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Treatment outcome of dome osteotomy of the pelvis combined with trochanteric advancement for sequelae of Perthes' disease

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ABSTRACT

Objective: Disparity in size between femoral head and acetabulum could promote premature degeneration of the hip joint. The purpose of this study was to report the results of Kawamura's dome osteotomy for acetabular dysplasia due to sequelae of Perthes' disease.
Patients and Methods: Fourteen patients (14 hips) operated between 1999 and 2012 were retrospectively reviewed. There were 9 males and 5 females with a mean age of 29 years (range, 15–54 years). Functional and radiological results were reviewed at mean follow-up of 9 years (range, 4–12 years).
Results: Pain relief was obtained in 13 of 14 (92.8%) patients postoperatively. Good to excellent functional outcome was obtained in 10 of 14 (71.4%) patients. Mean Harris hip score was improved from 63 to 84 ($p < 0.05$) at the final follow-up. Improvement of limping gait was observed in 10 of 14 (71.4%) patients. Center edge angle improved from mean 24° (11–36°) preoperatively to mean 35° (27–46°) postoperatively ($p < 0.05$), acetabular angle improved from mean 43° (36–49°) preoperatively to mean 37° (32–44°) postoperatively ($p < 0.05$), acetabular head index improved from mean 69% (50–83%) preoperatively to mean 85% (73–100%) postoperatively ($p < 0.05$). Progression of arthrosis stage occurred in 3 of 14 (21%) patients. None of the hip with preoperative Stulberg III, 2 of 9 hips with Stulberg IV and 2 of 2 hips with Stulberg V needed conversion to total hip arthroplasty during the follow-up.
Conclusion: Dome osteotomy of the pelvis combined with trochanteric advancement could give a reasonable treatment outcome for acetabular dysplasia due to Perthes' disease at mid to long-term follow-up. Advanced stage of arthrosis, preoperative Stulberg V and no improvement of limping gait after the surgery possibly associated with poor outcome.
Level of evidence: Level IV, therapeutic study.
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Introduction

One characteristic of the sequelae of Perthes's disease is the presence of disparity in size between femoral head and acetabulum.[1] This condition can induce pain and promote early degeneration of the joint.[2] Previously, Chiari osteotomy was known as an alternative salvage operation to solve this problem.[3] The original Chiari osteotomy was done by making a flat osteotomy at the superior margin of the acetabulum. The femoral head coverage was then increased by making a medial displacement of the pelvis inferior to the osteotomy.[4] This procedure could increase hip joint function and its longevity.[5]

As a modification to the original Chiari osteotomy, Kawamura[6] has described a dome osteotomy of the pelvis through lateral approach of the hip by making a standard trochanteric osteotomy. This procedure will result in a dome shape bone shelf to cover the femoral head. By making a dome shape pelvic osteotomy, the resulted acetabular roof will match with the sphericity of the femoral head, thus a higher joint contact area is obtained.[7,8] Simultaneous advancement of the greater

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trochanter is also possible through this technique. Here we report the treatment outcome of dome osteotomy combined with greater trochanter advancement for sequelae of Perthes' disease.

Patients and methods

All patients who received dome osteotomy of the pelvis as treatment for sequelae of Perthes' disease between January 1999 and December 2012 were retrospectively reviewed. A total of 15 patients received the procedure within the period. However, one patient was lost to follow-up. Therefore, a total of 14 patients (14 hips) were reviewed in this study. Indication for surgery was progressive hip pain not adequately responding to conservative treatment. There were 9 males and 5 females with a mean age of 29.2 years (range, 15–54 years). The mean of follow-up was 9 years (range, 4–12 years). Two patients had history of Salter innominate osteotomy, one patient had history of femoral varus osteotomy while the other patient had adductor tenotomy and iliopsoas release prior to pelvic dome osteotomy. One patient received femoral valgus osteotomy simultaneously with the procedure of pelvic dome osteotomy (Table 1). All patients received greater trochanter advancement during the procedure.

