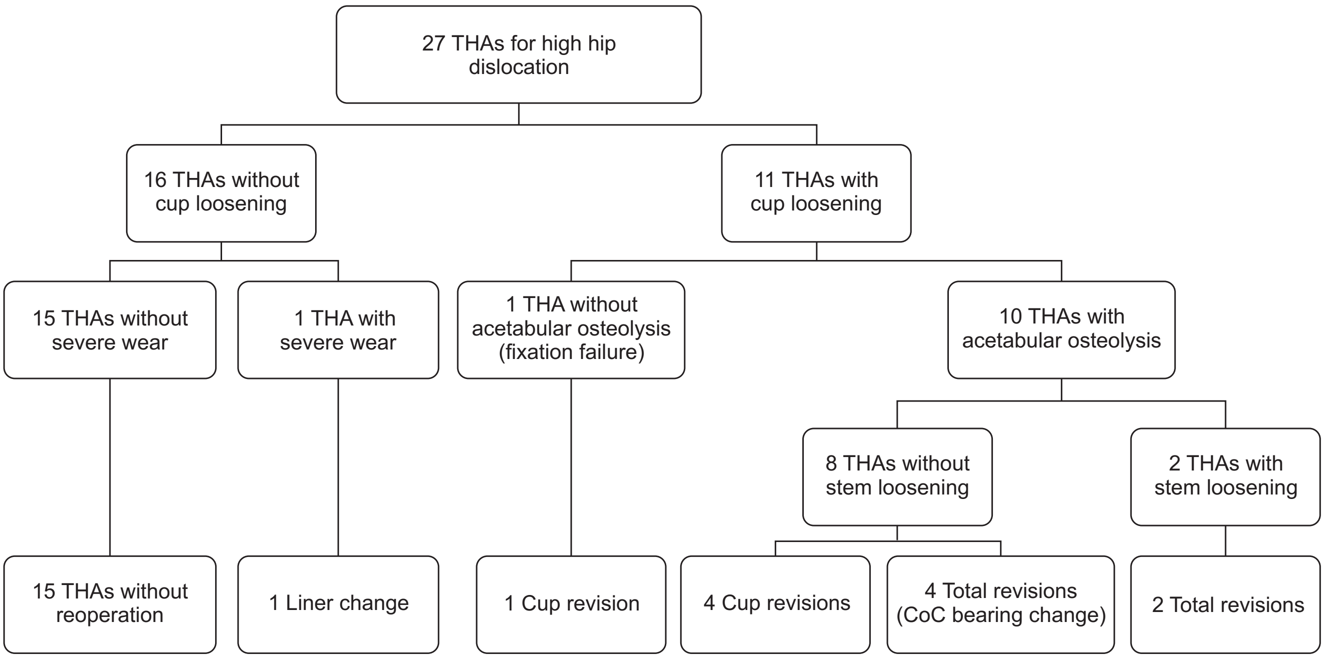

Fig. 2. Flowchart of the results of total hip arthroplasty involving trochanteric osteotomy without subtrochanteric shortening osteotomy for high hip dislocation. THA: total hip arthroplasty, CoC: ceramic-on-ceramic bearing.

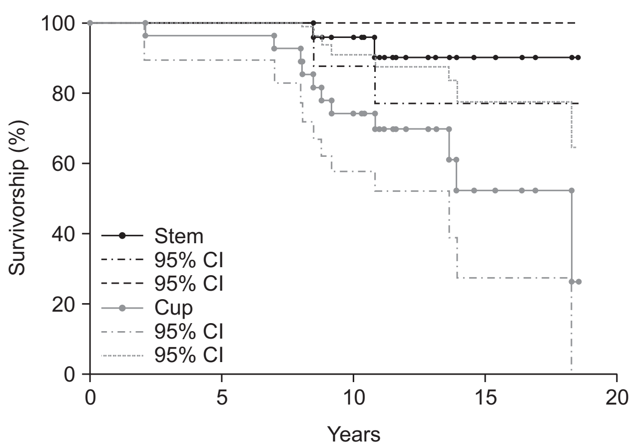

Fig. 3. Kaplan-Meier survival analysis of cups and stems. CI: confidence interval.

