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A Clinical Comparative Study of the Direct Anterior With Mini-Posterior Approach

Two Consecutive Series

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Abstract: We classified 182 consecutive patients (195 hips) treated by primary cementless minimally invasive total hip arthroplasty (MIS-THA) into 2 groups via the surgical approaches: direct anterior approach (DAA, 99 hips) and a mini-posterior approach (MPA, 96 hips). Ninety-nine percent of the cups in the DAA group and 91% in the MPA group had been implanted within the safe zone ($P = .008$). Patients in the DAA group could get single-leg stance of more than 5 seconds by 16.6 days ($P = .0004$), had positive Tredelenburg's sign by 29%, got 50-m walking time of 52.3 seconds ($P = .017$), and showed improvement in the use of assistive walking aids ($P = .031$) at 3 weeks postoperatively. The results of this study suggest more rapid recovery for hip function and gait ability after MIS-THA via a DAA when compared to an MPA. **Key words:** minimally invasive surgery, total hip arthroplasty, direct anterior, mini-posterior.

Minimally invasive total hip arthroplasty (MIS-THA) has been widely performed for several years. At the present time, various approaches are used in MIS-THA [1-7]. The optimum approach to achieve reduced operative invasion, operative accuracy, and early functional recovery after the operation is unknown. There are advantages and disadvantages in muscle damage to each approach. Moreover, it is unclear how muscle damage in MIS-THA affects clinical outcomes in functional recovery such as hip stability and ability to walk.

In 2002, Berger [1] advocated a 2-incision technique combined with muscle-splitting procedure for MIS-THA. He adopted a "blind" technique for femoral broaching and stem implantation under an image intensifier [1]. However, gluteus medius or minimus muscles or external rotators were more extensively damaged in this 2-incision technique than in the mini-posterior approach (MPA) in the cadaveric study [8].

In 2004, a muscle-preserving procedure of MIS-THA via a direct anterior approach (DAA) was described in an attempt to improve the clinical results of MIS-THA [6]. The DAA was developed by modifying the Smith-Peterson approach [9], the Heuter anterior approach as described by Judet and Judet [10], and the short Smith-Peterson approach as described by Light and Keggi [11]. Moreover, the gluteus medius was not damaged in either DAA or MPA, but the gluteus minimus was less damaged in

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DAA than in MPA in the cadaveric research regarding muscle damage [12].

However, it is still an unsolved concern whether a muscle-preserving MIS-THA using DAA can be clinically effective for less muscle damage followed by rapid functional recovery, compared with MIS-THA using MPA. We hypothesized that less muscle damage followed by early functional recovery could be achieved more consistently by a muscle-preserving MIS-THA via DAA than by MIS-THA via MPA.

The purpose of the present study was to compare the short-term clinical and radiographic outcome of MIS-THA performed by MPA with results using DAA and to clarify the differences in efficacy for functional recovery in MIS-THA via the 2 different approaches (MPA and DAA).

Materials and Methods

We started MIS-THA by MPA from May 2003. We changed the approach for MIS-THA from MPA to DAA expecting early functional recovery and started muscle-preserving MIS-THA by DAA from March 2005. From May 2003 to December 2006, 195 hips in 182 patients were treated with consecutive primary cementless MIS-THA. The exclusion criteria were a history of previous surgery on the affected hip, inflammatory polyarthritis, and required shortening femoral osteotomy because of their affection for hip functional recovery after surgery. One hip with a history of previous surgery on the affected hip, 7 hips with rheumatoid arthritis, and 1 hip with required shortening femoral osteotomy that was admitted for THA during the study period were not enrolled in the consecutive series. There were 156 females and 26 males. The average age at operation was 64.3 years (range, 38-88 years). The average height was 153.5 cm (range, 135-181 cm) and the average body weight was 54.5 kg (range, 34-80 kg). The average body mass index was 23.1 kg/m^2 (range, 16.0-34.2 kg/m^2). Primary diagnosis was secondary osteoarthritis (OA) due to hip dysplasia or congenital dislocation of the hip in 164 hips, osteonecrosis in 24 hips, and rapidly destructive coxarthritis in 7 hips. One hundred and seven hips with secondary OA were classified into the first degree, 43 hips into the second, 10 hips into the third, and 4 hip into the fourth by Crowe's classification system [13] for dislocation of the hip. Implants used were Centpillar (Stryker, Mahwah, NJ) in 118 hips, CTi II (Corin, Cirencester, UK) in 40 hips, and Super Secur-fit Plus (Stryker) in 36 hips. Patients with secondary OA due to hip dysplasia or congenital dislocation of the hip had various canal shape of the femur. We selected femoral components according to the femoral canal shape described by Noble et al [14]. We chose Centpillar in cases with normal canal, CTi II in cases with champagne-fluted appearance, and Super Secur-fit Plus in cases with stovepipe canal. Implant type was selected by femoral canal shape, not by surgical approach. There was no significant difference in implant type between the DAA and MPA groups.

