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Early Experience of Direct Anterior Approach Total Hip Arthroplasty: Analysis of the First 53 Cases

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Purpose: To determine if it is feasible and safe for a surgeon to transition from using the posterolateral approach to direct anterior approach (DAA) by evaluating the first 53 cases of total hip arthroplasty using a DAA.

Materials and Methods: A retrospective review of 52 patients who underwent THA using a DAA between July 2017 and December 2018. Reasons for THA were: femoral neck fracture (n=34), avascular necrosis (n=13), and arthritis (n=6). The mean age was 70 years old. An assessment of feasibility was made by analyzing mean operative time and blood loss. Cup inclination, anteversion, and leg length discrepancy (LLD) were measured using postoperative radiology. Safety of the DAA was judged using the incidence and nature of all complications.

Results: The mean operative time was 112 minutes. 135 minutes for the 1st 10 cases, 100 minutes for 2nd 10 cases, 113 minutes for 3rd 10 cases, 119 minutes for 4th 10 cases, and 91 minutes for the final 13 cases. The mean blood loss was 724 mL. Average cup inclination was 40.27˚; 2 cases were out of safety angle. Mean anteversion was 16.18˚. No intraoperative fractures or infections were observed. LLD was detected in 3 cases, one of which underwent revision due to walking difficulty. Dislocation occurred in 3 cases, all within the first 20 cases, however, there was no recurrent dislocation.

Conclusion: DAA for THA was deemed to be feasible and safe based on an assessment of operative time, blood loss and complications.

Key Words: Hip replacement arthroplasty, Learning curve, Minimal invasive surgery

INTRODUCTION

Along with advances in implant materials and surgical techniques for total hip arthroplasty (THA), favorable results at long-term follow-up have been reported and indications for the procedure have expanded. In recent years, investigations on surgical procedures that reduce postoperative pain and improve recovery times by minimizing soft tissue injuries have continued.

A variety of surgical approaches for THA have been introduced; the posterolateral approach (PA) is the most common[1]. However, PA has been associated with increased soft tissue injury and higher dislocation rates compared to other approaches[2].

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In 2003, Mears[3] introduced two-incision minimally invasive THA that minimizes soft tissue damage, enables early postoperative ambulation, and shortens hospital stays. However, this technique has not been adopted as a common surgical intervention due to a long learning curve and a high incidence of early postoperative complications. The direct anterior approach (DAA) for THA has been garnering much attention because the procedure matches the aim of minimally invasive surgical procedures[4,5].

Some of the benefits of DAA compared with other approaches include less damage to soft tissue, reduced postoperative pain with no muscle splitting or injury, rapid recovery of gait ability, more stable artificial hip and decreased dislocation risk. Moreover, this approach allows easier prediction of implant position and facilitates the use of fluoroscopic imaging during surgery since the patient is in the supine position[6,7]. Despite these advantages, DAA requires longer operative time, is associated with a long learning curve as it is technically demanding, and has been shown to be associated with high rates of complications (e.g., proximal femoral fracture, infection).[2,8-10].

The authors of this study aimed to determine the feasibility and safety for a surgeon to transition from PA to DAA THA by assessing operation times and early complications in the first 53 cases of THA using the DAA at a single institution.

MATERIALS AND METHODS

1. Subjects

This study included a review of data from 52 patients (53 cases; 15 males and 38 females) who underwent THA using a DAA between June 2017 and December 2018. All operations were performed by a senior author who had experience performing more than 500 THAs using a PA. The mean patient age at time of surgery was 70 years old (range, 26-94 years), mean BMI was 23.06 kg/m^2 (range, 17.30-30.44 kg/m^2) and mean BMD was –2.9 g/cm^2 (range, –5.8 to –1.0 g/cm^2). BMD was the average of two lowest T-scores from L1 to L4 or the lowest T-score obtained from either the contralateral femoral neck or total femur. Preoperative diagnosis revealed 34 cases of femoral neck fracture, 13 cases of avascular necrosis of the femoral head and 6 cases of osteoarthritis. The acetabular component used was a Bencox® cup (Corentec, Cheonan, Korea) (n=48), and a Continuum® acetabular cup (Zimmer, Warsaw, IN, USA) (n=5). The femoral component was a Bencox® M stem (Corentec) (n=48), and the M/L Taper Hip Prosthesis (Zimmer) (n=5). Neither C-arms nor cement were used in the insertion of acetabular and femoral components.

