

Comparison of short-term results in THA patients with SuperPath[®] and the conventional approach for dysplastic OA of the hip

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Abstract. *Background and aim:* The purpose of this study is to compare clinical outcomes and lower extremity recovery between THA of SuperPath[®] approach (Group S) and that of conventional posterior approach (Group C) for secondary OA derived from acetabular dysplasia. *Methods:* Both 30 patients (Group S) and 36 patients (Group C) were investigated for clinical scores and recovery of lower limb function. *Results:* JOA scores showed no significant difference in preoperatively, but at discharge (Group C: 76.8±4.3, Group S: 86.7±5.1, $p<0.01$) and postoperative 2 months (Group C: 85.0±3.5, Group S: 91.5±7.2, $p<0.01$) they were significantly improved in group S over group C. The mean length of stay was 16.3±4.9 days for group S, which was significantly shorter than of 25.5±4.6 days in group C ($p<0.01$). In terms of recovery of lower limb function, a mean time from postoperative to walking 50-meters with a cane was 3.2±2.3 days in group S, significantly shorter than that of 13.8±5.1 days in group C ($p<0.01$). The mean time to achieve ascend and descend of stairs using a handrail was 3.8±1.4 days in group S, significantly shorter than that of 12.8±5.1 days in group C ($p<0.01$). *Conclusions:* Clinical outcomes were good in both groups with mild dysplasia. Since postoperative JOA score, LOS, postoperative period to walking 50-meters with a T-cane and to achieve ascend and descend of stairs in group S are better than that in group C, SuperPath[®] approach achieved significantly faster recovery of lower extremity function than the conventional posterior approach. (www.actabiomedica.it)

Key words: total hip arthroplasty, SuperPath approach, early recovery, minimally invasive surgery, percutaneous assisted total hip

Introduction

Total hip arthroplasty (THA) has become the preferred treatment for symptomatic and advanced osteoarthritis (OA) of the hip joint, alleviating pain and restoring pain-free joint function. Due to its high success rate, THA is often referred to as the surgery of the century (1). Despite the highly standardized surgical procedure, anatomical abnormalities such as dysplasia, coxa profunda, and protrusio acetabuli pose significant challenges to the surgeon and may hamper

the postoperative outcome if not adequately addressed prior to surgery. On the other hand during the last 20 years or so, minimal invasive approaches for both anterior and posterior-lateral (PL) approaches have been introduced and progressed (2-5). Even though the results of the anterior approach including direct anterior approach (DAA) have been fanatically reported, the requirement for a PL minimally invasive approach is still largely driven by its perceived popularity with orthopedic surgeons, particularly those without specialized training. Therefore, further improved

PL approaches may be expected by many surgeons who are seeking a minimally invasive approach but who are uncomfortable dealing with a new learning curve of DAA. Consequently, several PL minimally invasive approaches including SuperPath[®] of a superior approach as well as STAR (6), DSA (7), HEROS (2) and so on have been introduced. In 2011, Chow introduced SuperPath[®], a surgical technique combining SuperCAP and PATH for THA (8), and its excellent results have been reported in Europe and the United States, where primary osteoarthritis (OA) is common, and the superiority of SuperPath[®] has been demonstrated in comparative studies with other approaches (9-11). Similarly, in Japan, favorable results of THA with SuperPath[®] for secondary OA derived from acetabular dysplasia have also been reported (12). However, there have been no comparative studies with THA using other approaches for this indication. The purpose of this study was to compare clinical outcomes and lower extremity recovery of THA for secondary OA in two groups with similar implant designs but different approaches - SuperPath[®] and conventional posterior approach.

