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Transitioning from the Posterior Approach to the Direct Anterior Approach for Total Hip Arthroplasty

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Purpose: Total hip arthroplasty (THA) using the direct anterior approach (DAA) is known to have a learning curve. The purpose of this study was to review cases where surgery was performed by an arthroplasty surgeon transitioning from the posterior approach (PA) to the DAA. We hypothesized similar complication rates and improvements in surgical duration over time.

Materials and Methods: A review of 2,452 consecutive primary THAs was conducted. Surgical duration, length of stay (LOS), surgical complications, decrease in postoperative day (POD) 1 hemoglobin, transfusion rates, POD 0 and POD 1 pain scores, incision length, leg length discrepancy (LLD), and radiographic cup position were recorded.

Results: No differences in surgical duration were observed after the first 50 DAA cases. A shorter LOS was observed for the DAA, and statistical difference was appreciated after the first 100 DAA cases. There were no differences in periprosthetic fractures. A higher rate of infections and hip dislocations were observed with the PA. The PA showed an association with higher transfusion rates without significant difference in POD 1 decrease in hemoglobin over the first 100 DAA cases. Similar POD 0 and POD 1 pain scores with a smaller incision were observed for the first 100 DAA cases. The DAA cohort showed less variation in cup inclination, version, and LLD.

Conclusion: DAA is safe and non-inferior in terms of reduced LOS, smaller incision, and less variation in cup position. Fifty DAA cases was noted to be the learning curve required before no differences in duration between approaches were observed.

Key Words: Direct anterior approach, Total hip arthroplasty, Learning curve, Complications, Surgical duration

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INTRODUCTION

Improved quality of life after total hip arthroplasty (THA) in the population of arthritic patients has been well documented[1]. THA is commonly performed by use of a posterior or direct anterior approach (DAA); each method has advantages and disadvantages. When using the posterior approach (PA), excellent visualization can be obtained during trialing and selection of implants and the incision can be extended in order to mitigate potential complications. However, the risk for posterior hip dislocation following THA performed using the PA has been described in previous literature[1]. Performing THA using the DAA is also a technically challenging procedure that involves a learning curve, thus higher rates of complications and longer surgical times can be anticipated[2,3]. In addition, the DAA is also not free of complications, which include nerve injuries, fractures, and infection[1]. Interest in the DAA originated from literature that reported a more rapid recovery, shorter length of stay (LOS), lower dislocation rates, and more consistent cup placement[4-6]. Given that there is controversy surrounding the utilization of the DAA as opposed to the traditional PA, the main objective of our study was to evaluate the validity and accuracy of previous reports by review of a cohort of patients who underwent THA using the DAA or PA. In all cases included in our study, surgery was performed by a single, fellowship-trained arthroplasty surgeon working in a high-volume practice, who transitioned from the PA to the DAA. According to our hypothesis, the complication rates for the DAA would be similar to those for the PA, while improvements in surgical duration would be observed with increased experience.

MATERIALS AND METHODS

Following approval by the Institutional Review Board (IRB) (No. 1474771-3), a retrospective review of 2,452 consecutive patients who underwent THA from October 2006 to November 2019 at Methodist Sports Medicine Research & Education Foundation was conducted. The informed consent was waived by the IRB. Intra- and postoperative variables including surgical duration, LOS, surgical complications (intraoperative calcar fractures, postoperative periprosthetic fractures, superficial and deep infections, dislocations, and overall complications), decrease in postoperative day 1 (POD 1) hemoglobin, transfusion rates, POD 0 and POD 1 pain scores, incision length, leg length discrepancy (LLD), and radiographic cup position (inclination and version) were retrospectively collected from the electronic health record. Superficial infections were defined as infections that required a return to the operating room (OR) for incision and drainage (I&D) with closure. Deep infections were defined as infections that required a return to the OR for either I&D and polyethylene exchange or two-stage revision. Transfusions were defined as administration of either autologous blood collected prior to surgery or blood administered from the blood bank. Evaluation of radiographic cup positioning variables was performed using postoperative plain radiographs. Collection of radiographic data was performed one-month postoperatively and measurements were performed by either the senior author or his physician assistant. Cup inclination and LLD was measured on an anteroposterior pelvis view. Cup version was measured on the cross table lateral view of the hip.