2. Surgical Methods

All patients were positioned supine on a specialized orthopedic table (Hana® Orthopedic Fracture/Trauma Surgical Table; Mizuho OSI, Union City, CA, USA). After the anterior superior iliac spine was checked, the tensor fascia latae was palpated and incised, and then capsulotomy was performed via a medial approach without excision of tendons or muscles. The femoral neck was cut in twice and after removal of the femoral head, the acetabulum was exposed. After reaming by progressively increasing reamer diameters, the acetabular cup was inserted followed by placement of the liner. A femur elevator hook was placed around the proximal femur and then lifted up it with the leg externally rotated. To allow for femoral preparation, the hip was extended and adducted by lowering the foot-end of the Hana table. After determining the correct positioning and orientation of the femoral component using a canal finder, rasping was conducted and an appropriately sized stem was inserted. After impacting the head onto the stem, reduction was performed with proper traction and internal rotation in a leg-raising manner. After cleansing the surgical site and soft tissue wound, subcutaneous and skin layers were closed (Fig. 1).

3. Study Methods

For assessment of surgical procedures, the mean operative time and blood loss were measured. Operative time was defined by duration from skin incision to the completion of wound suturing. Total blood loss was defined as the sum of intraoperative blood loss and postoperative drainage volume.

For radiologic assessment, inclination of the acetabular component was measured on the anteroposterior pelvic radiograph taken immediately after surgery, and anteversion was measured on the cross-table lateral view. Leg length discrepancy was determined by measuring the distance between the ischial tuberosities and the superior margin of the lesser trochanter on AP pelvic radiographs taken with both legs internally rotated 15°. Leg-length discrepancy was considered to have occurred when the difference between the distances was greater than 10 mm.

Intra- and postoperative complications that patients

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experienced were examined (e.g., dislocation, proximal femoral fracture, infection).

This study was performed after gaining Institutional Review Board (IRB) approval from Kwangju Christian Hospital (IRB No. KCH-M-2019-03-007).

For statistical analysis, operative time and blood loss were analyzed in groups of 10 consecutive cases and a significant decrease was noted in the cut-off point. All statistical analyses were performed using PASW Statistics ver. 18.0 (IBM Corp., Armonk, NY, USA); chi-squared and paired *t*-tests were conducted to test for differences between two groups. Differences were considered statistically significant at $P<0.05$.

RESULTS

The mean operative time was 112 minutes (range, 75-230 minutes), and mean blood loss was 724 mL (range, 261-1,808 mL). A comparison of the mean operative time between the first 10 cases (135±39.2 minutes) and following 43 cases (104.3±21.6 minutes), demonstrated a statistically significant difference ($P=0.037$). The mean operative time between the initial 40 cases (116.4±29.1 minutes) and remaining 13 cases (90.8±11.4 minutes) was also significantly different ($P=0.003$) (Table 1). Additionally, the mean blood volume lost was significantly different between the first 10 cases (1,071±426 mL) and remaining 43 cases (643±197 mL) ($P=0.001$)

