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Improved perioperative outcomes with direct anterior approach total hip arthroplasty in a Veteran's Affairs patient population

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ABSTRACT

Background: A trend toward improved perioperative outcomes with direct anterior approach total hip arthroplasty (DAA THA) in comparison to posterior approach THA has been described. The benefits of the DAA THA have not been examined in the Veteran's Affairs (VA), a health system unique in its highly comorbid patient demographic and federally subsidized budget. Optimizing outcomes in this population could help reduce costs, readmissions, and complications. This study sought to compare the perioperative and radiographic outcomes of veterans who underwent a DAA THA versus a posterior approach THA.

Methods: We retrospectively reviewed the records of 110 primary posterior approach THAs and 93 primary DAA THAs performed for primary osteoarthritis by a single surgeon at a VA hospital between 2012 and 2018. We compared mean surgical duration, intraoperative blood loss, perioperative blood transfusion requirements, discharge disposition, hospital length of stay, as well as acetabular component inclination, femoral offset discrepancy, and leg length discrepancy using postoperative anteroposterior pelvis radiographs.

Results: The DAA group demonstrated significantly lower perioperative blood transfusion rates (5% vs. 20%), increased likelihood of discharge prior to postoperative day three (OR 2.12; 95% CI 1.02–4.44), and higher rate of discharge to home (65% vs. 40%). Acceptable acetabular inclination rate was higher in the DAA group (83% vs. 37%).

Conclusion: Among veterans undergoing primary THA at a VA hospital, patients undergoing DAA THA had better perioperative outcomes than patients treated with the posterior approach despite similar demographics, American Society of Anesthesiologists score, and the DAA learning curve.

1. Introduction

The direct anterior approach (DAA) to the hip is rising in popularity for performing total hip arthroplasty (THA).[1] The approach uses the internervous plane between the sartorius and tensor fascia lata in the superficial layer and the plane between the gluteus medius and rectus femoris in the deep layer.[1] Several recent studies have demonstrated its benefits compared to the lateral and posterior approaches, including reduced need for narcotic pain medications, improved preservation of the soft tissues, decreased length of hospitalization, quicker postoperative recovery, improved gait kinematics, and decreased risk of dislocation.[2–6] Some concerns have been raised regarding increased operative time, blood loss, wound healing complications, lateral femoral cutaneous nerve injury, and decreased surgical exposure during femoral and acetabular component implantation.[7–13] However, these observed complications may be associated with the considerable learning curve for adopting this technique.[14]

The direct anterior approach requires supine positioning of the patient, facilitating the use of fluoroscopy for intraoperative assessment of implant positioning.[15] The approach is associated with improved rates of acceptable acetabular angle, and equivalent rates of acceptable acetabular anteversion, leg length, and femoral

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offset compared to the posterior approach.[16] Optimal component positioning is associated with lower postoperative instability, improved range of motion, and decrease risk of polyethylene wear, which translates to improved long term outcomes and longevity of a total hip replacement.[17–19] While trends toward shorter hospital stays, quicker recoveries, and improved component positioning have been noted with the DAA THA, the evidence is still insufficient to conclude the DAA is superior to the other approaches.[20,21]

The VA represents a uniquely integrated healthcare system that is different from the private sector in its highly comorbid patient population, budget regulation, and provision of care.[22] For example, obesity rates are higher among veterans who use the VA for health care compared with veterans who do not use the VA. This has important implications from an outcomes perspective, as obesity is an independent risk factor for infection, readmission, and component malpositioning.[16] To our knowledge, no study has examined the benefits of the DAA THA in the veteran's affairs (VA) arthroplasty population. Further studies are needed to examine if there is a benefit in this population, both to improve implant longevity in an at-risk population and reduce utilization of hospital resources funded by a federally constrained budget. The purpose of this study is to compare the perioperative clinical and radiographic outcomes of veterans who underwent a total hip arthroplasty (THA) via a direct anterior approach (DAA) versus those who underwent a posterior approach at a VA healthcare facility.