Materials and Methods

Of the patients scheduled for THA for hip dysplasia at our department between April 2014 and March 2018, 36 patients who underwent THA via conventional posterior approach and 30 patients who underwent THA via SuperPath[®] approach agreed to participate in the study. At our institution, from

April 2014 to March 2016, all THA were performed using the conventional posterior approach, and after March 2016, all THA were performed using the SuperPath[®] approach, and the choice of approach was determined by time. All THA were done by the same experienced surgeon. Patients with a preoperative dislocation degree of Crowe type (13) 3 or 4 or a preoperative UCLA activity score (14) of 2 or less were excluded. Also, patients who did not have a postoperative follow-up visit were excluded. The study was approved by our Institutional Review Board. 66 patients including 8 males and 58 females, all with secondary OA of acetabular dysplasia were included. 1 patient in group C was excluded because it did not come to the postoperative follow-up. The mean age at surgery was 65.2 years, mean BMI was 23.5 (kg/m²), and mean postoperative follow-up period was 2 months. The preoperative UCLA Activity Score was 3 (42 patients), 4 (23 patients), and 6 (1 patient), respectively. Table 1 shows the details of the two groups.

All surgeries were performed under general anesthesia in a lateral position. Please refer to the section below of surgical technique for details. After surgery, the patients were confined to bed rest on the day of surgery, followed by rehabilitation starting the next day. No special rehabilitation program was given; the patients were told to train with the goal of improving gait ability and ADL according to the patients' condition. Surgical time and intraoperative blood loss were investigated. Clinically, JOA-Japanese Orthopedic Association-scores consisting of questions on pain (0-40), range of motion (0-20), walking ability (0-20) and ADL (0-20); with a minimum score of 0 points and

Table 1. Patient Demographics Mean±SD of age, BMI (Body mass index), height, Weight and UCLA score (University of California, Los Angeles activity score) of both Conventional (Group C) and SuperPath (Group S)

	Conventional (Group C)	SuperPath (Group S)	p-value
Number of Patients	36	30	
Sex Ratio (M/F)	3/33	5/25	
Age(yrs.)	64.9±8.3	65.7±8.7	0.70
BMI (kg/m ²)	24±2.5	23±2.2	0.09
Height(cm)	153±7.5	154±7.6	0.59
Weight(kg)	53±7.3	56±8.4	0.12
UCLA score	3.3±0.47	3.4±0.66	0.83

a maximum of 100 points (15) were evaluated preoperatively, at discharge, and at postoperative 2 months. Complications (e.g., dislocation, fracture, infection, pulmonary embolism, and neuropathy) up to postoperative 2 months were also investigated. To evaluate recovery of lower limb function, length of stay (LOS) and the number of postoperative days until patients could a) walk more than 50-meters with a cane and b) ascend and descend stairs with a handrail were also investigated. Radiographically, the degree of acetabular dysplasia was measured using Sharp angle (16) and the lateral center edge (CE) angle (17) from a preoperative hip AP x-ray and the degree of dislocation was evaluated using the Crowe classification (13). Immediately postoperative and 2-month postoperative hip x-rays were compared for evaluating implant migration and fixation (18) (19). Implant alignment was also evaluated by hip CT at postoperative 2 months.

Surgical technique

In 30 patients who underwent SuperPath® THA, a superior approach was used that the short external rotators were preserved. The hip was entered from between the piriformis and the posterior border of a gluteal muscle to the joint (Figure 1), and a straight incision was made in a posterior joint capsule (Figure 2) (8). After femoral broaching without dislocation (Figure 3), femoral head was resected, and a cannula was inserted for acetabular manipulation using a portal through a separate skin incision (Figure 4). After implantation, the joint capsule was sutured. All patients used MicroPort Orthopedics (Arlington, TN, USA) Dynasty® Biofoam® cementless acetabular cup, and PROFEMUR® Z cementless femoral stems (30 cases). No screws were used for cup fixation, and no cases required massive bone grafting on the acetabulum. Ceramic heads were used in all cases, and the head size was determined by the diameter of the cup used (28 mm in 6 cases, 32 mm in 24 cases). Intraoperatively, the navigation system (Stryker) was used in 22 cases and Xp control was performed in all cases to confirm implant placement and alignment.