Comparison of mean POD 1 decrease in hemoglobin, surgical duration, POD 0 and 1 pain scores, incision length, and LOS was performed using a Student's t-test. Each t-test was two-tailed with a significance level of 5%. Comparison of categorical data between the two approaches, including overall complications, intraoperative calcar fractures, dislocations, postoperative periprosthetic fractures, transfusion rate, and superficial and deep infections, was performed using a chi-squared test. Finally, evaluation of the variability in cup positioning, including inclination, version, and LLD between the two approaches was performed using an F-test.

RESULTS

According to the results, 445 patients underwent THA using the PA, while 2,007 patients underwent THA using the DAA. A complete summary of the cohort demographic data for the PA and DAA is shown in Table 1.

When all cases were evaluated, the mean surgical duration was 77.5 minutes for the DAA, which was significantly shorter compared to 84.7 minutes for the PA (P<0.05; 95% CI, 5.418-8.982). In the initial review of the first 100 DAA cases compared to the final 100 PA cases, the mean duration of the PA (86 minutes) was significantly shorter than that of the DAA (102 minutes) (P<0.05; 95% CI, 11.17-21.83). However, in evaluation of the mean surgical duration of DAA 51-100 cases (92 minutes) with the duration of the final 50 PA cases (89 minutes), no significant differences were observed (P=0.32; 95% CI, –2.498 to 9.898). In addition, a statistical difference in the mean duration was observed for the final 100 DAA cases (66 minutes) compared to the final 100 PA cases (86 minutes) (P<0.05; 95% CI, 15.747-23.853). Notably, approximately 400 cases using the DAA approach were required in order to lower the mean surgical duration to approximately 84 minutes or the mean time for the PA. A complete summary of these findings is shown in Fig. 1 and Table 2.

A significantly shorter mean LOS was observed for the DAA (1.64 days) compared to the PA (2.82 days) (P<0.05; 95% CI, 1.0548-1.3052). Also of note, in evaluation of the first 100 DAA cases and the final 100 PA cases, there were no differences in the LOS (2.37 vs. 2.59 days, respectfully) (P=0.09; 95% CI, –0.0443 to 0.4843).

Regarding pain scores, no differences in POD 0 pain scores were observed for the first 100 DAA cases and the final 100 PA cases (P=0.91; 95% CI, –0.6601 to 0.7401). In addition, no differences were observed in POD 1 pain scores (P=0.14; 95% CI, –0.0679 to 0.4279). A summary of the results regarding LOS and pain scores between the PA and DAA is shown in Table 3.

A significantly higher rate of transfusion was observed following the PA (P<0.05). No significant difference in POD 1 decrease in hemoglobin was observed between the first 25, 50, and 100 DAA cases and the final 25, 50, and 100 PA cases (P>0.05). However, the overall mean POD 1 decrease in hemoglobin was 3.56 for the DAA, which was significantly lower than 4.41 for the PA (P<0.05; 95% CI, 0.6347-1.0653). This finding also held true in evaluation of the POD 1 decrease in hemoglobin for the final 100 DAA cases (2.72) and the final 100 PA cases (4.47) (P<0.05; 95% CI, 1.1949-2.3051). Overall, a significantly larger mean incision length

Table 1. Cohort Demographic Data

	DAA (n=2,007)	PA (n=445)	P-value	95% CI
Demographics				
Age (yr)	62.9	62.2	0.24	–0.41 to 1.81
Sex	M: 46.7%, F: 53.3%	M: 54.4%, F: 45.6%	<0.005*	-
Sex last 100 DAA vs. All PA	M: 45%, F: 55%	M: 54.4%, F: 45.6%	0.09	-
Laterality	R: 53.3%, L: 46.7%	R: 57.3%, L: 42.7%	0.12	-
Body mass index (kg/m^2)				
First 100 DAA vs. Last 100 PA	28	30	0.06	0.47 to 3.53
First 25 DAA vs. Last 25 PA	27	29	0.17	–0.93 to 4.93
Last 100 DAA vs. Last 100 PA	28.7	29.8	0.13	–0.357 to 2.557
Overall	28.9	29.8	<0.0005*	0.364 to 1.436

Values are presented as mean only.
DAA: direct anterior approach, PA: posterior approach, M: male, F: female, R: right, L: left, CI: confidence interval.
* P<0.05.