2. Materials and Methods

This study was approved by the institutional review board. We retrospectively identified from the operative logs consecutive cohorts of 121 primary posterior THAs performed between January 10, 2012 and May 12, 2015, and 93 primary DAA THAs performed between May 19, 2015 and January 16, 2018. All procedures were performed by a fellowship trained arthroplasty surgeon at a single VA hospital. The indication for surgery was primary hip osteoarthritis in all cases. One patient from the posterior THA group had Paget's disease. Exclusion criteria included acetabular dysplasia, avascular necrosis, and revision arthroplasty cases. We excluded from the study 11 patients in the posterior THA group with restricted medical records, reducing the total number of posterior THA cases included in the analysis to 110. Among the 93 DAA and 110 posterior surgeries, 11 patients (6 posterior and 5 DAA) were removed from radiographic analysis for having radiographs that were not amenable to technical review, yielding 192 (104 posterior and 88 DAA) radiographs available for analysis.

Data on pre-operative patient factors and intra-operative surgical factors were collected, including age, body mass index (BMI), gender, laterality, American Society of Anaesthesiology (ASA) score, operative time, and intraoperative blood loss. There were no differences between approaches with regards to BMI, patient age, gender, laterality and ASA score.

Data on postoperative outcomes were extracted through a chart analysis. These parameters included hospital LOS (in days), number of packed red blood cell units transfused, discharge disposition, and ICU admission. Discharge disposition was a binary outcome, documented as either “home” or “other” (including inpatient rehabilitation or skilled nursing facility).

2.1. Surgical technique

Posterior Approach: The patient was placed into the lateral decubitus position with the operative side up. A pre-incisional intravenous 1 g dose of tranexamic acid was administered to all patients. An incision beginning 5 cm distal to the greater trochanter, centered on the femoral diaphysis, was continued proximal to the greater trochanter. At that point, the incision was curved toward the posterior superior iliac spine for 6 cm. Iliotibial band was incised and the gluteus maximus was split. Piriformis tendon was detached at its femoral insertion and tagged, as were the external rotators and the capsular flaps following posterior capsulotomy. Placement of the acetabular cup was performed using straight inserter handles. Implant orientation was confirmed largely by evaluating the relationship between the inserter handle and the orientation of the pelvis. At the time of closure, the posterior hip capsule was repaired and the external rotators were reattached.

Anterior Approach: A regular OR table was used for all DAA surgeries. A pre-incisional intravenous 1 g dose of tranexamic acid was administered to all patients. An incision starting 2 cm lateral and 2 cm distal to the anterior superior iliac spine and proceeding 8 cm distally toward the fibular head was made. The tensor fascia lata (TFL) fascia was split, and the TFL was mobilized and retracted laterally. The interval between rectus femoris and gluteus medius was employed to access the anterior hip capsule. Intraoperative fluoroscopy was utilized during acetabular preparation and insertion of the shell. Intraoperatively, acetabular inclination and version were judged based on an intraoperative anteroposterior pelvis view. Straight inserter handles were used for acetabular cup positioning and confirmation of component alignment.

Implants: A Zimmer Biomet G7 acetabular component and Zimmer Biomet Echo femoral stem were used for all procedures except in rare cases.

2.2. Radiographic review

Two independent reviewers - a senior orthopaedic resident and a fellowship trained arthroplasty surgeon - were blinded to each patient's surgical cohort and clinical course, but given a spreadsheet with the patient's pre-assigned study identification number, laterality, and size of implanted acetabular cup. The reviewers measured acetabular cup inclination angle, LLD, and femoral offset for the 203 patients with available radiographs. Eleven patients without acceptable images were excluded from the radiographic analysis, yielding 192 total radiographs for inclusion for radiographic review. Reasons for exclusion were inappropriately rotated pelvic films, ischial tuberosities not visible in radiograph, or inadequate proximal femur visualized to obtain offset measurements.

The most immediate postoperative anteroposterior (AP) pelvis radiograph available for each patient was used for measurement assessment (Figs. 1 and 2). The methods used are demonstrated in Fig. 3, as adopted from a prior radiographic analysis performed by Lin et al.[16] All measurements were made using OrthoView digital software (Materialise, Leuven, Belgium). The implanted acetabular cup diameter was used to calibrate each image to produce accurate measurements for LLD and offset.

