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Original Research

Radiographic and Clinical Outcomes After Direct Anterior Versus Mini Posterior Total Hip Arthroplasty

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A B S T R A C T

Background: Total hip arthroplasty (THA) is a successful surgical treatment for end-stage hip arthritis. There is controversy over whether the surgical approach leads to any differences in implant sizing, implant positioning, and clinical outcomes. This study sought to compare radiographic and clinical outcomes when performing primary THA through the direct anterior approach (DAA) and posterior approach (PA).

Methods: In this retrospective cohort study of patients undergoing primary THA, 198 DAA patients were matched to 198 PA patients. Surgeries were performed by 3 fellowship-trained surgeons. Radiographic parameters analyzed were acetabular cup anteversion and abduction angles, femoral stem coronal alignment, femoral offset, and leg-length discrepancy. Postoperative complications, including periprosthetic joint infection, wound complications, periprosthetic fracture, and dislocation, were extracted from the medical record. Statistical analysis was performed to compare radiographic and clinical outcomes between groups.

Results: There were no statistically significant differences for any postoperative complications between the 2 groups. One dislocation occurred in the PA group, and no dislocations occurred in the DAA group. DAA had a longer operative time (117 vs 79 minutes, $P < .01$). PA had a higher increase in femoral offset compared to the contralateral limb (2.76 mm vs 1.01 mm, $P < .01$), higher cup anteversion (26.17° vs 23.44°, $P < .001$), and higher use of dual mobility components (6.06% vs 1.01%, $P = .007$).

Conclusions: Both DAA and PA lead to acceptable clinical and radiographic outcomes for primary THA, with significant differences noted for cup position, femoral offset, and use of dual mobility components. These differences likely represent surgeon factors to help mitigate the risk for dislocation.

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Introduction

Total hip arthroplasty (THA) is one of the most commonly performed orthopaedic procedures, and its demand is projected to grow continuously [1,2]. Multiple approaches can be used in THA, with the most common being the posterior approach (PA), direct anterior approach (DAA), and anterolateral approach [3]. The choice of surgical approach remains controversial and can be influenced by several surgeon (eg, training, equipment available, desire to use intraoperative fluoroscopy) and patient factors (eg, activity level, anatomical variations, body habitus, soft tissue laxity) [4,5].

Radiographic outcomes after THA are known to influence clinical outcomes, but there is conflicting literature comparing radiographic measurements of component positioning after DAA or PA for primary THA [6-8]. Component positioning variables that are commonly assessed on a postoperative anteroposterior (AP) pelvis radiograph include femoral offset, acetabular cup abduction and version, and femoral stem coronal alignment. Surgeons aim to replicate the native hip offset in order to restore appropriate biomechanics of the joint

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[9,10]. Too much or too little offset can cause pathology, such as trochanteric bursitis or instability, respectively [11,12]. Cup abduction and version not only play a key role in THA stability but also inappropriate cup placement can lead to extra-articular soft tissue pathology, such as iliopsoas tendinitis or prosthetic impingement [9,13]. Femoral stem coronal alignment is also important in THA, and stems placed in too much varus have been postulated to increase stress at the distal implant, which may lead to bone remodeling, thigh pain, and even femoral fracture [14-16].

While most patients who undergo THA with any approach are satisfied with their outcomes, there is always a risk for complications with any surgical procedure [17]. Some studies have shown that the incidence of particular complications is different between the DAA and the PA. For example, THA performed through a DAA had a lower incidence of dislocation compared to the PA in some studies [18], whereas in other studies the PA has been shown to be equivalent [19]. Several studies have shown the DAA to be associated with an increased incidence of superficial wound complications, but the incidence of deep infection has been shown to be equivalent between the 2 approaches [20,21].

The purpose of this study is to compare radiographic outcomes and complications for patients undergoing primary THA through a DAA and PA. Additionally, perioperative variables for these patients, including procedure time and implant selection (use of dual mobility components and/or high offset femoral stems) were compared for the 2 approaches. The authors hypothesized that there would be no differences in the radiographic outcomes or complication profile between groups, but that the DAA would have longer procedure times with lower use of both dual mobility and high femoral offset implants.