We classified 182 consecutive patients (195 hips) into 2 groups via the surgical approaches (MPA and DAA). This study is a retrospective comparison of a consecutive series of primary cementless MIS-THA via the 2 different approaches by a single senior joint surgeon. There were no significant differences in age, sex, diagnosis, height, body weight, body mass index, or preoperative hip function between the 2 groups (Table 1).

In the MPA group, the patients were placed in lateral position on a standard orthopedic table. A reverse U-shape incision of the short rotators (piriformis to obturator externus) and capsule was performed as one bulk (muscle-capsular flap) and sectioned subperiosteally from their insertion. After cup and stem insertion, enhanced 1-layer suture of the gluteus minimus and the muscle-capsular flap, which was modified from White's procedure [15] combined with Kessler's method [16], was performed by a pullout technique to the major trochanter to prevent postoperative dislocation.

Our operative technique for DAA is slightly modified from that described by Siguier et al [6]. The patients were placed in supine position on a

Table 1. Demographic Data of the Patients

	DAA Group	MPA Group	*P* Value
No. of hips	99	96	
Age (y) *	62.9 ± 1.2	65.6 ± 1.2	.113 ‡
Sex (M/F)	16/83	13/83	.607 §
Height (cm) *	153.7 ± 0.9	153.3 ± 0.6	.752 ‡
Body weight (kg) *	54.1 ± 0.9	54.8 ± 1.0	.591 ‡
Body mass index (kg/m^2) *	22.9 ± 0.4	23.3 ± 0.4	.448 ‡
Preoperative diagnosis (hips)			.228 §
Osteoarthritis	80 (81%)	84 (88%)	
Osteonecrosis	15 (15%)	9 (9%)	
Rapidly destructive coxarthritis	4 (4%)	3 (3%)	
Preoperative functional score*,†			
Pain	1.6 ± 0.1	1.7 ± 0.1	.794 ‡
Mobility	4.0 ± 0.07	3.9 ± 0.08	.139 ‡
Ability to walk	2.6 ± 0.1	2.4 ± 0.1	.230 ‡
Total	8.2 ± 0.2	7.8 ± 0.2	.111 ‡

*Values are given as the mean ± SE.
†Merle d'Aubigne and Postel score.
‡Mann-Whitney *U* test.
§χ^2 Test or Fisher exact probability test.

standard orthopedic table. The operation table was positioned in horizontal condition to the floor. The frontal plane of the pelvis which is from the anterior superior iliac spines (ASIS) to the pubic tubercles was checked to be set parallel to the floor (or upper plane of the operation table) to place the pelvis in neutral tilting angle. If the frontal plane of the pelvis is not parallel to the floor because of muscle atrophy of the unilateral buttock, a few towel pads should be placed under the atrophic buttock to stabilize the pelvic movement.

The cup was inserted in 40° inclination angle by referring to the interconnected line of bilateral ASIS and alignment rod for inclination of cup positioner, and 20° anteversion angle by referring to the operation table and alignment rod for the version of cup positioner. We reconfirmed that the angle between the line of bilateral ASISs and cup positioner, and the angle between the horizontally positioned operation table (the frontal plane of the pelvis) and alignment rods for version of cup positioner were respectively acceptable as accurate cup alignment before, during, and after cup impaction. We did not use any controls by image intensifier or any x-ray for estimation of inclination and anteversion angle of cup intraoperatively.

After cup implantation, the caudal side of the operation table was tilted by 20°, and its cranial side by 10° for 30° of extension of the hip joint. The femur was positioned by 90° external rotation and 15° adduction. The superolateral capsule was released for appropriate anterior elevation of the femur followed by good femoral exposure and preparation. If further anterior mobilization of the femur was necessary, short rotators' tendons were released from their insertion subperiosteally. Femoral reaming, broaching, and stem implantation were performed after checking the direction of femoral axis and anterior bow of the femur.