Operative technique

All operations were done by the senior author (TRY). Details of the procedure have been reported previously.[9] Briefly, patient was placed in lateral position. A longitudinal skin incision was made centered over the greater trochanter. After skin incision, fascia lata was devided. Then a superomedial directed greater trochanter osteotomy was done. The attachment of abductor muscle and vastus lateral muscle to the greater trochanter was retained. Exposure of outer table of ilium was obtained with the limb positioned in abduction while the greater trochanter musculo-osseus sleeve was reflected anteriorly. A stainmann pin with diameter of 3.5 mm was inserted to the pelvis at upper border of the capsule in superomedial direction with an angle approximately 15° to horizontal line. The position of the Steinmann pin was confirmed with fluoroscopy. A dome osteotomy was done with the guidance of the Steinmann pin position using an oscillating saw. After osteotomy was completed, distal pelvic fragment was displaced medially. The resulted femoral head coverage was confirmed with fluoroscopy. Internal fixation of the pelvis osteotomy was achieved using a Steinmann pin with diameter of 2.4 mm. Then the greater trochanter was reattached using two cancellous screws or stainless steel wire at a distally advanced position. One patient received closed wedge femoral valgus osteotomy simultaneously.

An abduction brace was used postoperatively. Non-weight bearing crutch walking was allowed within one week and continued until approximately three months upon evaluation for radiological bone union. The Steinmann pin was removed at 6–12 weeks. Patients were followed at one month, three months, six months, one year, and every year thereafter postoperatively. Evaluation for improvement of the pain, gait pattern, joint range of movement (ROM), and functional assessment with Harris hip score (HHS)[10] was carried out at each follow-up.

Standard anteroposterior radiographs of the pelvis were taken preoperatively, immediate postoperatively, and at each follow-up. Center edge angle of Wiberg[11], acetabular angle of Sharp[12], and acetabular head index[13] were measured for all radiographs. Joint space at the weight bearing area and the narrowest point were also measured. The angle of pelvic osteotomy, distance and percentage of displacement at the pelvic osteotomy, and distance of greater trochanter advancement were measured for immediate postoperative radiographs (Fig. 1). All radiographic measurement was performed digitaly using Marosis PACS software (Marotech Inc., Seoul, South Korea). With this software, measurement of angles and distances resulted in two decimal points after compensation of magnification. It was then rounded off. Based on modified classification of the Japanese Orthopaedic Association[14], all hips were classified into the following four stages of arthrosis based on anteroposterior pelvic radiographs: prearthrosis (dysplasia only), early arthrosis (slight joint space narrowing and subchondral sclerosis), advanced arthrosis (marked joint space narrowing with or without cyst or sclerosis), and terminal arthrosis (obliteration of joint space). Preoperative radiographic of the hip was also classified based on Stulberg classification.[15]

Statistical analysis was performed using SPSS for Windows version 17.0 software (SPSS Inc, Chicago, IL, USA). Paired student's *t*-test was used to evaluate the significance of data. A p value of less than 0.05 was considered statistically significant.

Table 1
Patient's characteristics and preoperative data.

No	Age (years)	Sex	Side	BMI (kg/m^2)	Previous Surgery	Preoperative			
						HHS	Limping gait	Arthrosis Stage	Stulberg Classification
1	23	M	R	27,1	Proximal femur varus osteotomy	47	Moderate	Early	V
2	24	M	L	21,6	–	73	Moderate	Pre-	IV
3	20	M	R	20,1	–	76	Moderate	Early	III
4	19	M	L	24,2	–	71	Mild	Early	III
5	19	F	L	19,5	Salter osteotomy	48	Severe	Pre-	IV
6	15	M	R	23,4	Adductor tenotomy and psoas release	73	Moderate	Advanced	V
7	30	F	L	27,7	–	60	Mild	Pre-	IV
8	40	F	R	25,9	–	47	Moderate	Early	IV
9	41	M	L	24,7	–	84	Mild	Early	IV
10	51	F	R	20,7	–	61	Mild	Pre-	IV
11[a]	54	M	R	32,5	–	45	Moderate	Early	IV
12	34	F	R	22,5	–	52	Severe (crutch)	Advanced	III
13	20	M	L	22,8	Salter osteotomy	81	Moderate	Advanced	IV
14	19	M	R	32,2	–	68	Mild	Early	IV