Material and methods

Patient selection

After obtaining institutional review board approval, we performed a retrospective chart review of 634 patients who underwent primary THA at a single institution from January 1, 2019, to July 1, 2022, by 1 of 3 fellowship-trained surgeons. One surgeon only utilized the PA for all THA, while the other 2 surgeons utilized the DAA for the majority of their primary THA cases (>80%) with the decision ultimately based on patient factors (eg, age, bone quality, inguinal skin, body habitus). Both DAA surgeons had performed a minimum of 50 DAA cases to minimize any potential influence of the learning curve [22]. Inclusion criteria were a minimum postoperative clinical follow-up of 1 year, preoperative and postoperative AP pelvis radiograph, and surgical indication of osteoarthriti, rheumatoid arthritis, or osteonecrosis. Patients were excluded if they underwent THA for femoral neck fracture (N = 20), underwent conversion of prior hip surgery to THA (N = 4), underwent same-day bilateral THA (N = 1), had insufficient follow-up (N = 210), or had incomplete imaging (N = 3).

The authors first identified 198 DAA patients during the study period that met the inclusion criteria. The 198 DAA patients were matched to 198 PA patients using age, gender, body mass index, and the American Society of Anesthesiologists score. After matching, the medical record for each PA patient was reviewed to ensure that the inclusion criteria were met. If a PA patient did not meet the inclusion criteria, the PA patient was excluded, and the DAA patient matched to this PA patient went through another round of cohort matching. The cohort matching was repeated until all the DAA patients were appropriately matched to a PA patient. Patient demographics are presented in Table 1. No statistical differences existed in demographic variables between DAA and PA cases. Additionally, no significant differences between case types were observed for surgical indication, diabetes, smoking status, osteoporosis, or presence of spinal hardware. There was no difference in the length of follow-up between groups with a mean follow-up of 27.1 ± 12.1 months in the DAA group and 25.4 ± 12.8 months in the PA group (P = .19).

Table 1
Demographics, indications, and comorbidities.

Demographics			
Variable	DAA	PA	Sig. ($P < .05$)
N	198 (m = 77, f = 121)	198 (m = 77, f = 121)	1.000
Age (y)	63.10 ± 11.04	64.99 ± 10.67	.084
BMI (kg/m^2)	29.14 ± 5.55	29.09 ± 5.51	.927
ASA	2.33 ± 0.58	2.78 ± 0.44	.188
Indications and comorbidities			
Variable	DAA	PA	Sig. ($P < .05$)
Indication-OA	85.35%	90.40%	.124
Indication-AVN	13.64%	9.09%	.154
Indication-dysplasia	1.01%	0.51%	.562
Spinal hardware	4.55%	8.59%	.105
Diabetes	14.14%	17.68%	.336
RA	6.06%	9.60%	.190
Osteoporosis	1.01%	1.01%	.000
Anticoagulation	5.05%	3.54%	.457
Smoking (former)	30.30%	34.85%	.335
Smoking (active)	9.09%	7.58%	.585

BMI, body mass index; ASA, American Society of Anesthesiologists; RA, rheumatoid arthritis; AVN, avascular necrosis; OA, osteoarthritis.
Data are presented for demographics as means ± SD as well as frequencies of indications for surgery as well as comorbidities.

Data collection

The medical records of both the DAA and the PA patients were first reviewed to identify relevant perioperative data, including implant selection (including implant manufacturer, sizes, stem offset, and bearing surface), estimated blood loss, procedure time, distance walked with physical therapy on the day of surgery and the day after surgery, time to discharge, and discharge destination. Postoperative complications, including acute and chronic periprosthetic joint infection (PJI), poor wound healing, periprosthetic fracture, and dislocation, were also obtained from the medical record.

After extraction of perioperative data from chart review, radiographic measurements were performed. We used a digital imaging software (TraumaCad, Voyant Health, Petach-Tikva, Israel) to perform the measurements, which included preoperative femoral offset (Fig. 1), preoperative leg length discrepancy (Fig. 2), postoperative femoral offset, postoperative leg length discrepancy, acetabular cup version and abduction angles (Fig. 3), and femoral stem coronal alignment (Fig. 4). The acetabular version measurement tool offered by TraumaCad utilizes an elliptical principle that has been previously described and shown to correlate well with computed topography [23,24]. The measurements were performed by 2 orthopaedic surgery adult reconstruction fellows (D.A.H. and C.A.M.), and 30 of the patients were measured by both observers to ensure appropriate interobserver reliability.