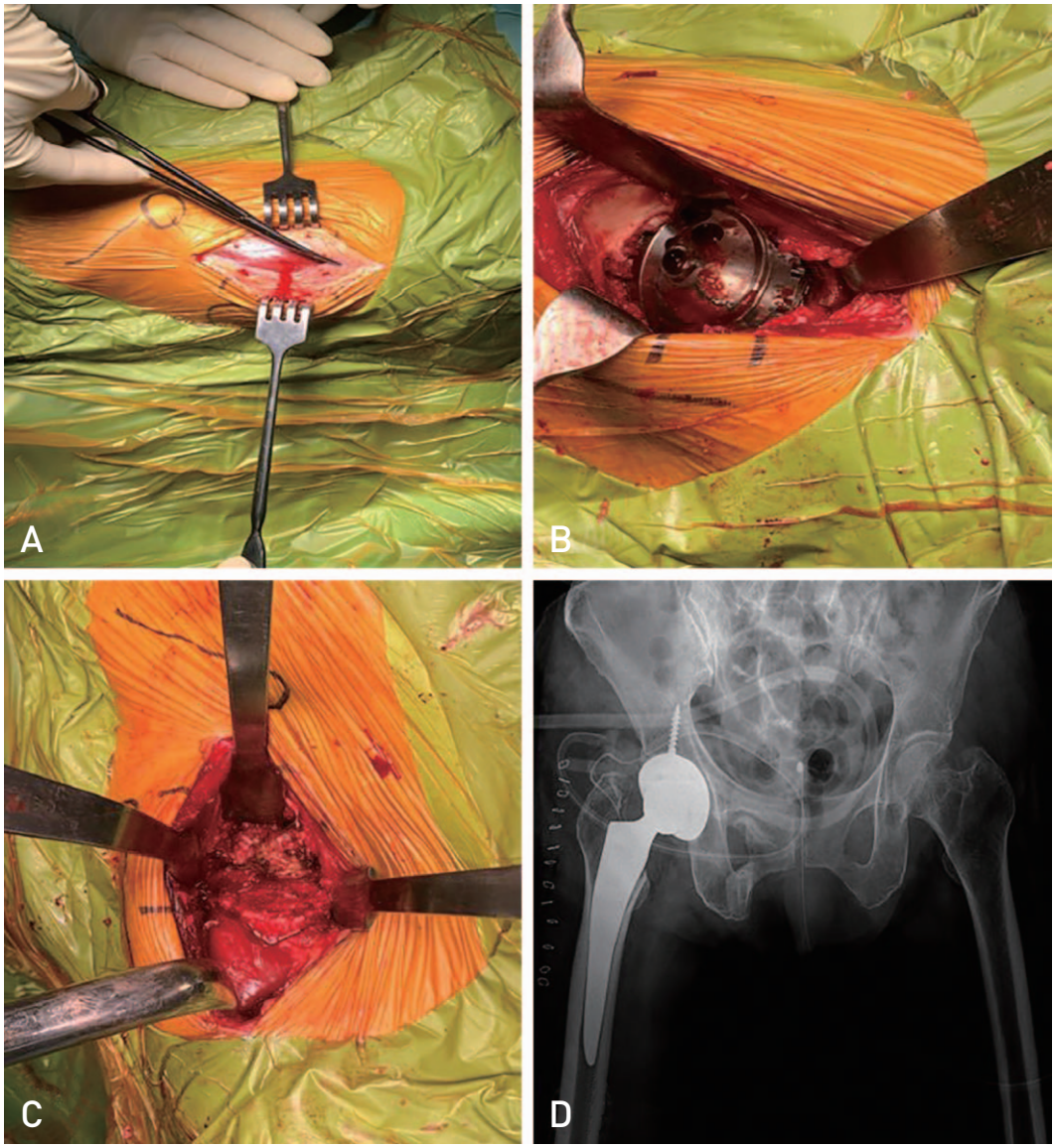

Fig. 1. (**A**) Direct anterior approach (DAA) skin incision; (**B**) Cup insertion, (**C**) Femur elevation and exposure; (**D**) Total hip arthroplasty using DAA was performed.

(Table 2).

The average cup inclination was 40.27° (range, 23.8-55.1°), and the cup was positioned outside of the Lewinnek et al.[11] safe zone in two cases (Fig. 2). The average cup anteversion was 16.18° (range, –2.41-52.3°). After the first 20 cases, there were significantly fewer (n=0) anteversion angles outside the safe zone (Fig. 3).

No postoperative complications (e.g., infection, femoral fracture) were observed. A discrepancy in leg lengths more than 10 mm was detected in 3 cases (5.7%); in one of these cases, revision surgery was conducted due to a complaint of discomfort when walking immediately after surgery. Anterior dislocation occurred in 3 (5.7%) out of the first 20 cases; all were managed with conservative treatment and there were no recurrent dislocations.

Table 1. Comparison of Mean Operative Time according to the Serial Case Number of Surgeries

Number of case	Mean operation time (min)	*P*-value
Initial group (n=10):2nd group (n=43)	135±39:104±21	0.037
Initial group (n=20):2nd group (n=33)	117±35:105±22	0.151
Initial group (n=30):2nd group (n=23)	115±31:103±21	0.084
Initial group (n=40):2nd group (n=13)	116±29:90±11	0.003

Values are presented as mean±standard deviation.