HHS: Harris hip score; BMI: body mass index; M: male; F: female; R: right; L: left.
[a] Received simultaneous proximal femur valgus osteotomy during dome osteotomy.

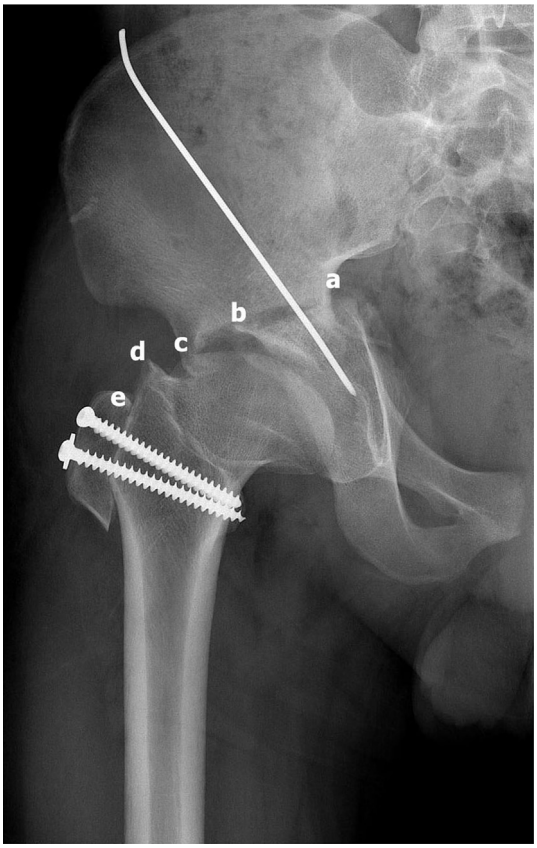

Fig. 1. Important points on radiographic measurement. b–c: Distance of acetabular displacement; b-c/a-c x 100%: Percent of acetabular displacement; d–e: Distance of trochanteric advancement.

Results

Mean HHS was significantly ($p < 0.05$) improved from 63 (range, 45 to 84) preoperatively to 84 (range, 58 to 100) at the last follow-up. Functional outcomes were excellent in 6, good in 4, fair in 2, and poor in 2 patients. Pain relief was obtained in all patients except one who experienced persistent pain postoperatively. Preoperatively, four patients had severe pain, 9 patients had moderate pain, and 1 patient had mild pain. At the last follow-up, 6 patients had no pain, 4 had mild pain, and 4 had moderate pain. Postoperative joint ROM was not significantly different from preoperative joint ROM.

The effect of this procedure on gait pattern was also evaluated. Limping gait (part of HHS) was improved in ten patients. Four patients reported no difference on gait between preoperative and postoperative. Preoperatively, two patients had severe limping, seven patients had moderate limping, and five patients had mild limping. One patient who had severe limping preoperatively need one crutch aid during walk. Postoperatively, no limping gait was observed in 5 patients and mild limping was observed in 7 patients. The other two patients had moderate limping gait (Table 2). None of these patient required walking aid during ambulation at the last follow-up. One patient experienced inferior gluteal nerve injury and buttock muscle atrophy during follow-up. However, gait pattern in this patient was still improved (moderate to mild limping) postoperatively. No other complications related to dome and greater trochanter osteotomies occurred during the follow-up. Four cases finally converted to total hip arthroplasty (THA) during the follow-up. Of the four cases, THA was needed for three due to pain. The other THA was needed due to unsatisfactory ROM.

