



Original research

Financial impact of total hip arthroplasty: a comparison of anterior versus posterior surgical approaches

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ABSTRACT

Background: Compared to the posterior approach, the anterior approach to total hip arthroplasty (THA) offers the potential for an accelerated recovery secondary to less dissection and therefore less pain in the immediate postoperative period. This offers potential financial benefit through a reduction in length of stay. This study retrospectively reviewed 98 anterior approach and 69 posterior approach THA cases (N = 167) to compare perioperative outcomes and cost-effectiveness.

Methods: Patients who underwent anterior approach THA were discharged sooner than those who underwent posterior approach THA.

Results: The anterior approach was also less expensive per patient than the posterior approach. Overall, differences in perioperative outcomes between these approaches to THA are less robust than previously reported. There is a significant difference in operative cost between these surgical approaches.

Conclusions: Although there are many sources for this difference in cost, the predominant contributor is surgeon implant preference.

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Introduction

Traditionally, one of the most common surgical approaches to total hip arthroplasty (THA) has been the posterior approach (PA), in which the hip joint is accessed by splitting the gluteus maximus muscle [1,2]. However, in recent years, there has been increasing focus on minimally invasive surgical approaches to THA because of the potential to improve perioperative outcomes and hasten patient recovery [2–4]. The anterior, or Smith-Petersen, surgical approach has been shown to improve functional recovery in the early postoperative period [5–10]. Although the AA and PA have comparable long-term success rates, discrepancy is reported in the early postoperative period [2,4,6,11]. The anterior approach (AA) uses the intermuscular and internervous intervals between the sartorius and the tensor fascia lata muscles. This has been reported

in previous work to cause less soft tissue damage, decrease postoperative pain, and decrease length of stay (LOS) in the hospital compared to cases using the PA [12–18]. In addition, patients who underwent AA THA were more likely to be discharged to home vs to rehabilitation when compared to patients receiving the PA [12–15]. These outcomes offer significant benefits for patients in the immediate postoperative period, as well as the potential to decrease hospital costs. Furthermore, the demand for THA is expected to rise over the next decade because of an aging and increasingly sedentary United States population [19,20]. Therefore, improvements in THA that can decrease length of recovery may significantly impact health care costs through a reduction in needed medical services.

The purpose of our study is to review the perioperative and financial results of THA performed through the AA vs PA to compare their perioperative outcomes and cost-effectiveness. Given the muscle-sparing nature of the AA and based on previous research, we hypothesized that patients who underwent AA THA would have a decreased length of hospital stay resulting in considerable cost reduction.

Material and methods

We obtained institutional review board approval at our institution to retrospectively evaluate 98 AA and 69 PA THA cases (N = 167) which took place between January and June of 2013. All AA THAs

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were performed by a single, experienced, fellowship-trained arthroplasty surgeon. A different surgeon with a similar background performed all PA THAs. Patient demographics included age, gender, American Society of Anesthesiologists score, body mass index, and surgical indication. Operative records were analyzed for perioperative outcomes including surgical time, blood loss, pain (visual analog scale pain score, 1- to 10-point scale), complications, discharge disposition (home or rehabilitation facility), and LOS. Complications were defined as undesired or unexpected results of the operation including, but not limited to, dislocation, infection, heterotopic ossification, and limb length discrepancy. All AA cases used the same implants: a Pinnacle uncemented acetabular component, a highly cross-linked polyethylene liner, a Trilock BPS uncemented femoral stem, and a Biolog Delta ceramic femoral head (all Depuy, Warsaw, IN). All PA cases used a Zimmer Trabecular metal cup, a highly cross-linked polyethylene liner, a metal stem, and a cobalt chromium head (all Zimmer, Warsaw, IN). All patients were treated at a single location in the same academic medical center.

The AA was performed with the patient in the supine position on a HANA (Mizuho OSI, Union City, CA) operative table. The incision started 2 cm distal to and 2 cm posterior to the anterior superior iliac spine and continued distally for 8–10 cm in alignment with the lateral edge of the patella. This approach, between the tensor fascia lata and the sartorius muscles, has been described previously in greater detail [10,11,14,21]. The PA was performed with the patient in the lateral decubitus position on a standard operating table and pegboard. A posterior oblique incision was made centered over the posterior tip of the greater trochanter. The gluteus maximus muscle fibers were split, and the piriformis and conjoint tendon were reflected. The PA is also well described in previous orthopaedic texts [14,21,22].