Epidural analgesia for 36 hours after operation and oral taking of nonsteroidal anti-inflammatory drugs for 7 days postoperatively were applied as postoperative pain management. In principle, transfer to wheel chair with full weight bearing was permitted from the first postoperative day. Gait using a walker was started from the third day postoperatively. Patients were permitted to walk with a cane from the fifth to the seventh day after operation and to go up and down the stairs using handrail or a cane from the 10th day postoperatively. Walking with the aid of a cane or a walker was based on patients' ability. Physical therapists instructed gait training and stair ambulation during the patients' hospital stay. Patients were allowed to leave the hospital when they were able to get single-leg stance for more than 5 seconds and to achieve the negative Trendelenburg's sign, and were discharged when they could get sufficient hip function for their activity of daily living (ADL).

The rehabilitation protocol (transfer to wheel chair, no restriction of weight bearing, commencement of gait exercise, stair climbing and ADL training, and criterion for discharge) and pain management (epidural anesthesia and oral medication) for the DAA group were similar to that for the MPA group.

Elastic stocking and pneumatic compression boot were applied to the unoperated leg for intraoperative deep venous thrombosis. No deep venous thrombosis prophylactic agents (heparin, low-molecular-weight heparin, aspirin, or warfarin) were used in either group, but patients used elastic stocking and intermittent pneumatic compression for 7 days after the operation.

We evaluated operative time (skin incision to skin closure) and intraoperative and postoperative blood loss volume as indices of the operative invasion. Intraoperative blood loss volume was estimated by using intraoperative cell saver, and postoperative blood loss volume was measured by drain output postoperatively. Operative complications were recorded as they occurred.

Anteroposterior (AP) pelvic radiographs for hips and lateral radiographs of the proximal femur were routinely obtained on postoperative day 1, at 3 weeks, 2 months, 6 months, and 12 months, and subsequently every 1 year. Radiologic assessment was performed by measuring cup inclination angle [17], cup anteversion angle [17,18], positioning of cup within the safe zone of the Lewinnek et al [17] method, and stem alignment to estimate operative accuracy. Stem alignment of varus or valgus positioning of less than 3° was considered neutral position on AP radiographs, and stem alignment of anterior or posterior positioning of less than 3° was defined as neutral position on lateral radiographs. The 2-month AP and lateral radiographs were used to evaluate cup inclination angle, cup anteversion angle, and stem alignment. Evaluation was performed by 2 independent senior orthopedic surgeons and not by the senior joint surgeon (operating surgeon), which was not done in a blinded fashion.

Several indices for hip functional recovery were estimated postoperatively such as the required time up to walking by a single cane for more than 200 m, required time up to single-leg stance of more than 5 seconds, presence of Trendelenburg's sign preoperatively, at 5 days and 3 weeks after operation; required time up to recognition of negative Trendelenburg's sign, a timed 50-m walk to assess walking velocity, use of a walking aid before operation and at

3 weeks postoperatively. Required time up to recognition of negative Trendelenburg's sign was estimated independently by a nurse and a junior joint surgeon, not by the senior joint surgeon (operating surgeon). Trendelenburg's sign could be recognized as negative in achieving correspondence between the estimations of the nurse and the junior joint surgeon. Hip function was assessed clinically using the Merle d'Aubigne and Postel score [19], which gives a maximum of 6 points for each of the 3 categories of pain, mobility, and gait. Clinical assessment was performed preoperatively, at 2 months, 6 months, and the final follow-up.

Statistical Analysis

Continuous data were analyzed by using non-parametric Mann-Whitney *U* test, and data grouped into distinct categories (sex, diagnosis, implant, cup and stem positioning, presence of Trendelenburg's sign, use of a walking aid) were analyzed with the χ^2 test or Fisher exact probability test. *P* value of less than .05 was considered significant.

Results

Operative Invasion

Operative invasion such as intraoperative and postoperative blood loss volume was more extensive in the DAA group than in the MPA group (Table 2). There was no significant operative time between the 2 groups (Table 2).