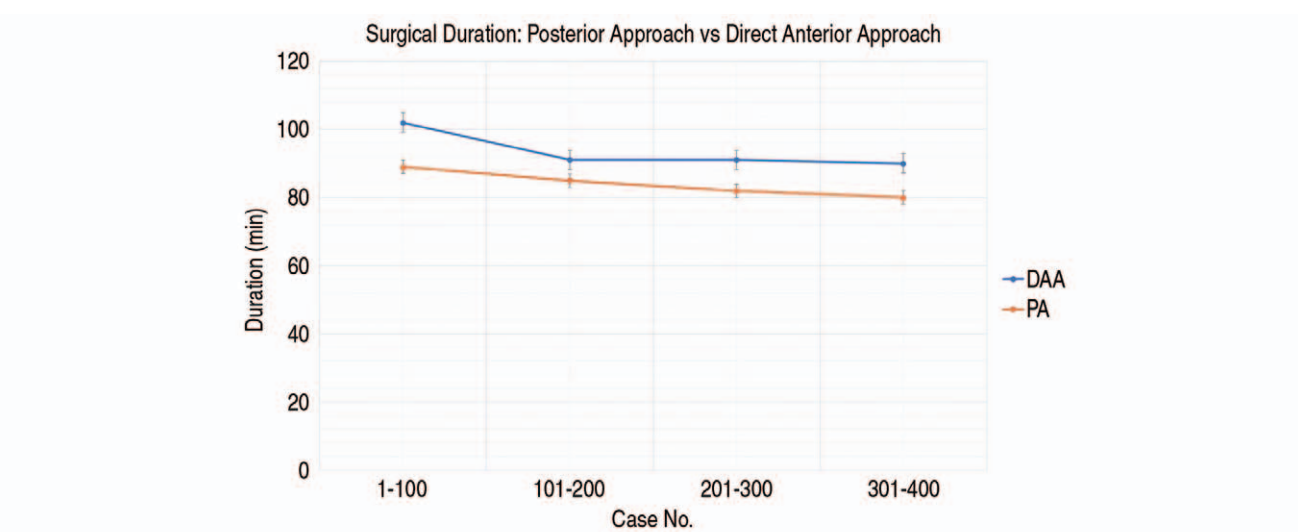

Fig. 1. Surgical duration for the posterior approach (PA) versus direct anterior approach (DAA).

Table 2. Surgical Duration for Direct Anterior Approach (DAA) versus Posterior Approach (PA)

Case No.	TTOS DAA (min)	TTOS PA (min)	*P*-value	95% CI
1-25	116 (91-181)	85 (68-125)	-	-
26-50	107 (87-183)	92 (68-163)	-	-
51-75	92 (71-120)	94 (62-142)	-	-
76-100	93 (71-151)	85 (69-125)	-	-
1-100	102 (71-183)	89 (62-163)	-	-
101-200	91 (71-153)	85 (45-132)	-	-
201-300	91 (63-165)	82 (58-138)	-	-
301-400	90 (67-123)	80 (57-172)	-	-
401-500	85 (63-142)	-	-	-
501-2,007	73 (45-185)	-	-	-
Last 100 DAA vs. Last 100 PA	66 (45-95)	86 (57-172)	<0.05*	15.747 to 23.853
Overall mean TOS	77.5	84.7	<0.05*	5.418 to 8.982
Case 51-100 DAA vs. Last 50 PA	92 (71-151)	89 (57-172)	0.32	−2.498 to 9.898
First 100 DAA vs. Last 100 PA	102 (71-183)	86 (57-172)	<0.05*	11.17 to 21.83

Values are presented as mean (range) or mean only.
TTOS: total time of surgery, TOS: time of surgery, CI: confidence interval.
*$P<0.05$.

Table 3. Length of Stay following Direct Anterior Approach (DAA) versus Posterior Approach (PA)

	DAA	PA	*P*-value	95% CI
Length of stay (day)				
Overall	1.64	2.82	<0.05*	1.0548 to 1.3052
First 100 DAA vs. Last 100 PA	2.37	2.59	0.09	−0.0443 to 0.4843
Pain scores				
POD 0 first 100 DAA vs. Last 100 PA	2.22	2.26	0.91	−0.6601 to 0.7401
POD 1 overall	4.74	4.56	0.14	−0.0679 to 0.4279

Values are presented as mean only.
POD: postoperative day, CI: confidence interval.
*$P<0.05$.