Table 2. Comparison of Mean Amount of Blood Loss according to the Serial Case Number of Surgeries

Number of case	Mean blood loss (mL)	*P*-value
Initial group (n=10):2nd group (n=43)	1,071±426:643±197	0.001
Initial group (n=20):2nd group (n=33)	833±412:657±189	0.039
Initial group (n=30):2nd group (n=23)	766±368:668±176	0.264
Initial group (n=40):2nd group (n=13)	760±326:616±180	0.046

Values are presented as mean±standard deviation.

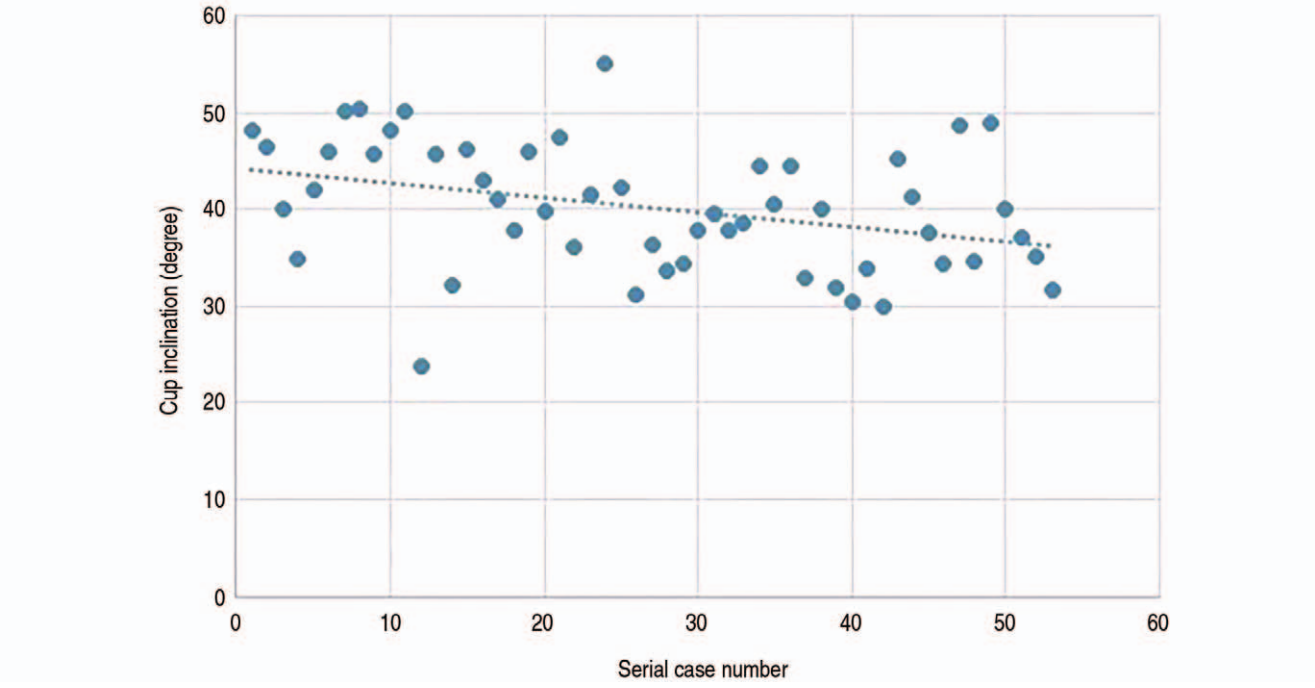

Fig. 2. Distribution of cup inclination – The average of cup inclination was 40.27°. Only 2 cases were out of Lewinnek's safety angle.