In 36 patients who underwent conventional THA, a posterolateral approach was used where

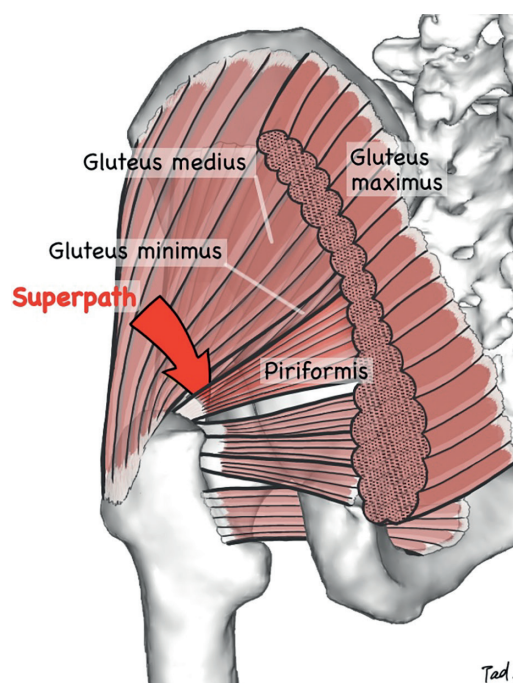


Figure 1. As shown by the red arrow, enter the joint from between the piriformis and the posterior border of a gluteal muscle.

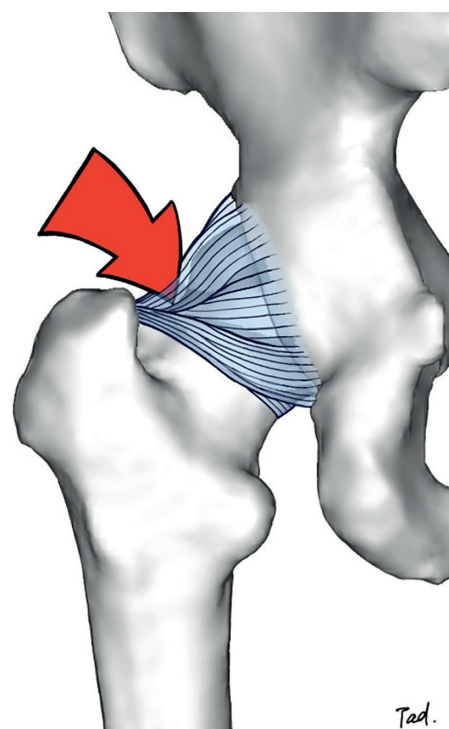


Figure 2. Make a straight incision in the posterior joint capsule as indicated by the red arrow.

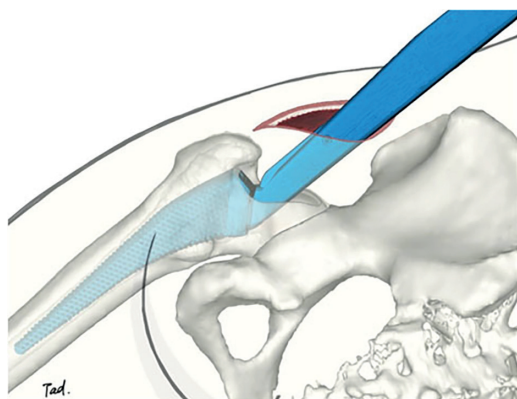


Figure 3. Femoral broaching was made without dislocation.