2.3. Measurement of acetabular inclination

The acetabular inclination angle was measured using the angle between a line tangential to the ischial tuberosities and a line through the axis of the major diameter of the acetabular component. We defined the range of acceptable acetabular inclination angle 30–50°, inclusive, based on the “safe zone” as described by Lewinnek *et al.*[17]

2.4. Measurement of LLD

LLD was measured by first creating a horizontal line tangential to the ischial tuberosities. The distance from the most medially prominent aspect of the lesser trochanter to the horizontal was

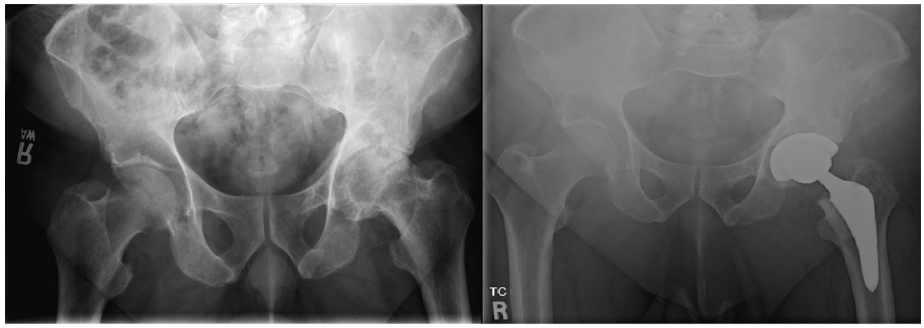

Fig. 1. Preoperative (left) and postoperative (right) AP pelvis radiograph of a patient who underwent left DAA THA.

Fig. 2. Preoperative (left) and postoperative (right) AP pelvis radiograph of a patient who underwent a left posterior approach THA.

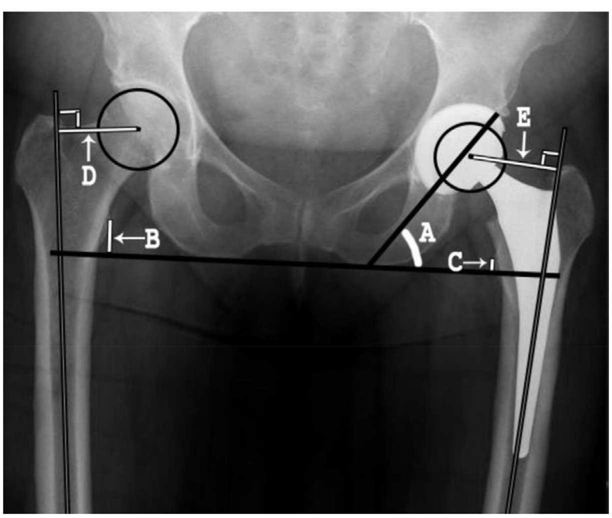

Fig. 3. Figure as adapted from Lin et al.[16] describing method for measuring acetabular inclination (angle A), offset (measurements D and E), and LLD (difference between measurements B and C) on a postoperative AP pelvis radiograph.

measured. This was compared to the distance on the contralateral side from the symmetric point on the lesser trochanter. For cases where the lesser trochanter was either dysmorphic or not visible in the radiograph, distance from the tip of the greater trochanter on each side was used instead. While there is no universally accepted value for meaningful difference in LLD, Konyves et al. found that approximately 90% of patients with a perceived LLD twelve months after THA had a perioperative radiographic LLD greater than five mm.[23] Hence, we chose five mm for our cutoff as a significant difference, where greater than five mm difference was considered unacceptable. Negative values for LLD represented an operative side shorter than the nonoperative side, and positive values represented a longer operative extremity. Hence, LLD values between −5 mm and 5 mm were considered "acceptable".

2.5. Measurement of femoral offset

Change in femoral offset was measured as described by Lecerf et al.[24] Lines were drawn to bisect the proximal femoral shafts on the operative and nonoperative sides. The perpendicular distance was measured from this line to the ipsilateral center of the femoral head. The change in femoral offset was the distance on the operative side minus the distance on the nonoperative side. A negative change in femoral offset denoted that the operative side offset was less than the nonoperative side. A value between -5mm and 5 mm was considered "acceptable", as supported by prior literature suggesting poorer outcomes with greater than 5 mm change from native offset.[19,25]

2.6. Statistical analysis

We statistically compared patient characteristics, perioperative clinical, and radiographic outcomes between the DAA and posterior THA cohorts. Categorical variables were compared with the Fisher exact test. Continuous variables were compared using the independent sample *t*-test and the Wilcoxon rank-sum test for parametric and nonparametric data, respectively. We calculated the odds of discharge prior to the third post-operative day for the DAA cohort in comparison to the posterior THA cohort, and tested for statistical significance with the chi-squared test. We performed all analyses using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

There were no significant differences between the DAA and posterior cohorts in terms of age, sex, BMI, surgical laterality, and

ASA score (Table 1). Both cohorts had a mean age of 66 years, were predominantly male (>97%), and had mean BMIs of 29.5. Less than 30% had ASA scores of I, most were ASA II, and less than 2% were ASA III in each cohort.