Surgical technique

The DAA surgical technique involved patient positioning supine on a traction table (Mizuho OSI, Tokyo, Japan) and included a standard longitudinal incision with capsulotomy and repair of the capsule when possible. Intraoperative fluoroscopy was used for cup placement, as well as trial and final implant evaluation. Patients were not prescribed hip precautions.

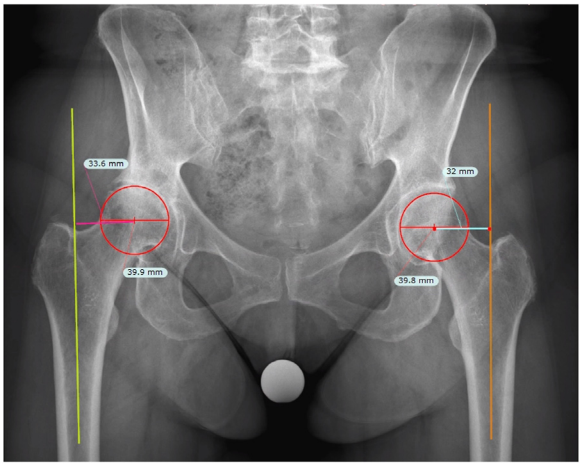

Figure 1. Preoperative AP pelvis radiograph demonstrating the measurement of femoral offset using the center of the femoral head and anatomical axis of the femur.

The PA surgical technique involved patient positioning in the lateral decubitus position on a standard table and included a standard mini curvilinear skin incision at the posterior third of the greater trochanter. Limited capsulotomy was performed from immediately superior to the piriformis tendon and went distally only to the superior edge of quadratus femoris. The capsule was repaired with drill holes in the greater trochanter at the end of the case. The piriformis was also repaired via suture under the gluteus medius and minimus tendons. For all PA cases, intraoperative portable X-ray was used after trial implant evaluation to confirm appropriate cup position and implant sizing. Patients were prescribed posterior hip precautions after the case, and these precautions were encouraged for 3 months.

In both the DAA and PA cases, surgeons followed their own guidelines for the use of dual mobility components. In general, prior spinal fusion, preexisting severe lumbar spine arthritis, or an intraoperative shuck of >6 mm (positive shuck test) with appropriate leg lengths led to the surgeon selecting a dual mobility bearing.

Statistical analysis

All analyses were performed using SPSS Statistics Software (v26, IBM, Armonk, NY). Continuous data for patient demographics, implant placement, length of stay, operative time, and activity were compared between case types (DAA vs PA) using an independent samples T-test. Next, a chi-square test was used to compare frequency-based data for comorbidities, discharge dispositions, implant characteristics between case types, and complications. Lastly, an F-test was used to compare variance in implant targeting for anteversion and inclination between case types. Type-I error was set at $\propto = 0.05$ for all analyses.

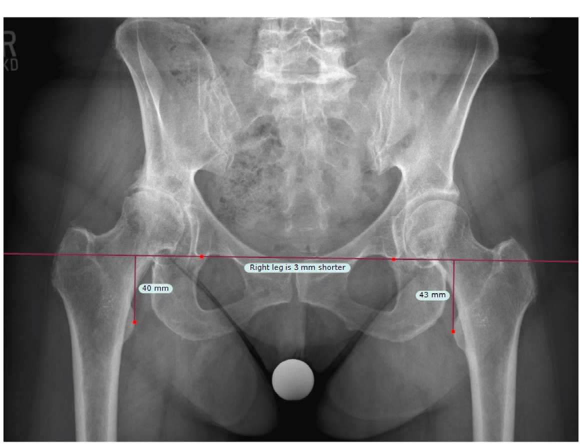

Figure 2. Preoperative AP pelvis radiograph demonstrating the measurement of leg length discrepancy using the interteardrop line and most prominent points of the lesser trochanter. Postoperative cup anteversion measurement.