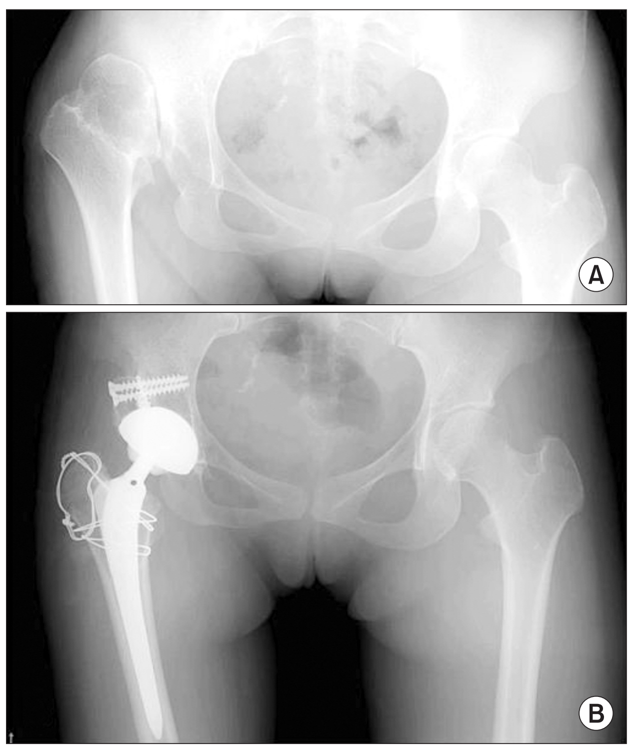

Fig. 4. Preoperative and postoperative radiographs of a patient with Crowe type III high hip dislocation. (A) The preoperative radiograph shows a limb length discrepancy of 3.2 cm and acetabular dysplasia. (B) The postoperative radiograph shows stable implant fixation without osteolysis or loosening at 14.6 years after total hip arthroplasty using a ceramic-on-ceramic bearing.

better survival than MoP bearings (p = 0.008) or non-CoC bearings (p = 0.037). Soft bearings (MoP or CoP) had significantly worse survival than hard bearings (CoC or MoM) (p = 0.017). There was no significant difference in age at THA, size of the cup, or LLD change by the type of bearing, but there was a significant difference in the follow-up after THA according to the type of bearing surface (p = 0.019) (Table 3). Also, hydroxyapatite (HA)-coated cups had significantly poor survival compared to porous-coated or grit-blasted cups (p = 0.03). However, with soft bearings alone, HA-coated cups and non-HA coated cups had no significant difference in survival (p = 0.55). HA-coated stems had poor stem survival without statistical significance (p = 0.057), although both of the loosened stems were HA-coated. The 10-year survival rate in Kaplan-Meier analysis showed no statistically significant difference among patients with dysplasia, pyogenic hip arthritis, and tuberculosis (p = 0.914) (Table 4).

There were 4 neurologic complications: 2 transient peroneal palsies and 2 permanent neurologic deficiency (1 femoral nerve palsy and 1 sciatic nerve palsy). The two transient peroneal nerve palsies were fully recovered within 2 days after occurrence. In the patient with femoral nerve palsy, motor function was recovered to a nearly normal range, though mild sensory deficit remained at the last follow-up. In the patient with sciatic nerve palsy, grade IV motor deficit remained at the latest follow-up. The perioperative LLD change in each of the patients with neurologic complications was more than 3.5 cm (mean, 4.0 ± 0.5 cm; range, 3.5 to 4.6 cm). Of the 12 patients with LLD changes over 3.5 cm (mean, 4.2 ± 0.7 cm; range, 3.5 to 5.7 cm), 4 experienced neurologic complications.

As for other complications, intraoperative femoral cracks occurred in 3 hips and the resulting fractures were fixed with wiring. There was one recurrent posterior dislocation due to abductor deficiency in a patient with a history of septic hip arthritis with meningomyelocele. Other than that, there was no other complication.