We conducted financial analyses based on data compiled from the institution's finance department. Cost was separated into direct and indirect categories. Direct costs included all expenses immediately associated with the surgical procedure, whereas indirect costs were facility, overhead, support, and administrative in nature. Relevant direct cost items included anesthesia, blood bank, imaging, laboratories, operating room (OR) supplies/implants, OR time, postanesthesia care unit and supplies, pharmacy, physical therapy/occupational therapy, radiation oncology, respiratory, and routine room and board (RMBD). Costs associated with the surgical approach but not grouped into another category were defined as others. These costs included vascular laboratory and noninvasive cardiology expenses, critical care support services, gastrointestinal services, and others. We calculated the total cost of the surgical procedure by approach and the median cost per approach. Because of differences in implant usage and physician preference regarding postoperative pain medication, the total procedural costs were corrected to exclude pharmaceutical and implant costs.

We performed a statistical analysis of the data by calculating the mean, median, standard deviation, and range for continuous variables and frequencies and percentages of categorical variables where appropriate. Median cost was determined where the assumption of normal distribution could not be made. Differences in the averages for continuous variables between anterior and PA patients were tested using Student's *t* tests when the assumption of normality was satisfied. Mann-Whitney tests were used when such an assumption could not be made. Pearson's chi-square and Fisher's exact tests were used to examine differences in categorical variables. A *P* value of <.05 was considered to be a significant difference.

Results

Financial and perioperative outcomes of 167 THAs performed within a 6-month period were reviewed. Ninety-eight THAs were

performed via the AA and 69 via the PA. Patient demographic data illustrated that patients in the AA and PA groups were similar in terms of age, gender, body mass index, and American Society of Anesthesiologists score ($P > .05$), as differences were found not to be statistically significant (Table 1). In both groups, the predominant indication for surgery was degenerative osteoarthritis.

Data related to the procedure and hospitalization showed several differences between the 2 groups. Mean surgical time was almost 7 minutes longer in the AA group than in the PA group (94.8 vs 88.3 minutes, $P = .005$, Table 2). Mean length of hospital stay was shorter in the AA group than in the PA (LOS: 2.12 vs 2.4 days, $P = .0132$, Table 2). The majority of patients in both groups had an LOS of 2 days (Table 3). However, a larger proportion of the AA patients were discharged to home vs to a rehabilitation facility (87.8% vs 71%, $P = .012$, Table 2).

Perioperative outcomes indicate that the AA patients experienced greater blood loss (452.6 vs 267.5 mL, $P < .0001$) and a greater reduction in pain (visual analog scale score: 3.5 vs 2.14, $P = .0003$). There were fewer complications (2% vs 4%, $P = .64$) noted in the AA group, but the difference in incidence of complications was not found to be statistically significant ($P = .64$, Table 4).

Financial results illustrated that the direct cost of AA THA was \$1002 more than the PA per patient (\$13,342 vs \$12,340; Table 5). However, when the direct cost was adjusted to account for prices of implants used and medications provided, the PA THA costs were \$580 more than the AA per patient ($P = .001$, Table 5). Based on the categorical direct cost data, the greatest difference in cost between the 2 approaches was in OR supplies/implants (\$1493, Table 6). Differences in OR time, imaging, radiation oncology, and other costs were also significant contributors to the resultant cost difference (Table 6). In general, the costs associated with OR supplies/implants (AA: \$8801, PA: \$7308), OR time (AA: \$1569, PA: \$1397), and routine RMBD (both \$916) comprised the greatest portion of the total cost of the procedure for each patient (Table 6). It is important to note that 9 PA patients, compared to just 1 AA patient, used radiation oncology services for prophylaxis and/or treatment for heterotopic ossification, costing between \$575 and \$1079 (Table 6).

Discussion

In this study, we compare early perioperative and financial outcomes of AA vs PA THAs. The results indicate that the patients who underwent the AA had a shorter LOS in the hospital than the patients who underwent the PA. However, the resultant impact on cost was minimal. When comparing direct costs of the surgical procedure, the AA was more expensive than the PA primarily due to the greater cost of the implant used in AA patients, a cost largely

Table 1
Characteristics of study population.

Characteristics	Anterior (n = 98)	Posterior (n = 69)	<i>P</i> value
Age	61.13	62.9	.12
Gender			
Male	45 (46%)	34 (49%)	.79
Female	53 (54%)	35 (51%)	
BMI	30.38	30.72	.39
ASA	2.44	2.39	.28
Surgical indications			
Osteoarthritis	96 (98%)	62 (90%)	
Avascular necrosis	1 (1%)	4 (6%)	
Developmental dysplasia of hip	1 (1%)	1 (1%)	
Fracture	0	2 (3%)	

ASA, American Society of Anesthesiologists; BMI, body mass index.