Based on Stulberg classification, preoperative radiograph was classified into type III in 3 patients, type IV in 9 patients, and type V in 2 patients. Preoperatively, 3 patients were in advanced arthrosis, 7 were in early arthrosis, and 4 were in prearthrosis stage. Progression of arthrosis was observed in three patients at the last radiograph follow-up.

Mean center edge angle of Wiberg, mean acetabular angle of Sharp, mean acetabular head index, and mean weight bearing joint space were improved significantly after the surgery (Fig. 2). No significant difference in minimum joint space at the final follow-up was found. Mean pelvic osteotomy angle was 19° (range, 15° to 28°). Mean distance of acetabular displacement was 15 mm (range, 10–21 mm). Mean acetabular displacement percentage was 27% (range, 15%–36%) (Table 3). There was no penetration of osteotomy into the joint. Mean greater trochanter advancement was 17 mm (range, 10–23 mm). No sign of infection, pelvic or greater trochanter nonunion, femoral head avascular necrosis, or heterotopic ossification was observed in our series.

Discussion

Acetabular dysplasia could be caused secondary to developmental dysplasia of the hip (DDH), neuromuscular disorders, Perthes' disease, or trauma.[16] Migaud et al[17] have reported the outcome of original Chiari osteotomy for treatment of acetabular dysplasia in 90 hips due to various etiology at mean follow-up of six years. At the final follow-up, they found that 73 patients had slight or no pain while the rest of them had moderate to severe pain.

Table 2
Final follow-up data.

Patient No	Followup Duration (months)	HHS	Limping Gait	Arthrosis stage	Progression of arthrosis	Conversion to THA	Reason of THA	Duration (months)	Functional After THA
1	145	78	Mild	Advanced	+	+	Pain	132	Excellent
2	78	86	Mild	Pre-	–	–	–	–	–
3	122	89	Mild	Early	–	–	–	–	–
4	66	100	No	Early	–	–	–	–	–
5	123	90	Mild	Advanced	+	–	–	–	–
6	82	60	Moderate	Advanced	–	+	Pain	48	Excellent
7	151	100	No	Pre-	–	–	–	–	–
8	155	84	No	Early	–	–	–	–	–
9	143	94	Mild	Early	–	–	–	–	–
10	62	92	No	Pre-	–	–	–	–	–
11	132	92	No	Advanced	+	–	–	–	–
12	52	85	Mild	Advanced	–	–	–	–	–
13	86	76	Moderate	Advanced	–	+	ROM	6	Excellent
14	120	58	Mild	Early	–	+	Pain	8	Excellent

HHS: Harris hip score; THA: total hip arthroplasty; ROM: range of movement.