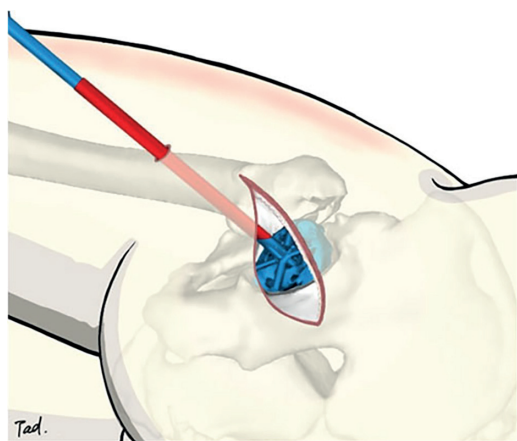


Figure 4. A cannula, shown in red, was inserted for acetabular manipulation using a portal through a separate skin incision.

the short external rotators were all resected and a T-shaped incision was made in posterior capsule. After implant placement, posterior capsule and short external rotator muscles were repaired. All patients used Smith & Nephew Reflection cementless acetabular cups and SL-PLUS MIA cementless femoral stems. No screws were used for cup fixation, and no cases required massive bone grafting on the acetabular side. All patients used Oxinium heads, and the head size was determined by the diameter of the placed cup (28 mm in 2 cases, 32 mm in 34 cases). A navigation system (Stryker) was used in all cases for intraoperative acetabular manipulation.

Results

JOA scores were 46.5 ± 9.2 in group C and 48.4 ± 8.2 in group S preoperatively but improved to 76.8 ± 4.3 and 86.7 ± 5.1 , respectively, at discharge, and 85.0 ± 3.5 and 91.5 ± 7.2 at postoperative 2 months, respectively. The JOA scores showed no significant difference between group C and group S ($p=0.30$) preoperatively, but group S was significantly better than group C at discharge and at 2 months postoperatively ($p<0.01$, $p<0.01$, respectively. Table 2).

In detail, though range of motion was larger in group S than in group C ($p<0.01$), there was no significant difference in all other items preoperatively. At the time of discharge and 2 months after surgery, only pain was not significantly different between the two groups, but range of motion, walking ability, and ADL were significantly higher in the S group (Table 2). The mean operative time was 106 ± 8 minutes in group C and 118 ± 11 minutes in group S, with group S having a significantly longer operative time ($p<0.01$). Intraoperative blood loss averaged at 392 ± 182 ml in group C and 417 ± 206 ml in group S. There was no statistically significant difference ($p=0.61$ Table 3).

The mean LOS was 16.3 ± 4.9 days in S group, significantly shorter than that of 25.5 ± 4.6 days in C group ($p<0.01$). Regarding recovery of lower limb function, a mean time from postoperative period to walking 50-meters with a cane was 3.2 ± 2.3 days in S group, significantly shorter than that of 13.8 ± 5.1 days in C group ($p<0.01$). A mean time to achieve ascend and descend of stairs using a handrail was 3.8 ± 1.4 days in S group, significantly shorter than that of 12.8 ± 5.1 days in C group ($p<0.01$) (Table 4).

As for complications, there were no cases of postoperative dislocation, infection, or serious pulmonary embolism in either group, but there was one case of intraoperative crack fracture of the proximal femur in each group, and both cases underwent additional intraoperative wire cerclage. In S group, sciatic nerve palsy was observed in one patient immediately after surgery, but the patient recovered completely within 3 months after surgery with conservative treatment. Preoperative radiographic evaluation showed an

Table 2. JOA score (Japanese Orthopedic Association) Mean $\pm$ SD of JOA score preoperatively, at discharge and postoperative 2months. JOA score including pain, range of motion, walking ability and activity of daily living (ADL) of both Conventional (Group C) and SuperPath (Group S)