Table 2
Characteristics of surgical procedure/hospitalization.

Characteristics	Anterior (n = 98)	Posterior (n = 69)	P value
Anesthesia			
General	47 (48%)	60 (87%)	
Regional	51 (52%)	9 (13%)	
Surgical time, min	94.8 ± 15	88.3 ± 17.6	.005
Length of stay, d	2.12	2.40	.0132
Discharge to			
Home	86 (87.8%)	49 (71%)	
Rehab	12 (12.2%)	20 (29%)	.012

based on surgeon preference. The AA was less expensive than the PA only when adjusting for such physician preference for the implant used, as well as for pharmacy needs. These results indicate that factors unrelated to immediate perioperative outcomes can significantly impact the procedure cost. In the absence of robust differences in perioperative outcomes, these costs are most prominent. To our knowledge, this is the first study to report cost outcomes associated with different approaches to THA.

The muscle-sparing nature of the AA THA theoretically offers the potential for a greater patient benefit in the immediate postoperative period. Several recent studies have reported decreased pain, increased mobility, and less use of assistive devices and pain medication with the AA in the early postoperative period [11-15]. Earlier discharge to home has also been reported [6-15]. Zawadzky et al. [12] suggested that these improvements in the early postoperative period could lead to decreased hospital costs through decreased utilization of services. Our results support this position, as reductions in OR time and routine RMDB can meaningfully reduce procedure costs.

Although many of the perioperative outcomes we report are consistent with recent literature comparing the AA to alternative transgluteal approaches, the differences we found were not as robust. Although statistically significant, AA THA patients were only discharged 0.28 days sooner than PA patients. Based on the LOS distribution, it is evident that the overwhelming majority of patients in both groups were being discharged on postoperative day 2. This contrasts with several studies that reported a decrease in LOS of at least 1 day with the AA compared to an alternative approach [11-14]. The small difference in LOS we obtained might be explained by the discharge disposition, as PA patients were more likely to be discharged to rehabilitation vs to home. However, the earlier discharge rates for patients undergoing each approach illustrate that benefits attributed to minimally invasive approaches might also be obtained in traditional transgluteal approaches. With technological advancements and refinements of prostheses, instrumentation, and techniques, this is becoming increasingly plausible.

Despite these minor differences in perioperative outcomes, the PA was \$580 more expensive per patient. In the context of this two-surgeon, 167-patient study, this amounts to a \$96,860 difference in cost for our institution over the 6-month period alone. However, categorical breakdown of direct costs shows that the increased expense in the PA when excluding OR supplies/implants and pharmacy was due to radiation oncology and other costs. Radiation oncology services were used for prophylaxis and/or treatment of

Table 3
Distribution of length of hospital stay by approach.

Days	2	3	≥4	Total	P value
Anterior	86	11	1	98	
Posterior	49	15	5	69	.0132

Table 4
Perioperative outcomes by surgical approach.

Outcome	Anterior	Posterior	P value
Blood loss, mL	452.6	267.5	<.0001
Transfusion, U PRBCs	0.52	0.47	.35
Transfusion needed	32 (33%)	19 (28%)	
Pain			
Post-op VAS score	5.74	5.3	.12
Discharge VAS score	2.24	3.16	.0065
Reduction in pain score	3.5	2.14	.0003
Complications			
Dislocation	1	0	
Infection	1	1	
Heterotopic ossification	0	1	
Post-op limb length discrepancy	0	1	
Total incidence	2 (2%)	3 (4%)	.64

Post-op, postoperative; PRBCs, packed red blood cells; VAS, visual analog scale.

heterotopic ossification. In our study, 9 PA patients required this treatment compared to 1 patient in the AA cohort. Heterotopic ossification is a frequent complication after THA, irrespective of approach, resulting from the displacement of osteoprogenitor cells during reaming and broaching processes [23]. However, the decision to use radiation prophylaxis might also vary based on surgeon preference similar to the choice of implant used. Nevertheless, radiation oncology services are a significant expense and were used more frequently with patients who underwent the PA. Therefore, further study is warranted to determine the clinical rationale for these services to truly illustrate the effects of this treatment on cost.