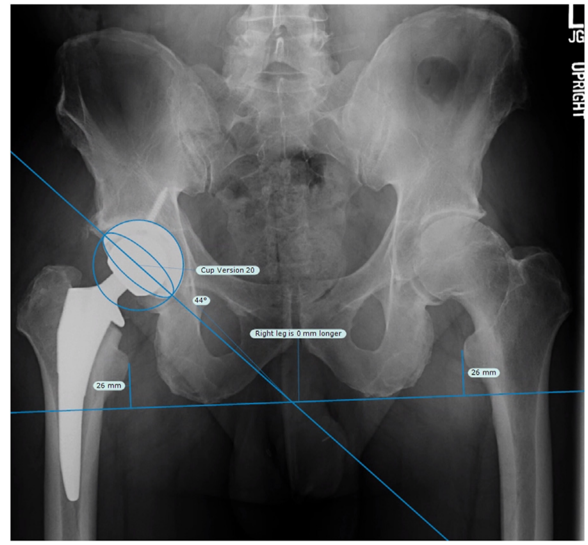

Figure 3. Postoperative AP pelvis radiograph demonstrating use of the elliptical principle and known cup diameter to measure acetabular version. Acetabular inclination is measured as the angle subtended by a horizontal reference (line across the ischial tuberosities) and a line across the rim of the cup.

Results

Radiographic outcomes

Data for radiographic outcomes are presented in Table 2. In the PA THA cases, the acetabular components were more anteverted compared to the DAA cases (+2.73 °, $P < .001$). The PA THA cases

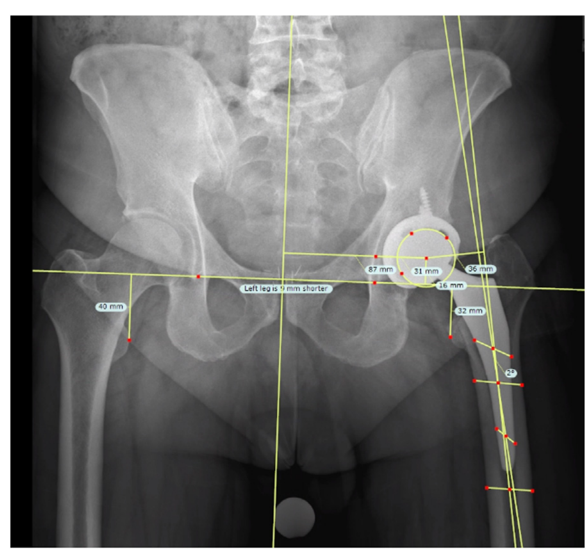

Figure 4. Postoperative AP pelvis radiograph demonstrating the measurement of femoral stem coronal alignment as the angle subtended by the long axis of the femoral component and the anatomical axis of the femur.

had a higher increase in femoral offset compared to the nonoperative side (Δ 1.75 mm, $P = .002$) resulting in a higher postoperative femoral offset (+1.10 mm, $P = .035$). No differences were observed for inclination, leg length changes, or the femoral stem coronal alignment. Lastly, while overall variance for anteversion was statistically similar between groups, variance for inclination was significantly reduced for the DAA cases compared to PA cases, indicating potential improved targeting ($P < .001$). Scatter plots for each procedure showing decreased inclination dispersion for the DAA approach are shown in Figure 5.

Perioperative variables

Data for perioperative assessments are presented in Table 3. PA THA had a shorter operative time compared to DAA (−38 minutes, $P < .001$). PA THA patients walked further on postoperative day 0 (+109 feet, $P < .001$) but the same on postoperative day 1. PA THA patients had a higher use of dual mobility components (PA = 6.06% vs DAA = 1.01%, $P = .007$) and trended toward a higher use of high offset stems (PA = 25.76% vs DAA = 17.68%, $P = .051$). Regarding discharge dispositions, DAA THA patients were observed to have a higher frequency of discharge to home (DAA = 95.45% vs PA = 87.37%, $P = .004$), and a greater portion of PA patients were discharged with home health care services (PA = 5.56% vs DAA = 1.01%, $P = .001$) (Table 3).

Clinical complications

No statistically significant differences were noted in any postoperative complications between the 2 groups (Table 4). The DAA group had 0 (0%) dislocations, whereas the PA group had 1 (0.51%) dislocation, which was noted on the immediate postoperative films and revised on the day of surgery (Fig. 6). The DAA group had 4 (2.02%) acute PJIs compared to 1 (0.51%) in the PA group, which were all successfully managed with incision and drainage, head/liner exchange, and appropriate antibiotic therapy. The DAA group had 3 (1.52%) cases of wound complication, which required a superficial wound debridement compared to 1 (0.51%) in the PA group. One (0.51%) chronic PJI occurred in the PA group that necessitated two-stage revision, while zero (0%) occurred in the DAA group. Regarding periprosthetic fractures, we identified 1 (0.51%) intraoperative and 1 (0.51%) postoperative in the DAA group. The intraoperative fracture was a calcar fracture that was stable with a single cable, and the postoperative fracture was a Vancouver B2 fracture that required revision THA. The PA group had 0 (0%) intraoperative and 2 (1.01%) postoperative fractures. The postoperative fractures were both Vancouver B1 fractures that were treated with open reduction and internal fixation. Each group had 1 (0.51%) patient undergo an isolated acetabular revision for iliopsoas tendonitis.