Table 2. Operative Data and Implant Alignment

	DAA Group	MPA Group	*P* Value
Operative time (min)*	104.7 ± 2.9	100.4 ± 3.0	.304‡
Intraoperative blood loss volume (mL)*	526.1 ± 60.5	426.9 ± 28.0	.046‡
Postoperative blood loss volume (mL)*	670.9 ± 28.9	512.8 ± 28.9	.0001‡
Cup alignment*			
Inclination angle (°)	41.9 ± 0.6	39.6 ± 0.7	.017‡
Anteversion angle (°)	19.6 ± 0.5	17.9 ± 0.6	.038‡
Cup positioning in the safe zone (hips)‡			.008§
Inside	98 (99%)	87 (91%)	
Outside	1 (1%)	9 (9%)	
Stem alignment (hips)			
Anteroposterior radiograph			.503§
Neutral	93 (94%)	91 (95%)	
Varus	6 (6%)	4 (4%)	
Valgus	0 (0%)	1 (1%)	
Lateral radiograph			.252§
Neutral	95 (96%)	94 (98%)	
Posterior	4 (4%)	1 (1%)	
Anterior	0 (0%)	1 (1%)	

*Values are given as the mean ± SE or n (%).
‡Lewinnek's safe zone.
†Mann-Whitney *U* test.
§χ^2 Test or Fisher exact probability test.

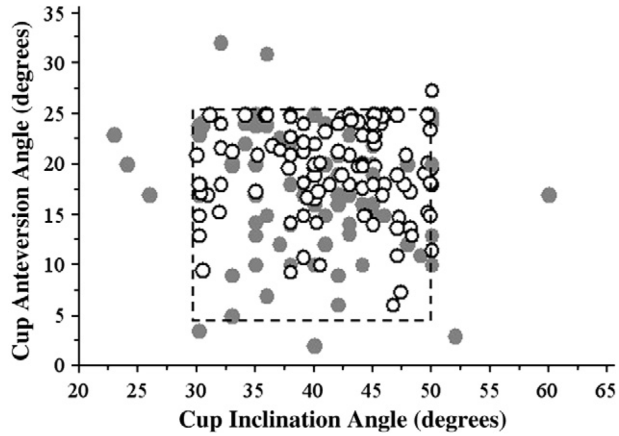

Fig. 1. A scatter diagram of cases in the DAA group and the MPA group. Circle, DAA group; filled circle, MPA group.

Operative Accuracy

Ninety-eight cups (99%) of the DAA group had been implanted within the safe zone of the Lewinnek et al [17] method, but 91% of cups in the MPA group were positioned within the safe zone [17] (*P* = .008; Table 2). There was a significant difference in cup safe-zone positioning between the 2 groups (Fig. 1). Intraoperative and postoperative complications are described in Table 3.

Functional Recovery (Hip Stability)

In the DAA group, required time to single-leg stance of more than 5 seconds was 16.6 days (range, 4-79 days). In the MPA group, required time to single-leg stance of more than 5 seconds was 22.9 days (range, 7-75 days) (Table 4). Positive Trendelenburg's sign was recognized in

Table 3. Complications

	DAA Group	MPA Group
Superficial infection (hips)	1	0
Deep infection (hips)	0	0
Calcar Fracture (hips)	1	2
Major trochanteric tip fracture (hips)	1	1
Nonfatal DVT (hips)*	1	0
Hyperesthesia of LFCN (hips)†	1	0
Nerve palsy (hips)	0	0
Postoperative dislocation (hips)	0	1
Postoperative femoral fracture (hips)	0	1
Cup migration (hips)	0	0
Stem subsidence (hips)	0	1

*Deep venous thrombosis.
†Lateral femoral cutaneous nerve.

Table 4. Postoperative Hip Function, Hip Stability, and Walking Ability

	DAA Group	MPA Group	*P* Value
Postoperative required time up to (d) *			
Gait with a single cane (>200 m)	12.0 ± 0.8	15.5 ± 0.7	.009 ‡
Single-leg stance (>5 s)	16.6 ± 1.3	22.9 ± 1.2	.0004 ‡
Negative Trendelenburg's sign	16.7 ± 1.4	24.8 ± 1.5	.0002 ‡
Presence of Trendelenburg's sign (hips)			
Before operation	96 (97%)	94 (98%)	.676 §
At 5 d after operation	96 (97%)	96 (100%)	.086 §
At 3 wk after operation	29 (29%)	64 (67%)	<.0001 §
At 2 mo after operation	8 (8%)	8 (8%)	.949
50-m walking time (s) *			
Before operation	69.0 ± 5.5	68.7 ± 7.8	.523 ‡
At 3 wk after operation	52.3 ± 4.0	74.5 ± 6.3	.017 ‡
Use of assistive walking aids (hips)			
Before operation			.654 §
No device	0 (0%)	1 (1%)	
Single cane	90 (91%)	87 (91%)	
Double crutch	8 (8%)	6 (6%)	
Walker	1 (1%)	2 (2%)	
At 3 wk after operation			.031 ‡
No device	34 (34%)	18 (19%)	
Single cane	59 (60%)	74 (77%)	
Double crutch	6 (6%)	4 (4%)	
Walker	0 (0%)	0 (0%)	
Length of hospital stay after operation (d) *	22.2 ± 1.4	30.4 ± 1.2	.003 ‡
Functional score*,†			
At 2 mo after operation			
Pain	5.1 ± 0.04	5.0 ± 0.01	.153 ‡
Mobility	5.0 ± 0.1	5.2 ± 0.4	.170 ‡
Ability to walk	5.0 ± 0.07	4.3 ± 0.5	.023 ‡
Total	15.1 ± 0.2	14.5 ± 0.9	.068 ‡
At 6 mo after operation			
Pain	5.8 ± 0.05	5.9 ± 0.03	.198 ‡
Mobility	5.5 ± 0.08	5.4 ± 0.06	.312 ‡
Ability to walk	5.4 ± 0.1	5.1 ± 0.1	.078 ‡
Total	16.7 ± 0.2	16.3 ± 0.2	.124 ‡