DISCUSSION

Cementless THA using TO without STO showed favorable long-term stem survival in the present study. Previously, cemented stems with TO or cementless stems with STO, which preserves a more proximal femoral geometry, were recommended in THA for high hip dislocation because deformed proximal femurs may lack secure purchase with cementless stems with TO.[4] In the present study, we used various types of stems and tried to fix the stems in the meta-diaphyseal junction or in the diaphysis. Though we observed a higher rate (29.6%) of osteolysis in zones 1 and 7 around the proximal femur, only 2 out of 8 stems showed progression of osteolysis to diaphysis and radiologic signs of stem loosening. With appropriate stem fixation according to the type of stem, meta-diaphyseal or diaphyseal fixation with TO seems sufficient for secure fixation of cementless stems.

In this study, without STO, LLD improved after THA and the mean residual LLD was 1.0 cm. Both preoperative and postoperative HHS was relatively high. Preoperatively, most of the patients were relatively young (mean age, 36.4 years) and active, and they complained more of LLD and limping than pain or disability. Postoperatively, LLD was significantly improved, only few patients complained of limping or residual LLD, and HHS was relatively high. In previous studies on THA with STO, residual LLD was not reported, LLD was evaluated in terms of functional method, the method of LLD evaluation was not stated, or residual LLD was more than 2.5 cm.[2,5,16,17] On the other hand, residual LLD was reported as 0.3–1.4 cm after THA without STO.[18-20] LLD seemed to improve more efficiently after THA without STO than THA with STO. However, in some of these studies without STO, lengthening was achieved by external fixation using an iliofemoral distraction device.[19] Lengthening by an external fixator seems unsuitable for THA due to concerns about the increased risk of infection.[21] In the present study, without an external fixator, the residual LLD was similar to that in previous studies without STO.

Excluding transient peroneal nerve palsy, permanent neurologic complications occurred in 2 out of 27 hips (7.4%). The rate of neurologic complications after THA for high hip dislocation was reported as 0%–20% in the literature.[8,16,19,20] Though LLD was changed without shortening osteotomy and limb lengthening was achieved acutely, the present study had a comparable rate of permanent neurologic complications to those in previous studies. Also, we observed that all neurologic complications occurred in patients with lengthening greater than 3.5 cm. Proper amount of lengthening of the extremities seems essential for the prevention of neurologic complications related to acute lengthening. For patients with expected limb lengthening of less than 3.5 cm, cementless THA using TO without STO appears to be a favorable treatment option without concerns of neurologic complications. In cases of expected limb lengthening over 3.5 cm, shortening osteotomy should be planned preoperatively to prevent neurologic complications. With TO, shortening could be achieved by more proximal bone resection to the distal level without STO.

Despite acetabular dysplasia, cup coverage could reach 90% with the use of medialization and bone grafts. However, long-term cup survival was not favorable with the remarkably high failure rate, especially in cups with the polyethylene (PE) liner. First, the small cup size might have contributed to the poor implant survival. In cups with PE bearing, adequate thickness of the PE liner is essential for longevity of the implant and resistance to wear.[22,23] In previous studies with high hip dislocation, high wear rates were reported for small cups with 28 mm heads which were used for stability of THA.[5] In the present study, the mean cup size was relatively small (47.1 ± 2.5 mm) and 28 mm heads were inserted in the majority of cases for stability. The thin PE liner and small cup with 28 mm head might have resulted in excessive PE liner wear and poor long-term cup survival. Second, biomechanical disadvantages without STO might have contributed to the poor implant survival. Without STO, cup might be placed in a relatively higher position known as high hip center.[9] The high hip center has biomechanical disadvantages such as the longer body weight lever arm than the abductor lever arm and greater shearing force on the cup.[9] These disadvantages might lead to excessive load on the hip joint and excessive PE wear.[9,24] Third, cementless cups fixed in the dysplastic acetabulum seemed vulnerable to loosening in the presence of osteolysis. With excessive PE wear, a higher rate of osteolysis around the cup (37.0%) was observed and loosening occurred in all cups with osteolysis.