Table 2
Radiographic outcomes.

Implant placement			
Variable	DAA	PA	Sig. ($P < .05$)
Preoperative LLD (mm)	−2.74 ± 5.73	−2.66 ± 5.95	.891
Postoperative LLD (mm)	2.25 ± 6.11	2.73 ± 4.86	.386
Δ LLD (mm)	4.99 ±6.34	5.40 ± 5.28	.494
Preoperative femoral offset (mm)	−1.54 ± 4.05	−2.17 ± 3.69	.108
Postoperative femoral offset (mm)	−0.53 ± 5.06	0.57 ± 5.37	*$P = .035$
Δ Femoral offset (mm)	1.01 ± 5.50	2.76 ± 5.81	*$P = .002$
Anteversion (degrees)	23.44 ± 6.28	26.17 ± 6.20	*$P < .001$
Inclination (degrees)	43.00 ± 4.13	43.43 ± 6.70	.443
Stem angle (degrees)	−0.34 ± 2.05	−0.20 ± 0.97	.380

LLD, leg length difference.
Data are presented for demographics as means ± SD. Significant differences observed between groups at $P < 0.05$ indicated with *P-values.

Discussion

Overall, DAA and PA for primary THA in this study both were safe and effective approaches with complication rates similar to what has been previously described in the literature [19]. Despite no differences in complication rates between the groups, there were differences observed for acetabular cup version, femoral offset, use of high offset stem, and use of dual mobility bearing, which may represent surgeon decisions to lessen the risk of dislocation when utilizing a PA.

Postoperative radiographic outcomes are important after THA, as implant positioning can influence a patient's risk for complications. Acetabular component safe zones have been described in order to help stability and longevity of the implants but have been called into question as surgeons prioritize patient-specific implant positioning goals [25,26]. Our study did note component placement well within the previously described "safe zones" for both DAA and PA. The increased anteversion by a few degrees in PA THA is likely because the surgeon favors more anteversion for a PA to help prevent posterior dislocation. One radiographic result that may favor the DAA technique was that DAA patients had less increase in offset compared to the contralateral side than the PA patients by 1.75 mm without sacrificing stability. This is perhaps an advantage to potentially prevent patients from developing excessive hip abductor muscle and iliotibial band tension that may predispose them to postoperative trochanteric bursitis, although the true pathophysiology of greater trochanteric pain is debated and recent literature has questioned the relationship between femoral offset and trochanteric bursitis [27]. A previous study comparing fluoroscopically guided DAA vs nonguided PA showed that the DAA had more accurate cup placement [8]. Our data demonstrated less variance in cup abduction angle with DAA THA compared to PA THA and may represent an improved ability of fluoroscopy over a flat plate radiograph to truly assess acetabular component orientation. However, the PA THA was still well within acceptable range for the target zone. Overall, both techniques provided acceptable postoperative radiographic outcomes.

Studies have previously shown a decreased dislocation rate in DAA compared to PA THA [18,28,29]. Our study did not show a significant difference between the 2 techniques; however, there was a dislocation on postoperative day 0 in the PA group. Multiple factors could account for the overall safety from dislocation in our PA THA group. The mini posterior technique with repair of the capsule through the greater trochanter and repair of the piriformis tendon under the abductors all allow for minimal soft tissue disruption and maximal ability of the surrounding tissues to provide stability [30]. Also, using an intraoperative X-ray to critically evaluate cup version, cup abduction angle, leg lengths, and offset prior to final implantation allows us to ensure safe component placement and appropriate biomechanical restoration of the hip prior to leaving the operating room.