*Values are given as the mean ± SE.
†Merle d'Aubigne and Postel score.
‡Mann-Whitney *U* test.
§χ^2 Test or Fisher exact probability test.

97% of the DAA group and 98% of the MPA group before operation, and in 97% of the DAA group and 100% of the MPA group at 5 days after operation. There were no significant differences in presence of Trendelenburg's sign before and at 5 days after operation between the 2 groups (Table 4). Positive Trendelenburg's sign at 3 weeks postoperatively in the DAA group was observed in 29 hips (29%) and in the MPA group was recognized in 64 hips (67%). There was a significant difference in the presence of Trendelenburg's sign at 3 weeks postoperatively between the 2 groups (P < .0001; Table 4). In the DAA group, required time to recognize negative Tredelenburg's sign was 16.7 days (range, 5-79 days) postoperatively and 24.8 days (range, 5-70 days) postoperatively in the MPA group (Table 4). Faster recovery of Tredelenburg's sign and single-leg stance were significantly accomplished in the DAA group (Table 4).

Functional Recovery (Ability to Walk)

In the DAA group, required time up to walking by a single cane for more than 200 m was 12.0 days (range, 2-43 days). In the MPA group, required time up to walking by a single cane was 15.5 days (range, 6-60 days). Fifty-meter walking time was 69.0 seconds (range, 48-84 seconds) in the DAA group and 68.7 seconds (range, 45-161 seconds) in the MPA group preoperatively, and it was 52.3 seconds (range, 32-78 seconds) in the DAA group and 74.5 seconds (range, 48-100 seconds) in the MPA group at 3 weeks after operation. There was a significant difference in walking velocity at 3 weeks postoperatively between the 2 groups (P = .017; Table 4). Thirty-four percent of patients in the DAA group were able to walk without the use of assistive walking aids at 3 weeks postoperatively, and 19% of patients in the MPA group could walk without the use of walking device at 3 weeks after operation. In the DAA group, the use of assistive walking aids at 3 weeks postoperatively was significantly improved (P = .031; Table 4).

Functional Recovery (Hip Function)

Preoperative hip function scores by the Merle d'Aubigne and Postel scale [19] were 8.2 points (range, 3-12 points) out of 18 points in the DAA group and 7.8 points (range, 4-12 points) in the MPA group (Table 1). Average score for ability to walk at 2 months postoperatively was 5.0 points (range, 3-6 points) in the DAA group and 4.3 points (range, 2-6 points) in the MPA group. There was a significant difference in ability to walk at 2 months postoperatively between the 2 groups (P = .023). Average clinical hip function at 6 months after operation was 16.7 points (range, 14-18 points) in the DAA group and 16.3 points (range, 13-18 points) in the MPA group (Table 4). There were no significant differences in total hip functional score preoperatively, at 2 and 6 months after operation between the DAA and MPA groups (Table 4).

Discussion

The DAA was developed using the short Smith-Peterson approach [9-11], which gave adequate credit and good clinical results [6,18,20].

In 2004, Siguier et al [6] reported the clinical results of a case series regarding DAA, in which frequency of postoperative dislocation was 0.96% (10/1037 hips). They concluded that DAA was a useful and reliable procedure as a technique for MIS-THA [6].

Matta et al [18] described the clinical results of 494 MIS-THAs using DAA, where 93% of cups could be implanted within a safe zone under intraoperative verification by an image intensifier. In their report, dislocation was observed in 0.6%, trochanter fracture in 0.6%, calcar fracture in 0.8%, and femoral nerve palsy in 0.2% [15]. Their complication rate is considered to be acceptable as a clinical result of an early series of DAA.