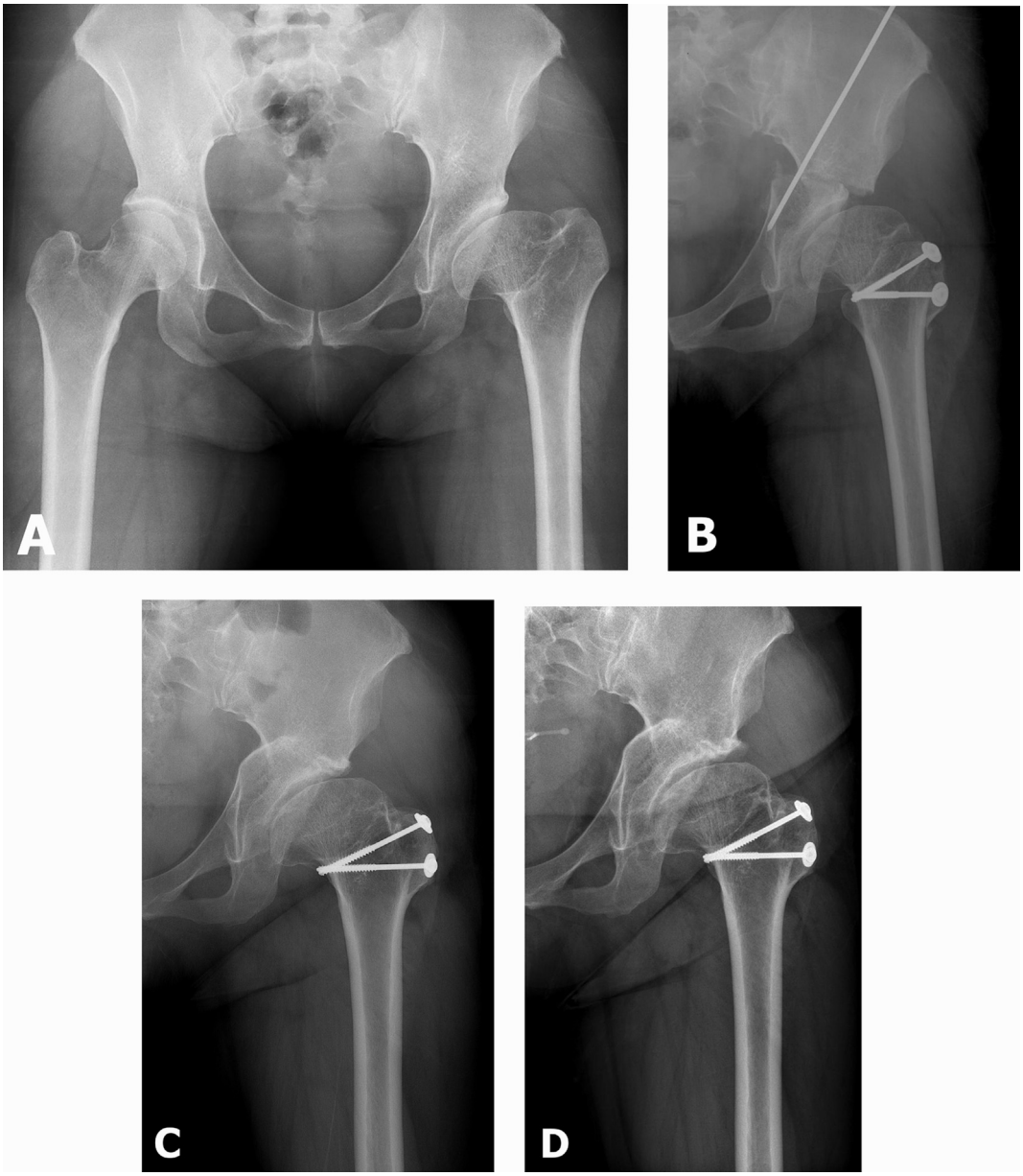

Fig. 2. (A) Preoperative radiograph of a 30-year-old female with left hip sequelae of Perthes' disease (Stulberg IV); (B) Immediate postoperative radiograph; (C) Radiograph at 6-year follow-up; (D) Joint space was maintained at 12-year follow-up. At this time, the patient was asymptomatic.

Table 3
Mean and range of radiographic parameters at preoperative, immediate postoperative, and final follow-up.

Radiographic parameters	Preoperative	Immediate postoperative	Final F/U	*p*-value	
				Preop-postop	Preop-final F/U
Center edge angle of Wiberg	24° (11-36°)	35° (27-46°)	37° (29-48°)	0.00	0.00
Acetabular angle of Sharp	43° (36-49°)	37° (32-44°)	37° (33-42°)	0.00	0.00
Acetabular head index	69% (50–83%)	85% (73–100%)	85% (57–100%)	0.00	0.00
Weight bearing joint space	5 mm (3–6 mm)	8 mm (5–12 mm)	6 mm (4–9 mm)	0.00	0.00
Minimum joint space	3 mm (1–4 mm)	4 mm (2–7 mm)	3 mm (2–5 mm)	0.040	0.547
Pelvic osteotomy angle	–	19° (15°–28°)	–	–	–
Acetabular displacement	–	15 mm (10–21 mm)	–	–	–
Acetabular displacement (%)	–	27% (15–36%)	–	–	–
Trochanteric advancement	–	17 mm (10–23 mm)	–	–	–

F/U: follow-up; Preop: preoperative; Postop: postoperative.