	Conventional (Group C)	SuperPath (Group S)	p-value
JOA Score			
Preoperatively	46.5 $\pm$ 9.2	48.4 $\pm$ 8.2	0.38
Pain	15.5 $\pm$ 6.0	13.3 $\pm$ 4.7	0.10
Range of motion	9.6 $\pm$ 4.4	12.5 $\pm$ 4.3	<0.01
Walking ability	9.2 $\pm$ 3.3	9.6 $\pm$ 2.3	0.57
ADL	12.2 $\pm$ 2.4	13.0 $\pm$ 2.1	0.15
at discharge	76.8 $\pm$ 4.3	86.7 $\pm$ 5.1	<0.01
Pain	35.9 $\pm$ 2.0	35.7 $\pm$ 1.8	0.67
Range of motion	13.8 $\pm$ 2.5	18.3 $\pm$ 1.3	<0.01
Walking ability	13.8 $\pm$ 2.1	16.4 $\pm$ 2.4	<0.01
ADL	13.3 $\pm$ 1.0	16.3 $\pm$ 2.2	<0.01
Postoperative 2 months	85.0 $\pm$ 3.5	91.5 $\pm$ 7.2	<0.01
Pain	38.4 $\pm$ 2.3	38.8 $\pm$ 2.1	0.28
Range of motion	16.1 $\pm$ 1.6	18.5 $\pm$ 1.3	<0.01
Walking ability	15.0 $\pm$ 0.5	16.9 $\pm$ 2.7	<0.01
ADL	15.5 $\pm$ 0.8	17.3 $\pm$ 2.7	<0.01
(point)			

Table 3. Intraoperative data Mean $\pm$ SD of operative time and Intraoperative blood loss of both Conventional (Group C) and SuperPath (Group S)

	Conventional (Group C)	SuperPATH (Group S)	p-value
Operative time (min)	106 $\pm$ 8	118 $\pm$ 11	p<0.01
Intraoperative blood loss (ml)	392 $\pm$ 182	417 $\pm$ 206	0.61

average Sharp angle of 47.8 ± 3.0 degrees and CE angle of 18.1 ± 7.6 degrees for acetabular dysplasia, and 65 patients had Crowe Type I and 1 patient had Crowe Type II. Immediate postoperative radiographic evaluation showed no significant difference in implant alignment: $38.9 \pm 3.5^\circ$ for group C and $39.9 \pm 4.1^\circ$ for group S of cup abduction angle ($p=0.20$), and $23.4 \pm 6.5^\circ$ and

$24.4 \pm 5.7^\circ$ for group C and group S, respectively, for cup anatomic anteversion angle ($p=0.51$). The anteversion angle of femoral stem was $30.2 \pm 10.3^\circ$ in group C and $34.0 \pm 9.8^\circ$ in group S, respectively, with no significant difference ($p=0.13$) (Table 5).

Stem alignment was within 2 degrees of varus / valgus in all patients in both groups C and S. Lateral femoral images showed an anterior insertion of more than 5 degrees (flexion) in 2 patients (6%) in S group, but not in C group. Comparison of the immediately postoperative and postoperative 2 months x-rays showed no change in cup alignment in all patients. Stem subsidence of more than 2 mm was observed in 2 cases (6%) in S group and 2 cases (5.6%) in C group from 2-month postoperative hip x-rays, but no additional progression was observed thereafter. No loosening of either cup or stem was observed in all cases at postoperative 2 months.

Table 4. Postoperative recovery of lower limb Mean $\pm$ SD of length of stay (LOS), postoperative period to walking 50-meters with a T-cane and postoperative period to achieve ascend and descend of stairs using a handrail of both Conventional (Group C) and SuperPath (Group S)

	Conventional (Group C)	SuperPATH (Group S)	p-value
LOS	25.5 $\pm$ 4.6	16.3 $\pm$ 4.9	<0.01
walking 50-meters with a T-cane	13.8 $\pm$ 5.1	3.2 $\pm$ 2.3	<0.01
ascend and descend of stairs	12.8 $\pm$ 5.1	3.8 $\pm$ 1.4	<0.01
(day)			

Table 5. Implant Alignment Mean $\pm$ SD of cup abduction angle, cup anteversion angle and femoral stem anteversion of both Conventional (Group C) and SuperPath (Group S)