Table 4. Hemodynamic Status and Incision Length following Direct Anterior Approach (DAA) versus Posterior Approach (PA)

	DAA	PA	*P*-value	95% CI
No. of transfusions	35	49	<0.005*	0.6347 to 1.0653
Hemoglobin drop				
POD 1 first 25 vs. Last 25 PA	3.85	4.32	0.30	−0.3303 to 1.8303
First 50 DAA vs. Last 50 PA	4.1	4.45	0.26	−0.3811 to 1.0811
First 100 DAA vs. Last 100 PA	4.23	4.45	0.39	−0.3097 to 0.7497
Last 100 DAA vs. Last 100 PA	2.72	4.47	<0.05*	1.1949 to 2.3051
POD 1 overall	3.56	4.41	<0.05*	0.6347 to 1.0653
Incision length (cm)				
First 100 DAA vs. Last 100 PA	12.1	13.3	<0.0005*	0.624 to 1.776
Last 100 DAA vs. Last 100 PA	10	13.3	<0.0005*	2.7092 to 3.7908
Overall	10.5	13.3	<0.05*	2.663 to 2.937

Values are presented as mean only.
POD: postoperative day, CI: confidence interval.
*$P<0.05$.

was observed for the PA (13.3 cm) compared to that for the DAA (10.5 cm) (*P*<0.05; 95% CI, 2.663-2.937). A complete summary of this data is shown Table 4.

No differences in intraoperative calcar fractures (*P*=0.683), postoperative periprosthetic fractures (*P*=0.503), and superficial infections (*P*=0.583) were observed between the PA and DAA. However, a significantly higher rate of postoperative hip dislocations was observed with use of the PA (1.57%) compared to the DAA (0.25%) (*P*<0.005). A significantly higher rate of deep infections was also observed with use of the PA (1.57%) compared with the DAA (0.25%) (*P*<0.005). Finally, significantly higher revision rates were observed with use of the PA (2.02%) compared to the DAA (0.25%) (*P*<0.005). Further illustration of a compilation of this data is shown in Table 5.

In evaluation of acetabular cup inclination, version, and LLD for the entire cohort, the DAA showed an association with less overall variance in cup position when compared to the PA (*P*<0.05). Data regarding cup position is shown in Table 6.

DISCUSSION

Findings from several studies have suggested that significantly better overall LOS and early pain control can be obtained by use of the DAA, which can potentially be attributed to the ability for rapid mobilization of patients following surgery and use of the muscle sparing approach[4,7]. Similar trends were observed in our study. The mean overall LOS for patients following THA performed using the

Table 5. Complications following the Direct Anterior Approach (DAA) versus Posterior Approach (PA)

Complication	DAA (n=2,007)	PA (n=445)	Anterior approach expected	Posterior approach expected	*P*-value
Total overall (n=113)	79	34	92	21	<0.005*
Intraoperative calcar fractures					
First 100 DAA vs. Last 100 PA	2	2	2	2	>0.999
First 1,000 DAA vs. PA	29	9	26	12	0.336
Last 100 DAA vs. Last 100 PA	4	2	3	3	0.407
Overall	47 (2.34)	9 (2.02)	46 (2.29)	10 (2.25)	0.683
Postoperative periprosthetic fractures					
First 100 DAA vs. Last 100 PA	0	1	1	1	0.316
First 1,000 DAA vs. PA	4	1	3	2	0.600
Last 100 DAA vs. Last 100 PA	0	1	1	1	0.317
Overall	9 (0.45)	1 (0.22)	8 (0.40)	2 (0.45)	0.503
Dislocations					
First 100 DAA vs. Last 100 PA	0	1	1	1	0.316
First 1,000 DAA vs. PA	4	7	8	3	0.017*
Last 100 DAA vs. Last 100 PA	0	1	1	1	0.316
Overall	5 (0.25)	7 (1.57)	10 (0.50)	2 (0.45)	<0.005*
Superficial infections					
First 100 DAA vs. Last 100 PA	1	0	1	1	0.316
First 1,000 DAA vs. PA	6	1	5	2	0.343
Last 100 DAA vs. Last 100 PA	0	0	0	0	-
Overall	8 (0.40)	1 (0.22)	7 (0.35)	2 (0.45)	0.583
Deep infections					
First 100 DAA vs. Last 100 PA	1	2	2	2	0.561
First 1,000 DAA vs. PA	2	7	6	3	<0.005*
Last 100 DAA vs. Last 100 PA	0	2	1	1	0.155
Overall	5 (0.25)	7 (1.57)	10 (0.50)	2 (0.45)	<0.005*
Revisions					
First 100 DAA vs. Last 100 PA	3	2	3	3	0.651
First 1,000 DAA vs. PA	4	9	9	4	<0.005*
Last 100 DAA vs. Last 100 PA	0	2	1	1	0.155
Overall	5 (0.25)	9 (2.02)	11 (0.55)	3 (0.67)	<0.005*