Some of the perioperative outcomes favored PA THA. The operative time was 38 minutes less for the PA THA surgeon compared to the two DAA THA surgeons in this study. This significant difference is an important consideration and consistent with a mean difference of 17 minutes reported in a recent meta-analysis [19]. A large database study in 2018 showed that an increase in operative time of 15 minutes led to an increased rate of blood transfusion, wound dehiscence, PJI, and urinary retention [31], and a more recent single-institution study solidified the relationship

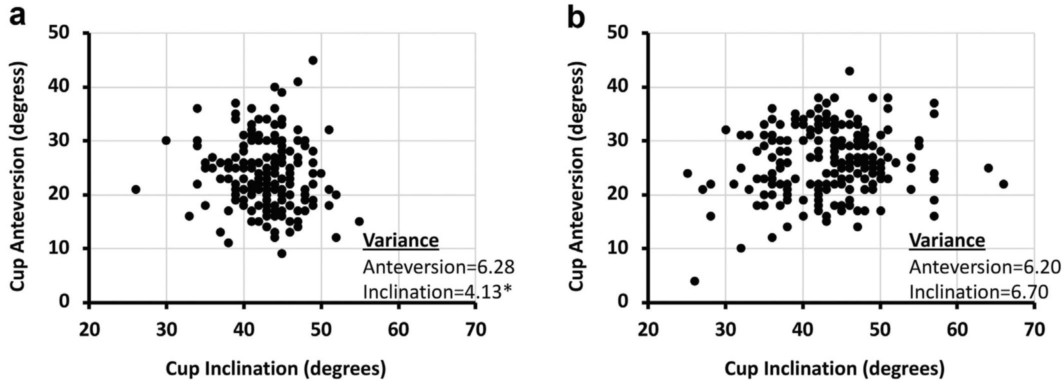

Figure 5. Scatter plot demonstrating acetabular cup anteversion and inclination for all patients using the (a) direct anterior approach and (b) posterior approach.

between an increase in operative time and an increase in PJI [32]. Our DAA group did have 4 acute PJIs and 3 superficial wound complications compared to one of each in the posterior group, which was not statistically significant, but still a trend worth noting. The increased operative time with the DAA could be one factor in these differences, although patient sex and body habitus, as well as surgeon management of soft tissue at the time of surgery, likely play a larger role in the development of superficial wound complications [33]. It is important to note that operative time is surgeon dependent, and not all DAA THA surgeons are universally slower than PA surgeons, especially when the surgeon is out of the learning curve and operative time plateaus [34].

The other perioperative factor that favored the PA THA was the distance walked with physical therapy on the day of surgery. The PA group walked on average 110 feet more than the DAA group (268 feet vs 158 feet). This finding should be taken with caution given we did not control for what time of day the surgery occurred, but early mobilization after surgery is known to be incredibly important. The enhanced recovery after surgery group consensus statement from 2020 includes a strong recommendation for early mobilization in all patients after hip and knee arthroplasty in order to help achieve discharge criteria [35]. A meta-analysis demonstrated a significant reduction in length of stay for patients who got out of bed in the first 24 hours [36], and another study focusing on mobilization of elderly and obese patients showed that same-day mobilization was not only safe but also effective in increasing readiness for discharge in those patient populations [37]. While the DAA is often touted as better for early functional recovery [38,39], our study demonstrated that the PA patients walked more on the day of surgery and that the two approaches were equivalent on postoperative day 1.

This study is predominantly limited by its retrospective nature, inclusion of surgeries performed by multiple surgeons, single-institution data, and nonrandomized methodology with regard to approach selection. Moreover, the study is likely underpowered to truly assess for statistical differences in the complication profile between the 2 approaches. However, the method of cohort matching to match patients between the DAA and PA groups helped ensure similar patient populations despite potential patient selection bias.

Table 3
Perioperative assessments.