The DAA THA group had a shorter LOS (IQR 3–5 days vs 3–6 days), increased likelihood of target discharge prior to postoperative day 3 (OR 2.12; 95% CI 1.02–4.44), longer operating room time (162 vs 151 min), higher intraoperative blood loss (50 mL higher), and lower rate of blood transfusion (5% vs 20%) ($p < 0.05$; Table 2). The DAA was protective against blood transfusion, with patients being 4 times less likely to be transfused than the posterior group (OR = 0.23; 95% CI 0.08–0.64; $p < 0.01$). Among those transfused between the two groups, the number of units administered were not significantly different ($p = 0.3$).

Discharge to home was achieved for 65% of the DAA THA group compared with 40% of the posterior THA group ($p < 0.001$). Patients undergoing DAA were nearly three times more likely to be discharged home compared to the posterior group (OR = 2.78; 95% CI 1.56–5.00; $p < 0.001$).

The rate of early discharge, defined as discharge on postoperative day 2 or earlier, was higher in the DAA group (23.7% vs 12.7%). The DAA group had a lower percentage requiring postoperative surgical ICU admission (2% vs 5%). Neither of these differences achieved statistical significance.

There was a higher percentage of subjects in the DAA group that had an acceptable acetabular inclination angle compared to the posterior group (83% vs. 37%, $p < 0.0001$; Table 3). The DAA was protective against an unacceptable angle compared to the posterior approach (OR = 0.12, 95% CI 0.06–0.23; $p < 0.0001$). The mean leg length discrepancies for the DAA cohort (−0.3 mm) and the posterior cohort (3.7 mm) were significantly different, however the rate of acceptable leg length discrepancy in each cohort was not significantly different (52% vs 50%, $p = 0.77$). The majority of all subjects had acceptable (<5 mm difference compared to contralateral side) offset, with no difference by approach (59% posterior vs. 52% anterior, $p = 0.33$).

There were a higher number of in-hospital morbidities in the posterior THA group. Four patients were admitted to the surgical intensive care unit (SICU) postoperatively for management of postoperative hypotension or monitoring after high intraoperative blood loss. One patient developed a superior gluteal artery aneurysm that required embolization. Two patients were admitted to the medical intensive care unit, one for management of atrial fibrillation with rapid ventricular response, the other for management of pulmonary edema. Two patients were transferred postoperatively to the medicine service, one for management of a gastrointestinal bleed, the other for atrial flutter. There were no in-hospital mortalities in both groups.

Table 1
Patient characteristics, DAA and posterior THA cohorts.

	DAA	Posterior	*P* value
Total number (% total cohort)	93 (45.8)	110 (54.2)	–
Mean age (SD)	66.4 (8.3)	65.9 (8.8)	0.65 *
Sex			0.63 §
Female	1 (1.1)	3 (2.7)	
Male	92 (98.9)	107 (97.3)	
Mean BMI (SD)	29.5 (4.3)	29.4 (5.3)	0.86 *
Laterality			0.26 §
Left	47 (50.5)	46 (41.8)	
Right	46 (49.5)	64 (58.2)	
ASA score			0.77 §
ASA I	26 (28)	30 (27.3)	
ASA II	65 (70)	79 (71.8)	
ASA III	2 (2.1)	1 (0.9)	

Percentage of cohort is in parentheses, unless otherwise indicated. Comparison between groups by (*) independent sample *t*-test, (§) Fisher's exact test.

Two patients in the DAA group sustained an intraoperative nondisplaced greater trochanter fracture. One case occurred during femoral elevation in the setting of an incomplete posteromedial capsular release, the other occurred during extraction of a femoral broach. Both patients were treated conservatively with abductor precautions and protected weight bearing in the perioperative period (approximately 4 weeks). Additionally, two patients were transferred to the SICU postoperatively for management of postoperative hypotension.