In contrast to cups with PE liners, cups with CoC bearings had excellent survival even after a considerable follow-up period in this study. CoC bearings showed extremely low amounts of wear particles with fewer bioactive features, resulting in the absence of osteolysis.[25,26] Therefore, ceramic bearings produced better results despite the relatively small size of the cups or the relatively high hip center of the cups. Though thin ceramic liners may increase the risk of ceramic bearing fractures,[27] we did not observe any ceramic bearing fractures in the present study.

Traditionally, most of the studies on THA for high hip dislocation involved STO.[4,5,7,16] However, Hartofilakidis et al.[8] demonstrated favorable results of cemented or hybrid THA with TO for high hip dislocation. With TO, acetabular exposure could be obtained more safely and easily with less additional operation time.[28] Also, nonunion rate could be relatively low, compared to THA with STO.[28] Hence, THA using TO could be a recommendable treatment option for most cases of high hip dislocation. However, in case of severe proximal deformity with malalignment which necessitates corrective osteotomy at the subtrochanteric level, traditional STO could be a better option for THA than TO. There are some tips for successful outcomes of THA with TO for high hip dislocation. First, careful preoperative planning should be performed, especially regarding the amount of limb lengthening. Excessive limb lengthening of more than 3.5 cm could increase the rate of neurological complications. During preoperative planning and templating, the amount of shortening should be estimated. In cases with TO, shortening could be performed with more proximal bone resection. Hence, in cases where shortening is required, proximal femoral neck cutting should be performed at a more distal level. Second, cementless stems should be fixed in the diaphysis or metaphysis-diaphysis junction. TO and additional proximal bone resection result in a remarkable amount of metaphyseal bone loss, and thus the metaphyseal area is not suitable for cementless stem fixation. Hence, cementless stems should be fixed at a more distal level than the proximal metaphyseal area. Third, the CoC bearing, rather than the MoP or CoP bearing, should be considered for THA for high hip dislocation. The cementless cup, which was fixed in the dysplastic acetabulum, was vulnerable to loosening in case of osteolysis by wear due to the small cup size and thin PE liner in the present study. In contrast, the CoC bearing showed excellent implant survival with absence of osteolysis despite the small cup and thin liner that may be associated with increased risk of ceramic liner fractures.

There are some limitations in the present study. First, the number of hips and patients was relatively small. A lot of patients were lost to follow-up of 10 years and were therefore excluded from the study. However, high hip dislocation is a relatively rare clinical condition in patients with THA, and we were able to show long-term results by excluding patients with less than 10 years of follow-up. Second, various types of implants and bearings were used and the follow-up period of THA according to the bearing surfaces differed. Since we began performing THA using CoC bearings in 1997, the length of follow-up for hips with the CoC bearings was shorter than that for hips with MoP or CoP bearings. THAs with CoC bearings were followed for a mean of 12.7 ± 1.7 years with 100% survival rate. In contrast, the survival rates of MoP and CoP bearings at postoperative 12.7 years were 37.5% ± 16.1% and 75.0% ± 15.3%, respectively. CoC bearings exhibited better survival rates than MoP and CoP bearings at postoperative 12.7 years. Further studies with a longer follow-up will be necessary to support our findings. Third, this study did not compare the results of THAs using TO with those using STO. Further comparative studies of THA with TO and THA with STO should be conducted to support the present study.

Cementless THA involving TO without STO showed favorable clinical results during the mid-term follow-up with regard to implant survival. However, the long-term results of cups and stems varied and so did the long-term results of bearing surfaces. LLD was successfully restored but excessive lengthening by more than 3.5 cm may increase the risk of neurologic complications. With proper selection of implants and bearing surfaces, and with adjustment of the amount of lengthening to less than 3.5 cm, cementless THA using TO without STO might be a favorable treatment option for patients with high hip dislocation.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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