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Original Research

Thirty-Day Outcomes After Bilateral Total Hip Arthroplasty in a Nationwide Cohort

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ABSTRACT

Background: Approximately 42% of patients with end-stage osteoarthritis have bilateral disease. Although bilateral total hip arthroplasty (THA) is physiologically demanding, certain patients may benefit from simultaneous rather than staged bilateral procedures. This study examines the intraoperative differences and 30-day outcomes in patients receiving bilateral THA compared with those who underwent unilateral THA.

Methods: Patients undergoing THA were selected from the National Surgical Quality Improvement Program database from 2008 to 2015. Patients were selected according to those with primary and concurrent coding for Current Procedural Terminology 27130. Thirty-day complications were recorded, and multivariate analyses were performed to determine whether concurrent THA was a risk factor for poor outcomes.

Results: A total of 97,804 patients and 587 patients who underwent unilateral and bilateral THA, respectively, were identified. Patients who underwent bilateral procedures were younger (57.3 vs 64.6 years, $P < .001$), were of lower body mass index (29.2 vs 30.2, $P < .001$), and had fewer comorbidities than patients who underwent unilateral procedures. Length of stay was not increased for bilateral recipients (3.13 vs 2.93 days, $P = .308$), although fewer were discharged to home (62.8% vs 77.6%, $P < .001$). The bilateral recipients required postoperative transfusions at a higher rate (29.8% vs 10.9%, $P < .001$) and had an increased incidence of deep wound infections on univariate analysis (1.2% vs 0.3%, $P = .002$). There was no increased risk of superficial infection, medical complications, or thromboembolic events for the bilateral cohort.

Conclusions: Although bilateral THA recipients are younger with fewer preoperative comorbidities, bilateral THA is associated with an increased rate of transfusion in a nationwide setting. With this knowledge, specific interventions should be instituted to target these procedure-specific risks.

Introduction

Severe hip pain and arthritis in the elderly of European ancestry is most commonly caused by primary osteoarthritis, with a prevalence of 3.1%. In affected people, bilateral disease occurs in 42%. Less common causes of hip disorders including osteonecrosis, rheumatoid arthritis, slipped capital femoral epiphysis, and developmental dysplasia of the hip also often affect both hips [1-4]. Total hip arthroplasty (THA) is a proven and reliable treatment for end-stage hip disease and one of the most successful procedures in orthopaedics as it provides predictable high patient satisfaction, improved function, and relief of pain [5,6]. Between 16% and 35% of patients undergoing THA will receive a contralateral THA within 1 year of the initial hip replacement [7]. In one study, radiographic evidence of contralateral arthritis was found in 82.1% of patients

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scheduled for unilateral THA [8]. Despite the prevalence of bilateral disease, only 0.9%-1.1% of all THAs are performed as simultaneous bilateral THAs [2,9].

Jaffe and Charnley reported the first simultaneous bilateral THA in 1971 [10]. Since that time, there has been significant debate regarding the safety and outcomes of simultaneous bilateral THA. Concerns about the perioperative safety of bilateral THA center on increased blood loss, increased need for blood transfusion, and increased rates of infection, thrombosis, and pulmonary embolism compared with unilateral THA [11,12]. However, several recent studies have demonstrated no significant difference in complication rates, improved cost-effectiveness, and improved outcomes. Cost-effectiveness models have found decreased total operative time, increased cost savings, and decreased length of stay (LOS) of bilateral THA when compared with staged THA [9,13].

Many studies on bilateral THA are limited by small sample size [6,14,15]. However, registry data from New Zealand demonstrated improved outcomes at 6 months for patients undergoing simultaneous bilateral THA with no increased complications compared with unilateral or staged THA [16]. The National Surgical Quality Improvement Program (NSQIP) database is a validated, risk-adjusted, outcomes-based program meant to measure and improve the quality of surgical care especially within the early postoperative period. The purpose of this study is to examine the intraoperative differences and 30-day outcomes in patients who received bilateral THAs in the same intraoperative setting compared with those who only underwent unilateral THA using data obtained from the NSQIP database.

Material and methods

Data source

Patients participating in the American College of Surgeons (ACS) NSQIP were examined. The structure of the ACS NSQIP has been described previously [17,18]. In short, the program prospectively collects detailed data regarding patient demographics, preoperative comorbidities, laboratory values, and specific operative variables. Patients are then followed up for 30 days after the index operation, and postoperative complications are collected regardless of whether the patient is an inpatient, has been discharged to their home or other facility, or has been readmitted to another hospital. Data are abstracted at each site by surgical certified reviewers using clinical records, using physician charts, and by contacting patients directly. Surgical certified reviewers are intensively trained with continuing education courses to standardize data collection. Data definitions are rigorous and standardized across all participating institutions. Data consistency and reliability are assessed at each hospital through an on-site inter-rater reliability audit program [19].