4. Discussion

The increased adoption of the DAA THA at arthroplasty centers nationwide has garnered attention in recent literature. Proponents of the DAA cite improved implant positioning, shorter hospital LOS, less postoperative pain, reduced blood transfusion rates and increased likelihood of discharge home in comparison to the posterior approach.[16,26,27] To our knowledge, no study has examined the benefits of the DAA for THA in the VA patient population. In our study of veterans undergoing primary THA at a VA hospital, patients undergoing DAA THA demonstrated better perioperative outcomes than patients undergoing the posterior approach despite similar demographics, ASA score, and the DAA learning curve.

Applying available arthroplasty outcome data from the private sector to the VA patient population may be fraught with biases. The VA manages a unique patient population that is different from the private sector patient population. Veterans who use the VA for health care have the highest rates of obesity compared with veterans who do not use the VA, and obese veterans who utilize the VA for services have higher rates of comorbidities, particularly diabetes.[28,29] This has important implications from a THA perspective, as obesity is an independent risk factor for infection, readmission, and acetabular component malposition.[16,30,31] The latter, in turn, is a risk factor for postoperative dislocation and implant wear.[17,32] Furthermore, the VA cares for a higher percentage of minorities who, as a group, often encounter barriers to care in community settings, socioeconomic burdens, and poor social support systems. Such access issues may translate to discharge barriers and prolonged hospital lengths of stay; poor social support may decrease the chances of a patient being discharged home.[22]

We found that the DAA THA was associated with a significantly lower perioperative blood transfusion rate, increased discharge to home rate, shorter LOS, and increased likelihood of discharge prior to postoperative day three when compared to the posterior approach. This is concordant with comparative studies performed in the non-VA population. Ponzio et al. found similarly improved perioperative parameters with the DAA at a large volume arthroplasty center, despite including the learning curve for DAA.[26] The finding of lower perioperative transfusion rates despite longer operating time and higher blood loss in the DAA group may be attributed to differences in postoperative hidden blood loss (HBL) between the two approaches. The posterior approach is associated with more soft tissue dissection and a considerably longer surgical incision, which are known influential factors of HBL in THA.[33] These factors are also implicated in the DAA 's known association with expedited postoperative mobilization, which was apparent in our study. At our institution, clearance for home discharge is determined by the patient's ability to mobilize independently, navigate stairs, and tolerate activities of daily living without significant discomfort. This accounted for the higher rate of home discharge clearances by our physical therapy department for the DAA cohort. Lastly, the higher likelihood of later discharge in the posterior cohort may be explained by several factors, such as the cohort's higher rate of medical morbidity (ie., anemia requiring transfusion)

Table 2
Perioperative outcome measures, DAA and posterior THA cohorts.

	DAA	Posterior	*P* value
Mean surgery duration (min; SD)	162 (33)	151 (23)	0.009 *
Estimated blood loss, median (ml; IQR)	300 (200–570)	250 (200–400)	0.007 **
Number transfused	5 (5)	22 (20)	0.003 §
Median units transfused (IQR)	1 (1–2)	2 (1–4)	0.14 **
Number admitted to SICU	2 (2)	6 (5)	0.30 §
Number discharged prior to POD3	22 (24%)	14 (13%)	
Odds of discharge prior to POD3 (95% CI)	2.12 (1.02–4.44)	–	0.042
Number discharged to rehab	32 (35)	66 (60)	<0.001 §

Percentage of cohort is in parentheses, unless otherwise indicated. Median units transfused reported for those patients in each cohort who received a transfusion. Comparison between groups by (*) independent sample *t*-test, (**) Wilcoxon rank sum test, (§) Fisher's exact test. Odds of discharge prior to POD3 reported for DAA compared to posterior cohort; p-value reported from chi-squared test.

Table 3
Radiographic outcome measures, DAA and posterior THA cohorts.

	DAA	Posterior	*P* value
Total number	88	104	
Mean acetabular inclination (degrees; SD)	36.8 (6.5)	51.9 (5.3)	<0.0001 *
Number acceptable (30°–50°)	75 (83)	37 (37)	<0.0001 §
Mean leg length discrepancy (mm; SD)	−0.3 (8.6)	3.7 (6.8)	0.0005 *
Number acceptable (-5 mm – 5 mm)	46 (52)	50 (50)	0.77 §
Mean femoral offset (mm; SD)	−0.8 (6.4)	−0.4 (6.8)	0.66 *
Number acceptable (-5 mm – 5 mm)	46 (52)	60 (59)	0.31 §

Percentage of cohort is in parentheses, unless otherwise indicated. Comparison between groups by (*) independent sample *t*-test, (**) Wilcoxon rank sum test, (§) Fisher's exact test.

and increased rate of rehabilitation referrals. Awaiting the resolution of postoperative anemia and acceptance at a local rehabilitation center can be lengthy processes that would delay discharge.