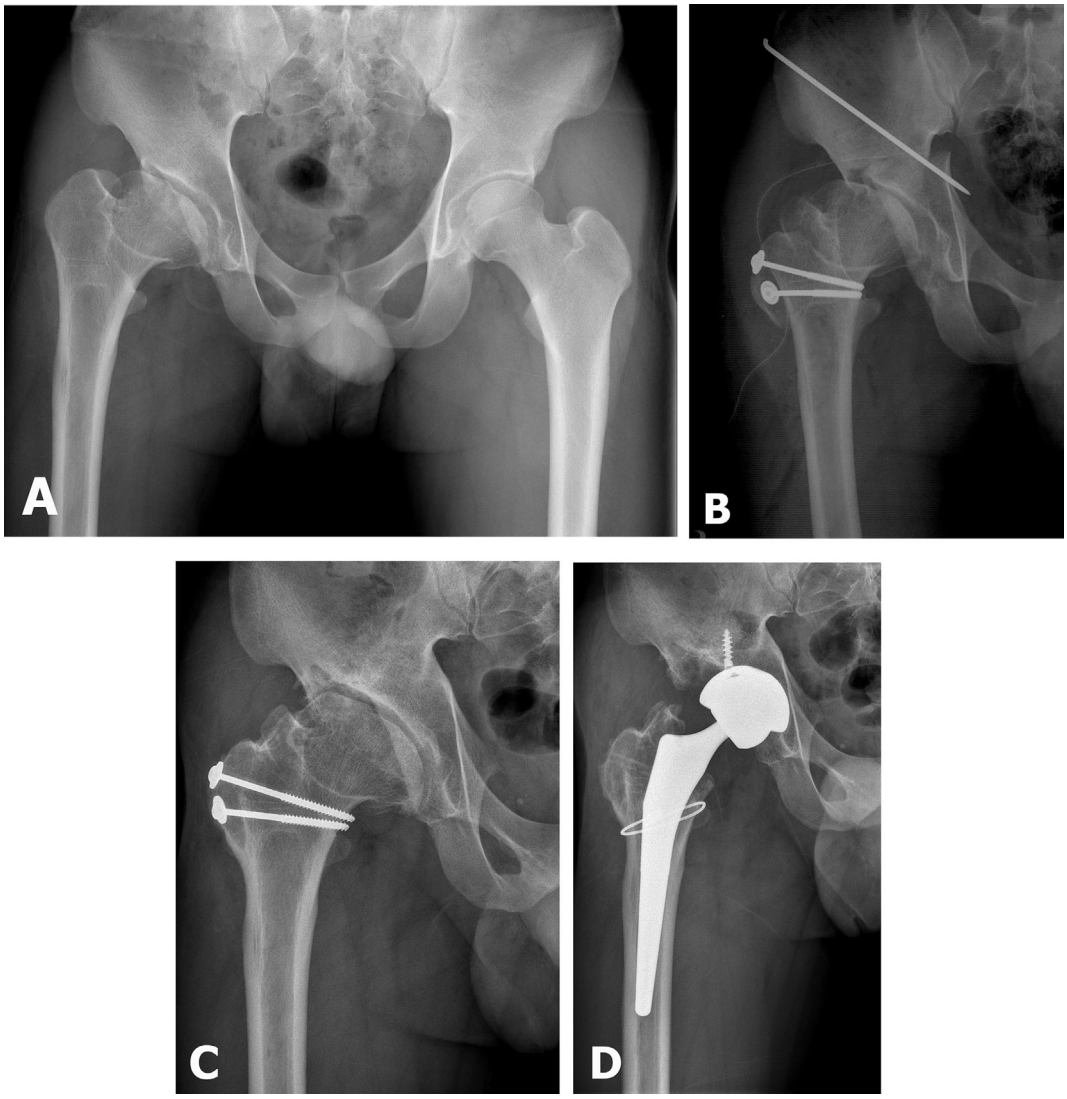

Fig. 3. (A) Preoperative radiograph of a 23-year-old male with right hip sequelae of Perthes' disease (Stulberg V); (B) Immediate postoperative radiograph; (C) Radiograph at postoperative11 years. At this time, the patient requested THA; (D) Radiograph at 4 months after THA.

Worsening of the joint arthrosis was found in 16 (17.7%) patients at the final follow-up. Anwar et al[7] have reported a relatively better outcome on the use of pelvic dome osteotomy combined with trochanteric advancement for treating acetabular dysplasia due to various etiologies. They reported excellent or good clinical result for 93 (92%) of 101 hips at a mean follow-up of 8.3 years. Progression of joint arthrosis was found in 10 cases at final follow-up. Factors significantly associated with poor outcome included advanced stage of arthrosis, valgus deformity of proximal femur, older age at time of operation, and postoperative persistence of abductor insufficiency.[7]

Different from the previous study, our series involved more adult population of acetabular dysplasia due to sequelae of Perthes' disease. Only a few studies have reported treatment outcome of dome osteotomy in this specific population. Koyama et al[18] have reported the outcome of dome osteotomy combined with trochanteric advancement for coxarthrosis after Perthes' disease. Similar to our series, they found that center edge angle of Wiberg, acetabular angle of Sharp, and acetabular head index were significantly improved on postoperative radiograph evaluation. They also found that pain was improved in 11 of a total of 14 hips (79%) at a median follow-up of 6 years. Median hip score was increased from 76 preoperatively to 91 postoperatively. However, they found that the overall activity of daily life was not improved.[18]