Patient selection and exclusion

Patients who underwent primary THA were identified using Current Procedural Terminology (CPT) codes from January 1, 2008, to December 31, 2015 (CPT 27130, arthroplasty, acetabular and proximal femoral prosthetic replacement (THA), with or without autograft or allograft). Patients who underwent same-day bilateral THA were identified by concurrent procedural coding with the same CPT (27130). Patients were excluded according to International Classification of Diseases, Ninth Revision coding with a history of infection, fracture, or neoplasm as the indication for surgery. All cases with incomplete diagnoses were excluded from this analysis.

Preoperative variables

Preoperative demographics, comorbidities, and 30-day complications were compared between the 2 data sets. Demographics included age, gender, height, weight, and body mass index (BMI). Comorbidities included history of myocardial infarction, current smoker, diabetes mellitus, history of severe chronic obstructive pulmonary disease, congestive heart failure, dialysis, ascites, preoperative acute renal failure, preoperative transfusions, anesthesia type, disseminated cancer, chronic steroid use, >10% weight loss 6 months before surgery, bleeding disorders, hypertension requiring antihypertensive medications, and American Society of Anesthesiologists physical status classification.

Outcomes

Postoperative variables included operative time, hospital LOS, and 30-day reoperation and readmission rates. Postoperative complications encompassed death, deep venous thrombosis, pulmonary embolism, cerebrovascular accident, myocardial infarction, surgical site infections, and postoperative transfusion involving bleeding that required at least 1 unit of transfusion. All variables were used as defined in the ACS NSQIP user guide [20].

Statistical methods

SPSS Statistics, version 22 (IBM, Armonk, NY) was used to perform all analyses in this study. In all cases, a P value of 0.05 was deemed statistically significant. The univariate analysis with Fisher's exact test was used to compare categorical preoperative variables. The independent-samples t test assuming equal variances was used to compare continuous operative details between the 2 procedures. To demonstrate whether bilateral THAs were independently associated with higher risk of complications, multivariate regression analyses were performed.

Candidate preoperative variables for each regression were screened from those with $P < .2$ and at least 5 incidences in each of the cohorts from our previous univariate analysis [21].

Results

A total of 97,804 patients and 587 patients who underwent unilateral and bilateral THA, respectively, were identified. Patient baseline demographics, medical comorbidities, and perioperative characteristics are reported in Table 1. Patients who underwent bilateral procedures were on average younger (57.3 vs 64.6 years, $P < .001$), were of lower BMI (29.2 vs 30.2, $P < .001$), were more likely to be non-Caucasian (14.7% vs 9.1%, $P < .001$), and had fewer comorbidities than patients who underwent unilateral procedures. Specifically, patients undergoing bilateral THA were less likely to be American Society of Anesthesiologists class ≥ 3 (29.3 vs 41.1, $P < .001$) and less likely to have diabetes mellitus (5.5 vs 11.6, $P < .001$) or hypertension requiring medication (39.9 vs 56.7, $P < .001$).

Operative time was expectedly longer for bilateral THA than for unilateral THA (161.4 vs 93.3 minutes, $P < .001$), and patients were more likely to receive general anesthesia in the bilateral group (67.1 vs 53.7, $P < .001$). Length of hospital stay was increased, although not statistically significantly, among patients receiving bilateral THA (3.13 vs 2.93 days, $P = .308$). Fewer patients receiving bilateral THA were discharged to home than those who underwent unilateral THA (62.8% vs 77.6%, $P < .001$). Postoperative complications are compared in Table 2. For the bilateral cohort, there was no increased risk of superficial infection, deep venous thrombosis, pneumonia, renal insufficiency, urinary tract infection, cardiac arrest, myocardial infarction, unplanned readmission, reoperation, or

Table 1
Characteristics of 98,391 patients undergoing primary total hip arthroplasty.