Routine RMBD is also a significant expense associated with THA. In our cohort, there was no difference in cost of routine RMBD between the 2 approaches, which is not surprising based on a similar mean LOS. The AA allowed patients to be discharged about a third of a day sooner compared to the PA. This difference in LOS is less demonstrable than what has been previously cited in the literature [11,12,14,15]. Nevertheless, its directionality is important to the finances of a medical institution, as the aggregate difference across numerous patients produces significant savings for hospitals. Furthermore, we report that a greater proportion of patients who underwent PA THA were discharged to a rehabilitation facility vs to home compared to AA patients. We did not report the additional cost of this rehabilitation, yet it represents a significant additional cost to the health care system at large. Therefore, it is likely that the overall difference in cost between the 2 approaches we report is an underestimation. Further follow-up analysis of the costs associated with rehabilitation from both surgical approaches is warranted.

OR time is another significant driver of cost associated with THA. AA patients spent only 7 minutes more in the OR than those patients undergoing the PA. Although this may be a small difference in OR time, it accounted for \$173 in excess cost per patient. Multiplied over 69 patients, it becomes clearer how cost reductions can occur through greater OR time efficiency.

Although recent literature supports minimally invasive approaches such as the AA to THA, uniform consensus has not been established. Several studies have suggested no significant

Table 5
Median cost outcomes per patient by surgical approach.

Approach	Direct cost	Indirect cost	Total cost	Total minus OR supplies/implants and pharmacy	Direct minus OR supplies/implants and pharmacy	P value
Anterior	\$13,342	\$6362	\$19,704	\$10,624	\$4262	
Posterior	\$12,340	\$5564	\$17,904	\$10,406	\$4842	
Difference	\$1002	\$798	\$1800	\$219	-\$580	.001

Table 6
Median direct cost outcomes per patient by cost category.

Cost category	Anterior (range)	Posterior (range)	Difference (A–P)
Anesthesia	\$341 (\$299–\$716)	\$341 (\$291–\$605)	\$0
Blood bank	\$59 (\$38–\$1096)	\$59 (\$38–\$1918)	\$0
Imaging	\$200 (\$63–\$605)	\$63 (\$63–\$1945)	\$137
Laboratories	\$84 (\$84–\$556)	\$91 (\$84–\$552)	–\$7
OR supplies/ implants	\$8801 (\$7202–\$17,983)	\$7308 (\$7202–\$12,001)	\$1493
OR time	\$1569 (\$898–\$1726)	\$1397 (\$898–\$2023)	\$173
Other	\$3 (\$3–\$950)	\$328 (\$273–\$383)	–\$325
PACU	\$243 (\$71–\$2416)	\$310 (\$71–\$793)	–\$67
PACU supplies	\$1 (\$1–\$52)	\$1 (\$1–\$104)	\$0
Pharmacy	\$279 (\$119–\$5097)	\$191 (\$69–\$1410)	\$88
PT/OT	\$235 (\$157–\$518)	\$272 (\$131–\$681)	–\$37
Radiation oncology	\$575 ^a	\$1029 (\$575–\$1079) ^a	–\$454
Respiratory	\$36 (\$18–\$386)	\$36 (\$17–\$507)	\$0
Routine RMDB	\$916 (\$916–\$6276)	\$916 (\$916–\$3483)	\$0

A–P, anterior minus posterior; PACU, postanesthesia care unit; PT/OT, physical therapy/occupational therapy.

^a Only 1 anterior approach patient used radiation oncology compared to 9 posterior approach patients.

difference in early outcomes, whereas others cited increased complication rates, increased blood loss and surgical time, and a steep learning curve causing poorer outcomes during the training period [7,8,12,24,25]. It should be noted that influence of both demographic disparities and learning curve issues were minimized in our study, as patient demographics were found to be similar between the 2 groups and both contributing surgeons had significant prior experience in THA using their respective approaches. Studies have also reported conflicting results regarding the efficacy of the AA in minimizing soft tissue damage [16,18]. In addition, Christensen et al. [26] have reported a higher incidence of acute wound complications that required reoperation in patients who underwent AA THA compared to the PA. In the absence of uniform agreement in the literature regarding the clinical efficacy associated with either approach, any differences in cost-effectiveness could play a significant role in guiding treatment.

Cost is a relevant consideration for institutions and surgeons in current health care practice. Financial consideration in THA is of particular interest given current and projected increases in demand for this procedure [19,20]. Moreover, recent interest in alternative and minimally invasive approaches has the potential to stimulate demand. Woolson et al. [7] described a substantial increase in procedure volume after the marketing of the AA as minimally invasive. Martin et al. [14] discussed the potential for cost discrepancy between approaches to THA based on differences in OR time, length of hospital stay, and routine inpatient accommodations. Our results demonstrate no substantial differences in cost related to these perioperative factors.