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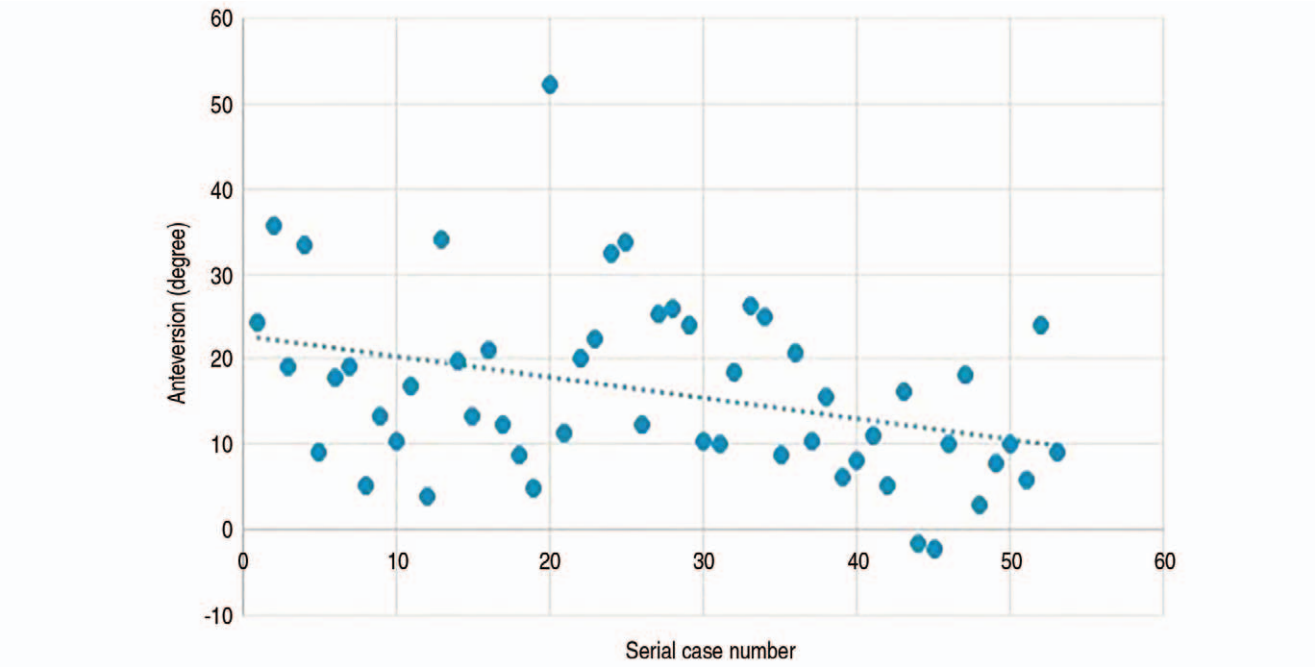

Fig. 3. Distribution of anteversion – The average of anteversion was 16.18° . After having conducted 20 surgeries, the variation decreased and fewer cases were outside of the Lewinnek's safty angle.

DISCUSSION

Refinements of prosthetic fixation and bearing surfaces for THA have increased survival rates for artificial hip joints as demonstrated by long-term follow-up studies. In recent years, surgical techniques that minimize damage to soft tissue and reduce postoperative pain, allowing for an early return to activities of daily living have increasingly gained much interest. In the early 2000s, two-incision minimally invasive THA was introduced with the goal of reducing damage to soft tissue. However, prolonged surgical time, increased blood loss and a high incidence of early postoperative complications have been reported due to the associated technical challenges. Tanavalee et al.[12] reported that two-incision THA was associated with problems including prolonged operative time and excessive blood loss. In a study by these authors[13], the mean operative time was 163 minutes, mean volume of blood loss was 974 mL, and intraoperative fracture occurred in 4 cases. Due to these limitations, two-incision THA has not been adopted as a common surgical procedure. As minimally invasive surgical procedures have gained increasing attention in recent years, the DAA has been the subject of many investigations[5,8,9]. In terms of operative time, blood loss and complication rates, multiple studies have reported the learning curve for DAA THAs ranges from 10 to 200 cases[14]. In a study by Stone et al.[15] in a consecutive series of 1,000 cases when transitioning from PA to DAA THA, the mean operative time increased by about 30% in the initial 50 cases, and decreased by 14% in the second 50 cases. They reported that operative time of DAA THA was shorter compared with posterior hip arthroplasty after the 500th cases. Spaans et al.[9] reported that the mean surgical time decreased with increasing experience in 46 DAA THA cases. In our study, the mean surgical time was 135 minutes in the first 10 cases, decreased to 104 minutes (23% reduction), and reduced to 90.7 minutes (an additional 13% reduction) after the 40th cases. In the authors' study on two incision THA[3], surgical time exceed 2 hours in all but 3 of 26 cases, and it appears as though a steeper learning curve may exist as compared with DAA since the average surgical time was 104 minutes after the 10th cases of DAA THA. Similar to two-incision THA, the major disadvantage of DAA has been reported to be an increase in blood loss. In a comparative study on DAA versus PA THA by Spaans et al.[9], the mean intraoperative blood loss was 703 mL in the DAA group, higher when compared to the PA group (364 mL), and there was no apparent reduction in the learning curve. Barnett et al.[16] assessed the overall volume of intra- and postoperative blood loss in 5,090 consecutive THA cases using the DAA. The mean blood loss was less than 400 mL in 67.1% and 400-800 mL in 29.4%. In this