Patient characteristics	Unilateral THA (97,804)	Bilateral THA[a] (587)	*P*-value[b]
	n (%)	n (%)	
Female	53579 (54.7)	294 (50.1)	$P = .024$
Non-Caucasian	8887 (9.1)	86 (14.7)	$P < .001$
Age (mean, yrs)	64.6	57.3	$P < .001$
BMI (mean)	30.2	29.2	$P < .001$
Current smoker	12955 (13.2)	88 (15.0)	$P = .221$
Diabetes melllitus	11354 (11.6)	32 (5.5)	$P < .001$
Hypertension requiring medications	55433 (56.7)	234 (39.9)	$P < .001$
Recent history of ≥10% weight loss	222 (22.7)	2 (0.3)	$P = .386$
Recent congestive heart failure exacerbation	290 (0.3)	1 (0.2)	$P = 1.000$
History of chronic obstructive pulmonary disease	3872 (4.0)	12 (2.0)	$P = .018$
Ascites	22 (0.02)	0 (0.0)	$P = 1.000$
Current or recent malignancy	242 (0.2)	0 (0.0)	$P = .411$
Dialysis	220 (0.2)	1 (0.2)	$P = 1.000$
Recent episode of acute renal failure	47 (0.05)	0 (0.0)	$P = 1.000$
Chronic steroid use	3531 (3.6)	31 (5.3)	$P = .030$
Bleeding disorder	625 (0.6)	1 (0.2)	$P = .195$
Preoperative transfusion ≥1 unit pRBC	142 (0.1)	0 (0.0)	$P = 1.000$
ASA class ≥3	40,184 (41.1)	172 (29.3)	$P < .001$
General anesthesia	52608 (53.7)	394 (67.1)	$P < .001$
Charlson Comorbidity Index (mean)	2.15	1.47	$P < .001$

ASA, American Society of Anesthesiologists; pRBC, packed red blood cells.
[a] Simultaneous or consecutive during the same intraoperative setting not specified.
[b] The chi-squared test unless otherwise noted.

death. However, the bilateral recipient cohort had an increased incidence rate of deep wound infections (1.2% vs 0.3%, $P = .002$). The increased rate of deep wound infections was not found to be significant on the multivariate analysis. The bilateral cohort required postoperative transfusions at a significantly higher rate (29.8% vs 10.9%, $P < .001$). These findings were significant on univariate and multivariate analyses and can be found in Table 3.

Discussion

The NSQIP is a representative national database that provides detailed information on 30-day admissions. We sought to identify the preoperative differences and 30-day outcomes in patients who received bilateral THAs in the same intraoperative setting compared with those who only underwent unilateral THA. Comparing 587 patients who underwent bilateral THA with 97,804 patients who underwent unilateral THA, we identified that patients who underwent bilateral procedures were on average younger, were of lower BMI, were less likely to have diabetes, take medications for hypertension, and had fewer comorbidities than patients who underwent unilateral THA. Given the physiologic demands of bilateral THA, this finding is not unique to our cohort as a number of studies have found patients undergoing simultaneous bilateral THA to be younger with fewer comorbidities than patients who underwent unilateral or staged bilateral THA [2,9,22-24]. Patients who undergo bilateral THA are more carefully selected because of the physiologic demands of bilateral THA, and elderly patients with significant comorbidities such as pulmonary insufficiency, cardiac disease, and diabetes are generally not candidates, nor are patients with fat emboli syndrome, pulmonary embolus,

Table 2
Postoperative complication rates by the procedure type.

Perioperative metrics	Unilateral THA (n = 97,804)	Bilateral THA[a] (n = 587)	*P*-value[b]
Perioperative metrics			
Operation time (min)	93.3	161.4	$P < .001$
Length of hospital stay (days)	2.93	3.13	$P = .308$
Discharge destination other than home	21,904 (22.4)	221 (37.6)	$P < .001$
Unplanned readmission (%)	3268 (3.3)	18 (3.1)	$P = .805$
Unplanned reoperation (%)	1957 (2.0)	14 (2.4)	.460
Death (%)	131 (0.1)	0 (0.0)	$P = 1.000$
Deep venous thrombosis (%)	393 (0.4)	0 (0.0)	$P = .183$
Pneumonia (%)	328 (0.3)	3 (0.5)	$P = .454$
Pulmonary embolism (%)	260 (0.3)	1 (0.2)	$P = 1.000$
Renal insufficiency (%)	103 (0.1)	0 (0.0)	$P = 1.000$
Urinary tract infection	1017 (1.0)	7 (1.2)	$P = .680$
Cerebrovascular accident (%)	89 (0.1)	1 (0.2)	$P = .417$
Cardiac arrest (%)	68 (0.1)	0 (0.0)	$P = 1.000$
Myocardial infarction (%)	229 (0.2)	1 (0.2)	$P = 1.000$
Bleeding requiring transfusion (%)	10,682 (10.9)	175 (29.8)	$P < .001$
Superficial surgical site infection (%)	674 (0.7)	6 (1.0)	$P = .309$
Deep surgical site infection (%)	290 (0.3)	7 (1.2)	$P = .002$
Wound disruption (%)	108 (0.1)	2 (0.3)	$P = .140$

[a] Simultaneous or consecutive during the same intraoperative setting not specified.
[b] Calculated using Fisher's exact test for categorical variables and independent samples t-test for continuous variables.

Table 3
Risk-adjusted odds ratios of 30-day adverse events among patients receiving total hip arthroplasty.