In our series, three patients experienced radiographic progression of arthrosis at the final follow-up. However, only one of them needed conversion to THA at the final follow-up. This patient received THA at 11 years after dome osteotomy (Fig. 3). Despite of good radiological result and pain relief, one of our patients requested THA because he was unsatisfied with the ROM of the joint. Similar to results of Koyama et al[18], significant improvement of joint ROM was not found at the final follow-up in this study. For comparison, Sakai et al[8] have reported a long term follow-up of dome osteotomy for acetabular dysplasia due to DDH. With a minimum follow-up of 25 years, 21 of 59 (36%) hips converted to THA at a mean of 18 years (range, 2.5–25 years). They found that older age, presence of preoperative Trendelenberg sign, higher arthrosis grade, and smaller postoperative acetabular head index predicted conversion to THA.[8]

In our series, 3 of 4 patients who had no improvement in limping gait needed THA conversion during the follow-up. We also paid attention to the role of Stulberg classification of preoperative

radiograph on the prediction of THA conversion. We found that 2 of 9 (22%) patients who had Stulberg IV and all (two) patients who had Stulberg V needed conversion to THA during the follow-up period. However, no patients who had Stulberg III needed THA conversion at the final follow-up.

This study has several limitations. It was a retrospective study with a small group of patients. Such small number of patients was included because most patients with sequelae of Perthes' disease who came to our hospital were at terminal stage of arthrosis which contraindicated joint preservation surgery. A longer follow-up is needed to determine the long-term outcome of this procedure. In addition, there was no control group in this study.

In summary, our study demonstrated that dome osteotomy of the pelvis combined with trochanteric advancement could give a reasonable treatment outcome for acetabular dysplasia due to Perthes' disease at mid to long-term follow-up. Advanced stage of arthrosis, preoperative Stulberg V and no improvement of limping gait after the surgery possibly associated with poor outcome.

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