	Conventional (Group C)	SuperPATH (Group S)	p-value
Cup abduction (deg.)	38.9 $\pm$ 3.5	39.9 $\pm$ 4.1	0.20
Cup anteversion (deg.)	23.4 $\pm$ 6.5	24.4 $\pm$ 5.7	0.51
Femoral stem anteversion (deg.)	30.2 $\pm$ 10.3	34.0 $\pm$ 9.8	0.13

Discussion

Superior approach for THA is a technique in which a surgeon enters hip joint between posterior border of the gluteus medius and piriformis muscle and incises the joint capsule. It was introduced by Murphy in 2003 as SuperCAP. (20, 21) It typically preserves a lot of anterior and posterior soft tissue. At the same time, Penenberg reported a technique using a portal for acetabular manipulation in THA by the superior approach called PATH (22). In 2011, Chow (8) introduced the SuperPath[®] technique, a combination of SuperCAP and PATH, and its promising short-term results have been reported in Europe and the United States where primary OA is common (9-11). In Europe and the United States, a comparative study between the conventional posterior approach and SuperPath[®] has already been reported, showing the superiority of the clinical results with SuperPath[®] (10, 11). Even, in Japan, where dysplastic OA is more common than in the West, SuperPath[®] THA has been reported to show successful outcomes (12). However, there have been no comparative studies with SuperPath[®] and THA using other approaches for this indication. Therefore, in this study, we compared two groups of patients with the same implant design but different approaches for dysplastic OA. In terms

of JOA score with SuperPath[®] postoperative 2months JOA score in group S is almost same as postoperative 12 weeks JOA score of both minimally aterolateral approach and direct anterior approach that 90.76 $\pm$ 3.16, 90.48 $\pm$ 6.97, respectively (23). Regarding perioperative pain, Branco, et al. (24) compared SuperPath[®] and conventional approaches for THA and reported that VAS was significantly lower with the SuperPath[®] approach at 3 days and 1 month postoperatively. Ramadanov, et al. (10) performed a meta-analysis comparing SuperPath[®] and conventional approaches for THA and found similar results where the VAS was significantly lower with the SuperPath[®] approach at 7 days postoperatively. These reports suggested that THA with SuperPath[®] was significantly less painful from early postoperative period to 1month postoperative period compared to the conventional approach. However, in this study, the JOA score was high for both the groups at discharge, indicating less pain, with no significant difference between the groups (C group:35.9 $\pm$ 2.0, S group:35.7 $\pm$ 1.8 p=0.67. Since the average LOS in group C was 25.5 $\pm$ 4.6 days and that in group S was 16.3 $\pm$ 4.9 days, and because the timing of evaluation of JOA pain score at discharge was different between the groups, the score was likely not significant. Li, et al. (25) reported significantly greater gait speed and step length in SuperPath[®] group at postoperative 7 days

and 1 month as compared to conventional approaches for THA. Fink, et al. (26) compared two THA groups, MIS posterior approach and standard posterior approach, and found that MIS posterior approach group had a significant difference in the meantime until a patient could walk with a cane in a ward (2.7 days) and the mean time until a patient could ascend and descend stairs (5.3 days). Previous reports have shown a significantly earlier recovery of objective parameters in gait analysis after THA with SuperPath[®] approach compared to conventional approach, and results of this study support previous reports. The results of this study on implant alignment showed that cup alignment was good in both groups. Stem alignment was within 2 degrees of varus/valgus in all cases, but anterior insertion (flexion) of more than 5 degrees was observed in 2 cases (6%) in the S group on the lateral femoral radiograph. Although no specific clinical problems were observed in these two cases, we believe that careful observation is necessary in the future. A meta-analysis of THA with SuperPath[®] approach and THA with conventional approach has been reported by Ge, et al. (27) where no difference was found in alignment between the two groups. Li, et al. (28) also reported no significant difference in alignment in a similar meta-analysis study, and no significant malalignment was found among the reports we read widely. As for complications, results of this study showed no cases of postoperative dislocation, infection, or serious pulmonary embolism in either group, but there was one case of intraoperative crack fracture of the proximal femur in each group. Both patients underwent wire fastening as an additional procedure during surgery. Both intraoperative fracture cases in this study were women over 80 years old, where poor bone stock may have been a factor. In this study, one case of sciatic nerve palsy was observed immediately after surgery in group S. This may be due to the fact that though THA with the SuperPath[®] approach does not usually allow direct observation of the sciatic nerve intraoperatively, the sciatic nerve is close to the operative field since most intraoperative manipulations are performed in hip flexion, further, the external rotator muscles are retracted backward with a retractor. Thus, it is highly possible that sciatic nerve damage was caused by Retractor. Fortunately, complete recovery from the neuropathy