study, the overall average blood loss was 724 mL. This average was 1,071 mL in the first 10 cases, 643 mL (reduction of 40%) in the remaining cases. Importantly, the average blood volume loss was 612 mL after the 40th case. Blood loss was dramatically reduced as additional experience was gained[17].

Since DAA THA is typically performed with patients in the supine position, a position familiar to surgeons, this approach allows for easier prediction and control when positioning acetabular and femoral components accurately and facilitates the use of intraoperative fluoroscopy[18]. A radiologic assessment of DAA vs. PA THA by Cheng et al.[19] reported that average inclination and anteversion angles of the acetabular cup were similar, however, the mean cup inclination and anteversion were within the Lewinnek safe zone (inclination: 40±10˚; anteversion: 15±10˚)[11] in 57% and 34% of DAA and PA cases, respectively. In a comparison of inclination and anteversion in 100 THA cases each by DAA and Hamilton et al.[20] noted that anteversion angles were different between those treated with DAA (17.6˚) compared with those treated with PA (22.6˚); inclination angles were similar in both approaches, however, it was reported that there was less variation in the DAA group. Although fluoroscopic imaging was not used in the current study, the average cup inclination was 40.27˚, and the cup was positioned outside of the Lewinnek safe zone in only two cases. The average cup anteversion was 16.18˚. Variation in anteversion was reduced after the first 20 cases, cases which the cup was positioned outside of the Lewinnek safe zone have also been reduced. Despite several advantages, the DAA has been reported to result in increased complication rates[9,21]. There are risks of intraoperative fracture due to traction and difficulty with complete exposure of the proximal femur, and hypoesthesia and paresthesia on the lateral femur due to injuries to the lateral femoral cutaneous nerve[9,10]. In are view by Barnett et al.[16] involving 5,090 consecutive THA cases using the DAA, intraoperative fractures were reported in 43 cases, calcar fracture in 26, and greater trochanteric fracture in 12. In the current study, no proximal femur fractures were detected. The use of the Hana fracture table that allows for lifting-up safely using femur elevate hook and for safe hyperextension, adduction and external rotation of the leg improved exposure of the greater trochanter is thought to prevent intraoperative fractures.

Theoretically, preservation of posterior structures (e.g., posterior capsule, abductors) have been shown to reduce dislocation rates. In previous studies, postoperative dislocation rates ranged between 0.6 and1.2%[22,23]. Free et al.[24] stated that dislocation did not occur in the initial 93 cases when transitioning to DAA THA and recommended that the DAA is a safe approach for novice surgeons. However, dislocations occurred in 3 of the first 20 cases in this study. Dislocation is thought to be caused by extensive resection of soft tissue for improved exposure of the proximal femur in the initial patients. There were no dislocations after the 20th case.

There are some limitations to note in the present study. First, there is a relatively short follow-up period due to its retrospective nature. This study was also limited by no clinical assessment of possible injuries (e.g., lateral femoral cutaneous nerve injury). Additional studies are warranted to further elucidate complications and prognoses. Despite these limitations, this study will be meaningful for surgeons who intend to transition from PA THA to DAA THA by highlighting the early experience of surgeons (i.e., the authors of this study) who are more familiar with PA THA. Importantly, the findings of this study cannot be generalized due to the relatively small sample size. Second, more studies with a larger sample size are warranted. In particular, the results from this study cannot be generalized because most subjects were elderly patients with femoral neck fractures. Third, prospective studies comparing PA and other approaches are thought to be needed. Furthermore, additional studies on the cut-off point with improved safety after switching to the DAA are warranted.

CONCLUSION

The DAA for THA is an alternative procedure that may replace the convention surgical approach by reducing the mean operative time and blood loss in a short learning curve. The risk of complications was not as high as expected. Caution is required to prevent possible complications from DAA as is the case for any new surgical technique.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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