Values are presented as number only or number (%).
* *P*<0.05.

Table 6. Radiographic Cup Positioning following Direct Anterior Approach (DAA) versus Posterior Approach (PA)

Cup positioning	DAA	PA	F-test
Cup version			
First 100 DAA vs. Last 100 PA	27.5±6.024	28.1±7.744	0.42
Overall	27.9±5.941	28.8±8.090	<0.005*
Cup inclination			
First 100 DAA vs. Last 100 PA	43.7±3.539	42.3±4.016	<0.005*
Overall	43.9±3.203	41.2±5.076	<0.005*
Leg-length discrepancy			
First 100 DAA vs. Last 100 PA	0.3±1.236	0.4±2.853	0.70
Overall	0.3±1.198	1.0±2.142	<0.005*

Values are presented as mean±standard deviation.
* P<0.05.

DAA was 1.64 days compared to that for the PA, which was 2.82 days. Results of our analysis showed that this difference of 1.18 days was statistically different (P<0.05). Regarding pain control early in the postoperative period, no differences between mean pain scores at POD 1 were observed for either the DAA or the PA (4.74 vs. 4.56; P>0.10).

Regarding surgical duration, findings of our study indicate that the learning curve is approximately 50 cases for the DAA, similar to previous findings reported by de Steiger et al.[8]. In addition, in order to exceed the time efficiency observed with use of the PA, experience with approximately 400 cases utilizing the DAA was required. Finally, the duration of the final 100 DAA cases was approximately 20 minutes shorter than that of the final 100 PA cases. These findings support the idea that surgeons can expect significant improvements in surgical duration and efficiency over time with increased utilization and experience in performance of the DAA.

Free et al.[4] reported on an evaluation of complications during transition from use of an alternative approach to the DAA. According to their findings, no significant difference in complications was observed during the learning curve, which is consistent with our results[2,4]. According to the findings of our study, when transitioning to the DAA approach, no significant difference in complications for intraoperative calcar fractures, postoperative periprosthetic femur fractures, dislocations, superficial and deep infections, and rates of revision (all P>0.05) was observed between the first 100 DAA cases and the final 100 PA cases (Table 5). The findings of our study showed that complications were most prevalent during the first 1,000 DAA cases. Complications were at par or less frequent over the final 100 DAA cases compared to the PA. Increased familiarity and expertise in performance of the DAA over time might explain this trend.

Significant blood loss usually associated with joint replacement surgery has been well described. According to the findings of our study a statistically significant difference (P<0.05) and an overall higher rate of transfusions as well as a higher POD 1 decrease in hemoglobin was observed for the PA group compared to the DAA group. These results are consistent with those of prior studies reported in the orthopaedic literature, where the DAA showed an association with a lower overall transfusion rate[9,10]. However, the senior author's use of postoperative auto-transfusions early in practice while performing THA is an important consideration. Use of this protocol has been reported to result in a reduction of the need for allogenic blood transfusion[11,12]. The senior author's use of postoperative drains early in practice, which may also have contributed to greater blood loss and need for transfusions, is another important point that should be considered.

Use of the DAA approach characteristically involves a smaller incision as compared to the PA approach, which partially explains its popularity among patients[9]. These findings were consistent with our results as the DAA showed an association with a smaller incision when the first 100 DAA cases were compared with the final 100 PA cases (12.1 cm vs. 13.3 cm) and in assessment of the final 100 DAA cases versus the final 100 PA cases (10 cm vs. 13.3 cm). For the entire cohort, the mean incision length was 10.5 cm with use of the DAA compared to 13.3 cm with use of the PA (P<0.05). However, it should be noted that beyond the aesthetic preference of the patient, the clinical impact of a smaller incision is still questionable.