Length of stay, operative time, blood loss, and activity			
Variable	DAA	PA	Sig. ($P < .05$)
Length of stay (h)	39.63 ± 29.16	36.48 ± 32.50	.310
Discharged same day	8.59%	13.13%	.146
Operative time (min)	117.32 ± 28.04	79.06 ± 17.94	*$P < .001$
Estimated blood loss (ml)	232.07 ± 133.62	166.70 ± 69.66	*$P < .001$
Distance walked POD0 (feet)	158.23 ± 151.58	267.70 ± 239.32	*$P < .001$
Distance walked POD1 (feet)	253.20 ± 138.16	258.92 ± 132.37	.692
Discharge dispositions			
Variable	DAA	PA	Sig. ($P < .05$)
Home	95.45%	87.37%	$P = .004$
Cancer center	3.54%	5.56%	.335
Home health	1.01%	5.56%	$P = .001$
SNF	0%	1.01%	.499
Patient expired	0%	0.51%	1.000
Implant characteristics			
Variable	DAA	PA	Sig. ($P < .05$)
Dual mobility	1.01%	6.06%	*$P = .007$
Standard stems	163 (82.32%)	147 (74.24%)	$P = .051$
High offset stems	35 (17.68%)	51 (25.76%)	

POD, postoperative day; SNF, skilled nursing facility.
Data are presented as means ± SD or as frequencies (%). Significant differences observed between groups at $P < 0.05$ indicated with *P-values.

Conclusions

Both DAA and PA THA provided excellent radiographic, clinical, and perioperative outcomes, with similar orthopaedic complications observed between approaches that occurred at a rate less than or equal to those previously described in the literature. Findings that favored the PA were a 38-minute reduction in surgical time, improved ambulation of roughly 100 feet on the day of surgery, and a lower incidence of wound complications. Surgeries

Table 4
Surgical complications.

Outcome	DAA	PA	P-value
Dislocation	0	1 (0.51%)	1.000
Acute PJI	4 (2.02%)	1 (0.51%)	.372
Chronic PJI	0	1 (0.51%)	1.000
Superficial infection	3 (1.52%)	1 (0.51%)	.623
Postoperative periprosthetic fracture	1 (0.51%)	2 (1.01%)	1.000
Intraoperative periprosthetic fracture	1 (0.51%)	0	1.000
Aseptic revision	1 (0.51%)	1 (0.51%)	1.000

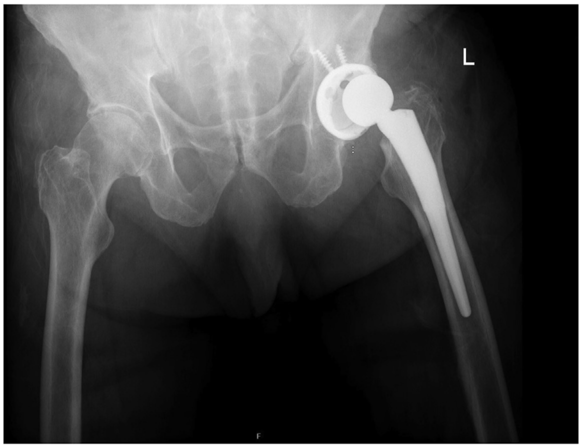

Figure 6. Postoperative AP pelvis radiograph demonstrating a patient with a left hip dislocation/subluxation.

performed through a PA were more likely to have greater acetabular anteversion, increased use of high offset femoral stems, and increased use of dual mobility components, likely representing surgical factors to help mitigate the risk for dislocation. Surgeons should be confident that they can achieve successful outcomes with both the DAA and PA for primary THA, and ultimately, approach selection should be based on surgeon experience.

Conflicts of interest

B. S. Lambert receives research support from Delfi Medical Innovations Inc. K. J. Park is a paid consultant for Zimmer Biomet Inc.; receives research support from Osteal Therapeutics Inc. and Zimmer Biomet Inc.; is an editorial board member of Journal of Bone and Joint Surgery (British); and is a committee member of American Association of Hip and Knee Surgeons. S. J. Incavo receives royalties from Innomed, Kyocera Medical Corporation, MicroPort Orthopedics Inc., Osteoremedies, and Zimmer Biomet Inc.; is a paid consultant for Zimmer Biomet Inc.; has stock options in Cranial Devices and OrthoInnovate LLC; and receives research support from Trellis Biosciences Inc. All other authors declare no potential conflicts of interest.

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CRediT authorship contribution statement

David A. Hamilton: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Colin A. McNamara:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Austin E. Wininger:** Writing – review & editing, Writing – original draft, Methodology. **Thomas C. Sullivan:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis. **Bradley S. Lambert:** Writing – review & editing, Supervision, Software, Resources, Methodology, Formal analysis. **Stephen J. Incavo:** Writing – review & editing, Validation, Project administration, Methodology, Conceptualization. **Kwan J. Park:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Data curation, Conceptualization.

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