The DAA is considered to be an internervous plane approach between the zones of innervation of the superior and inferior gluteal nerves laterally and the femoral nerve medially [6]. In this approach, the origin of the tensor fascia latae, sartorius, and rectus femoris is not sectioned, and insertions of the gluteus medius and minimus muscle are not detached by blunt exposure techniques. Therefore, DAA could be considered as a muscle-preserving procedure followed by rapid functional recovery. However, it is still an unsolved concern whether a muscle-preserving MIS-THA using DAA can be effective for less muscle damage followed by rapid functional recovery, compared with MIS-THA using MPA.

Our results showed more rapid recovery of hip function and hip stability in the DAA group than in the MPA group, such as time up to single-leg stance of more than 5 seconds (P = .0004), presence of Trendelenburg's sign at 3 weeks postoperatively ($P <$ .0001), required time up to recognition of negative Trendelenburg's sign (P = .0002), time up to walking with a single cane for more than 200 m (P = .009), walking velocity at 3 weeks postoperatively (P = .017), use of a walking aid at 3 weeks after operation (P = .031), and ability to walk at 2 months postoperatively (P = .023).

Gluteus medius and minimus are not detached or sectioned in either DAA or MPA. The tensor fascia origin is not detached from the pelvis and the reflected head of the rectus femoris is not sectioned by DAA. The gluteus maximus muscle is not incised in DAA, which is very important for hip extension and ADL such as getting out of a chair, going up and down the stairs, and getting out of a car. Moreover, the gluteus maximus and tensor fascia which are inserted in the iliotibial band and form a deltoid of the hip for abductors and pelvic stabilizer are undisturbed in DAA [18].

However, the gluteus maximus and tensor fascia are incised in MPA [18]. The short external rotators, which play many important roles in hip function and dynamic hip stabilization, are disturbed in MPA. Meneghini et al [12] reported in their comparative cadaveric research that the gluteus medius was not damaged in either DAA or MPA, but the gluteus minimus was less damaged in DAA than in MPA. We consider that rapid functional recovery in DAA is caused by the difference in invasion to the gluteus maximus, a deltoid of the hip, hip abductors, and short external rotators between DAA and MPA.

In the current study, operative invasion such as intraoperative and postoperative blood loss volume was more extensive in the DAA group, which might be caused by technical difficulty in femoral preparation or steep learning curve in DAA. Intraoperative bone bleeding after acetabular reaming might be less in MPA with lateral position because of gravity effect.

In the present study, cups were positioned within the safe zone of the Lewinnek et al [17] method more accurately in the DAA group than in the MPA group (P = .008). In MPA with lateral position, the pelvic tilting angle may be extensively changed by forced traction by retractors during acetabular exposure, which is followed by cup malpositioning.

On the other hand, DAA is the most superficial approach to the hip joint. Therefore, acetabular exposure is relatively easy, and extensively forced traction by retractors for acetabular exposure followed by intraoperative change of pelvic tilting angle is not necessary in DAA. The pelvis could be tightly stabilized in supine position on a horizontally positioned operation table, which is followed by less change in pelvic tilting angle in cup positioning. However, in DAA with supine position, the pelvic tilting might be changed intraoperatively followed by making errors in cup anteversion angle.

Our rehabilitation program and length of hospital stay are longer than those in the United States. There are several affecting factors for the length of hospital stay, including physiotherapy support, family support, community support, housing conditions, and functional recovery. Patients in Japan usually demand sufficient functional recovery at discharge from hospital to perform their ADL, sometimes in severe housing conditions (limited space, steep stairs, and non–barrier-free floor). Moreover, more than 80% of our patients have experienced hip dysplasia or congenital dislocation for several decades, which is followed by severe secondary OA with severe muscle atrophy, contracture, and limb length discrepancy. Therefore, it might take a longer time for our patients to leave the hospital with sufficient hip function than the usual hip arthroplasty patient in the United States.

A weakness of the present study includes its retrospective nature. We have a historical control of MPA to compare with DAA. However, the bias in patient selection, lack of randomization, and difference in learning curve regarding operative techniques might exist in this study. The strengths of this study include a continuous series of patients treated without selection and bias of radiographic severity for component positioning and application of a similar rehabilitation protocol and pain management in both DAA and MPA groups.

We conclude that muscle-preserving MIS-THA by DAA is a more useful and more effective procedure for rapid functional recovery than MIS-THA by MPA.

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