Institutions must also consider significant upfront costs in specialty equipment, training, and the learning curve that are associated with an alternative approach. These upfront costs might be offset by potential future reductions in medical services needed. Treatment options that offer superior or equivalent clinical outcomes while using fewer medical resources at a subsequently lower cost would be strongly considered by both orthopaedic surgeons and administrators alike. Our findings support greater savings with the AA only when controlling for implant and pharmacy costs. We acknowledge that greater cost differences might be found at institutions where there is a larger discrepancy in perioperative outcomes between the AA and the PA.

One important caveat is that significant geographic diversity exists across the United States with respect to medical costs.

Therefore, the magnitude of cost difference reported here might not be comparable to that at another institution. Nevertheless, similar trends might be extrapolated from the results we have provided. We showed that other costs not associated with routine inpatient care, OR time, or implants did significantly affect costs. Thus, further study is warranted to examine whether costs accrued as a byproduct of the surgical procedure, from the early post-operative recovery experience (ie, pain management), or from variability in physician preference could account for cost differences.

Our study has several limitations. Notably, it was a retrospective 2-surgeon study. Therefore, we could not ensure identical perioperative medication protocols and implants used. As a result, we also report cost corrected for OR supplies/implants and pharmacy. Although pharmacy costs were not expensive, OR supplies/implants were by far the greatest cost driver associated with the procedure and, when not excluded, changed the direction and magnitude of the cost difference. There is substantial variability in cost for different types of implants used for primary THA, with a difference of more than \$1500 between most and least expensive constructs [27]. Therefore, cost-efficiency with respect to implant selection can significantly reduce operative costs. Radiation oncology services, in the form of radiation prophylaxis for heterotopic ossification, represent another cost that might demonstrate interprovider variation. Subsequent study with standardization in these areas might yield meaningful results. Furthermore, Pour et al. [28] showed that numerous factors other than the surgical approach, such as patient preconditioning, preemptive analgesia, and rehabilitation protocol, significantly impacted the outcome of THA. Therefore, controlling for these parameters might also be pertinent in subsequent study.

In addition, our study examined perioperative outcomes only up to discharge from the hospital. Therefore, the potential exists for more long-term outcomes, and subsequent costs, to change whether patients experienced any other complications (ie, dislocation, loosening, and so forth). Any rehospitalization that may have occurred secondary to the THA and/or any surgical revision required would invariably significantly increase health care costs. This warrants further follow-up.

In summary, we reported minor differences in perioperative outcomes between the AA and PA THAs within the hospital admission, including increased OR time and greater blood loss with the AA despite its decreased LOS. These differences in clinical outcomes do not explain the difference in cost between the approaches, whereas differences in OR supplies/implant and radiation oncology costs do. The PA was only more expensive than the AA after excluding OR supplies/implant and pharmacy costs, and if radiation oncology costs were also excluded, the cost difference would be negligible. This illustrates the existence of inherent differences in medical service utilization between the 2 approaches that merits further study. Furthermore, because more patients who underwent PA THA were discharged to rehabilitation, we are likely underestimating the overall cost of immediate recovery, as additional rehabilitation costs are deferred to the rehabilitation facility. Therefore, even if differences in cost between approaches were equivocal in the acute perioperative period, the AA is favorable as it likely generates a lesser financial burden to the health care system.

Overall, surgeon preference and experience tend to dictate the surgical approach used. However, with intense cost pressures faced by hospitals and surgeons in the current health care market, it may be prudent to consider cost-efficiency with any procedure. At institutions considering the use of alternative approaches to THA, clinical indications should be assessed in relation to the feasibility of investment in training, equipment, and services necessary for the

approach. Further research is necessary to elaborate on prospective cost differences associated with recovery in the long term.

Conclusions

Financial consideration in THA is of interest given current and projected increases in demand for this procedure. Major cost drivers for this procedure include OR supplies/implants, OR time, and RMBD. When comparing anterior vs posterior surgical approach THAs, there were minimal differences in acute perioperative clinical outcomes, including LOS, which marginally impacted the difference in cost between the approaches. A cost differential was present largely as a result of physician preference for supplies/implant and ancillary interventions, such as heterotopic ossification prophylaxis. However, patients who underwent PA THA were more likely to be discharged to rehabilitation vs to home. Thus, when consideration is given to the total cost of the procedure and the recovery period, we are likely underestimating the overall cost difference between these approaches. Further study is warranted to assess these prospective total cost differences.

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