Finally, according to the findings of our radiographic assessments, in evaluation of radiographic cup position, the DAA showed much less variance from the mean compared to the PA. This could be attributed to the use of intraoperative fluoroscopy in performance of the DAA, which ensures that the surgeon is satisfied with cup positioning prior to leaving the OR. Although the usefulness of fluoroscopy with this approach has been demonstrated, findings from many studies suggest that there may also be a learning curve associated with implementation of intraoperative fluoroscopy with the DAA[5]. A specific study conducted by Slotkin et al.[5] which examined this learning curve associated with intraoperative fluoroscopy use reported that the accuracy of cup positioning using fluoroscopy showed significant improvement with every year of experience. This finding is in line with those of our study. For the first 100 DAA cases, no significant difference in the consistency of cup placement was observed in terms of version and LLD. However, according to our findings for the entire cohort, significantly greater precision was observed with use of the DAA in terms of cup inclination, version, and LLD when compared with the PA. LLD following THA has been reported as one of the most common reasons for litigation in the orthopaedic community[13,14]. As a result, maintenance or improvement of leg length equality in patients undergoing THA is even more important. The findings of our study showed that LLD was much less in patients undergoing THA using the DAA compared to the PA. According the findings of our study, this is a potential benefit of use of the DAA.

1. Surgical Tips and Pearls

We recommend increased repetition and preoperative preparation with utilization of the DAA during performance of THA. Use of this surgical approach will allow the treating surgeon to acquire an exponential increase in experience and consistency, ultimately leading to performance of safer and more efficient hip replacement surgery. Next, as also described by Cantrell et al.[15] in their meta-analysis, in order to decrease overall operative time and improve efficiency, we recommend minimizing the presence of trainees as much as possible. Finally, we recommend optimization of patient comorbidities and BMI prior to surgery. Greater complexity can be expected in cases involving patients with a significant number of medical problems and a high BMI. The additive effect of both will consequentially result in longer operative times.

2. Strengths

The main strength of our study is the large sample size of our patient cohort. This large sample size powered the study, enabling the discovery of small significant differences between the DAA and the PA. In addition, through conduct of an extensive retrospective review of the electronic health record, a significant number of variables were used for comparison of the two approaches.

3. Limitations

Our study has several limitations. The patient cohort selected originated from a single, fellowship-trained arthroplasty surgeon working at a single institution, therefore, the external validity of this study may be limited. Next, in the assessment of the overall demographics of our study, a statistical difference in sex and BMI was observed between approaches. Previous studies found in the literature have reported higher BMI showing correlation with a greater propensity for postoperative surgical complications following performance of the DAA[2,7,16,17]. In our study, the mean BMI was significantly lower through the first 25 DAA cases compared with the last 25 cases performed using the PA. However, ultimately, a statistical difference in BMI was no longer observed between approaches after the first 100 DAA cases and assessment of the final 100 DAA and PA cases showed no significant differences in BMI. This finding suggests that there was greater confidence with use of the approach and there was less selection bias with increased experience. In addition, we relied on the accuracy of reporting in the electronic health record in determining complication rates. Thus, there is a small potential for reporting inaccuracy or missing data. Finally, performance of the PA and DAA on hips occurred at different points in the surgeon's career. The PA to THA was performed earlier in the surgeon's career, while the DAA was utilized at the midpoint forward. Some differences in LOS, incision length, transfusions, and superficial and deep infections could be attributed to these differences in experience and any divergence in standard protocols.

CONCLUSION

During the transition from performance of the PA to performance of the DAA, there was no significant difference in complications involving intraoperative and postoperative fractures as well as superficial infections. However, use of the DAA showed an association with lower rates of dislocations, deep infections, revisions, smaller incision length, shorter LOS, and more consistent acetabular cup positioning (all $P<0.05$). The most significant disadvantage is increased surgical duration early during the DAA learning curve, but this difference becomes insignificant after the first 50 cases. However, the importance of patient selection

Hip Pelvis 34(4): 203-210, 2022

early in the DAA learning curve should be considered in order to optimize outcomes and prevent complications in elective THA. However, optimum patient selection is less consequential once this learning curve has been overcome.

CONFLICT OF INTEREST

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

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