was observed in 3 months after the surgery with no therapeutic treatment intervention but only follow-up observation. I believe it is still extremely important to manipulate the retractor in a safe and cautious manner (8, 12). In this study, we compared the SuperPath[®] approach and conventional approach to THA for dysplastic hip OA with a stem of similar design. The study design included patients with Crowe Type I and II, and a preoperative UCLA activity score of 3 or higher. The comparison of two groups showed that implant alignment was good, and no loosening was evident at postoperative 2 months in either of the groups, however, duration of hospitalization was significantly lower in group S than in group C, and that group S achieved significantly faster recovery of lower extremity function and recovery of walking ability and ADL in the JOA score at discharge and at postoperative 2 months. In patients with Crowe Type III or higher, a degree of upward dislocation becomes severe, making it difficult to preserve external rotator muscles intraoperatively and requiring additional procedures such as wider capsule release. The degree of acetabular dysplasia in this study was 47.8 ± 3.0 degrees of Sharp angle and 18.1 ± 7.6 degrees of CE angle. There were no cases that required massive bone grafting to acetabulum and only press-fit fixation was performed for cementless cup fixation without additional fixation with screws in all cases. However, in cases of significant dysplasia, screws may be required for bone grafting and cup fixation, which may increase complexity of acetabular manipulation. For those cases, conventional approach may be more suitable than the SuperPath[®] approach. Future study is needed to evaluate SuperPath[®]'s suitability in cases with severe deformity (Crowe Type III and IV) and severe dysplasia.

Limitation

This study has a small number of cases in each patient group, which reduces the power of the study. Also, this study includes only mildly deformed cases with Crowe classification of Type I and II. Thus, another study with larger sample size and including more deformed cases is needed to better understand SuperPath[®]'s performance in severe dysplastic cases.

Conclusions

Short-term results of THA with SuperPath® approach versus conventional approach for secondary OA of hip were compared involving a stem of similar design. Both groups had good clinical results in patients with Crowe Type I, II of mild dysplasia. Since postoperative JOA score, LOS, postoperative period to walking 50-meters with a T-cane and to achieve ascend and descend of stairs in group S are better than that in group C, SuperPath® approach achieved significantly faster recovery of lower extremity function than the conventional posterior approach.

Ethic Approval: This study was approved by Osaka Minami Medical Center ethics committee (Study ID: R5-54, Approved Date: September 14, 2023).

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors' Contribution: KH, KAA and KEA were involved in study design and data interpretation. KH and KAA were involved in the data analysis. All authors critically revised the report, commented on drafts of the manuscript, and approved the final report.

Declaration on the Use of AI: None.

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List of acronyms

Acronym	Definition
SuperPath®	SuperPath® Surgical technique SuperPath: Supercapsular Percutaneously Assisted Total Hip
THA	Total hip arthroplasty
OA	Osteoarthritis
JOA	Japanese Orthopedic Association
LOS	Length of stay

ADL	Activities of daily living
MIS	Minimally invasive surgery
UCLA score	University of California, Los Angeles activity score
BMI	Body mass index

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