The aforementioned findings have important clinical and financial implications. Longer index LOS, discharge after postoperative day three, discharge disposition to a nursing facility, and blood transfusion requirements are independent risk factors for 30-day readmission and complication after THA.[34] Perioperative blood transfusion has been independently linked with an increased risk of surgical site infection after THA.[35] Sutton et al. found discharge prior to postoperative day 2 to be an independent predictor against major postoperative complications.[36] Lastly, there is a significant difference in episode of care costs according to discharge disposition after THA, with discharge to home being the least costly.[37] The adoption of the DAA in the VA patient population has the potential to control future costs, rehospitalizations, and complications in an already economically burdened VA health care system.

A longer surgical duration and marginal increase in intraoperative blood loss was noted for the DAA THA group. We attribute these findings to the learning curve of the DAA, as well as the complexity of the DAA procedure, which requires greater skill in various steps. Not surprisingly, these findings are consistent with prior studies that similarly included the learning curve for the DAA.[38,39] The authors believe that this difference in surgical duration would not persist if this study were performed outside of the senior author's DAA learning curve.

Acetabular component inclination is an important modifiable risk factor for postoperative instability, bearing surface wear, periprosthetic osteolysis, and component impingement in THA.[32,40,41] The DAA cohort demonstrated an increased rate of achieving target acetabular component inclinations within the safe zone as defined by Lewinnek, matching prior trends demonstrated in the literature.[5,16,42] We do not attribute these findings to the use of fluoroscopy but rather to the nature of the DAA itself. The supine positioning facilitates anatomic comprehension and pelvic landmark identification, which is helpful when external alignment guides are utilized to gauge acetabular component positioning. Pelvic tilt and rotation have been found to be highly variable in the lateral decubitus position, leading to inconsistent and inaccurate orientation of the acetabular component despite intraoperative use of fluoroscopy.[43] Furthermore, Grammatopoulos et al. reported a significantly higher risk of acetabular component malposition and significantly greater discordance between intraoperative and postoperative radiographic component positioning with posterior THA, despite the use of intraoperative fluoroscopy in both cohorts.[44] Lastly, obscurity of pelvic landmarks and unpredictability of pelvic orientation in the lateral decubitus position, particularly in centrally obese patients, impedes accurate component positioning.[43] This is especially true when external alignment guides are used to gauge version and inclination of the acetabular cup, as was the case in this study.[43] We believe a combination of these factors explains the high percentage of acetabular component malposition seen in our posterior approach cohort.

Our study has several limitations. First, our data are observational and non-randomized, which may introduce selection bias and decrease the generalizability of our results. We compared surgeries performed by a single surgeon at a single VA site to optimize consistency and confer control to this comparative trial. Second, all cases in this study were performed by a fellowship-trained arthroplasty surgeon at a high-volume VA hospital consistently rated highly by the VA Strategic Analytics for Improvement and Learning (SAIL) quality improvement system.[45] Our results may not be applicable to VA centers with a dissimilar practice profile. Third, the surgeon used the posterior approach exclusively for approximately 6 years in his practice prior to adopting the DAA. The findings may be related to the surgeon continuing to refine and improve surgical skills over time. Fourth, we did not examine patient-reported or long-term outcomes in this study. While the perioperative findings we report have been associated with long-term clinical outcomes, we were unable to independently demonstrate this association in our patient population. The clinical superiority of the DAA THA in the VA population remains to be examined prospectively in future studies. Lastly, whether the perioperative benefits of the DAA offset the shortcomings of the procedure, including the cost of fluoroscopy and radiation exposure to the surgeon and the patient, are aspects to consider as well.

We found that despite the learning curve associated with surgeon adoption, DAA THA resulted in improved perioperative outcomes compared to the posterior approach in a VA patient cohort. Additionally, the DAA was associated with improved acetabular inclination angles compared to the posterior approach, and showed no difference in rates of unacceptable LLD or offset. While perioperative outcomes after THA are only one aspect of a patient's outcome, there is mounting evidence to suggest that longer term outcomes, including decreased post-discharge costs, readmission rates, and implant failures, are associated with the perioperative parameters examined in this study. We therefore advocate for increased adoption of the DAA THA technique for patients in the VA or similar health systems.

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