Adverse events	Bilateral THA (OR)	*P* value[a]	95% CI
Deep wound infection	0.920	.870	0.339-2.494
Deep vein thrombosis	1.008	.954	0.778-1.305
Postoperative transfusion	2.439	<.001	1.989-2.991

CI, confidence interval; OR, odds ratio.
[a] Calculated using binary logistic regression multivariate analysis; controlled for preoperative demographics and medical comorbidities.

adult respiratory distress syndrome, myocardial infarction, patent ductus arteriosus, or septal defect ideal candidates for bilateral single-staged THA [1]. Macaulay et al recommend the surgeon, anesthesiologist, and medical consultant must be in agreement that the patient is healthy enough to undergo the operation [1].

In this nationwide cohort of patients undergoing bilateral THA, there was no increased risk of superficial infection, deep venous thrombosis, pneumonia, renal insufficiency, urinary tract infection, cardiac arrest, myocardial infarction, or death. This is largely supported with several studies finding that compared with staged and unilateral THA, bilateral THA does not increase risk of systemic complications [2,6,23,24]. Although literature from the 1970s and 1980s reports increased rates of complications, especially pulmonary embolism [25], systematic review including 5868 simultaneous bilateral THAs by Babis et al found no difference in the incidence of venous thromboembolism between simultaneous bilateral THA and unilateral THA [26]. Shao et al compared simultaneous bilateral THA with two-staged bilateral THA and found no differences in developing PE. In their study, patients undergoing simultaneous bilateral THA were less likely to develop deep venous thrombosis compared with those undergoing 2-stage bilateral THA. Shao et al. proposed the increased risk of deep venous thrombosis in patients undergoing staged THA is a result of the risk at the time of each operation as the two-stage bilateral group underwent 2 separate procedural events, whereas the simultaneous bilateral group underwent a single procedural event. Shao et al. also referenced the potential limited rehabilitation of the staged group secondary to pain in the contralateral hip [6]. Beksac found a low rate of thromboembolic events in a multimodal prophylaxis protocol including chemoprophylaxis with aspirin or warfarin [27]. Modern preoperative optimization, early postoperative mobilization, and advances in venous thromboembolism prophylaxis likely account for the diminished number of thromboembolic events seen in our data.

Despite the favorable preoperative characteristics of patients undergoing bilateral THA and no increased risk of major systemic complications, bilateral THA is associated with a higher rate of postoperative transfusions than unilateral THA. This finding has been observed in multiple previous studies [7,22,24,28,29]. Allogenic blood transfusion is an independent risk factor for infection after THA [30-33]. In a study of bilateral THA, patients receiving allogenic blood transfusion had 166% higher odds of prosthetic joint infection (PJI) than those not transfused with allogenic blood [22]. The increased rate of allogenic transfusion did not affect early infection rates in our study, but further study of long-term infection rates may be necessary. The association of increased risk of PJI with allogenic transfusion emphasizes the importance of meticulous hemostasis, regional anesthesia, and perioperative tranexamic acid in patients who underwent bilateral THA, which may reduce the need for allogenic blood transfusion in patients receiving bilateral THA [29]. To investigate whether these trends impacted the number of transfusions given to the patient receiving bilateral THA, we analyzed our data trends from 2010 to 2015. We found a steady, significant decrease in the proportion of patients in the bilateral THA cohort requiring allogenic transfusions over the study period, Table 4. The decrease in allogenic transfusions seen in these data is likely due to the widespread adoption of hemostatic measures, including tranexamic acid and regional anesthesia, with regulation of transfusion indications over the study period.

Table 4
Transfusion in bilateral THA by the year.

Year of admission	Transfusion	Total number of patients	Percentage of patients receiving transfusion
2010	11	23	47.83%
2011	22	44	50.00%
2012	35	75	46.67%
2013	35	109	32.11%
2014	48	170	28.24%
2015	30	189	15.87%
Total	181	610	

R value: 0.248 $P < .001$.

There was a significantly increased incidence of deep wound infections in patients undergoing bilateral THA compared with those undergoing unilateral THA during univariate analysis, but no significant difference under multivariate analysis. There was no associated increased incidence in superficial wound infection. Recent meta-analysis was unable to separate superficial from deep infection, but also found increased incidence of infection in patients who underwent bilateral same-day THA compared with those who underwent staged THA [6]. Others have not found increased risk of wound infection in bilateral THA [2,16,22].

The increase in early PJI in bilateral THA on univariate analysis is not well understood. Although common sense may suggest that the longer an operative field and instruments are exposed to air, the higher the likelihood of potential contamination or break in sterility, this has not been shown to have any clinical significance in relation to increased infection risk after bilateral THA. In particular, a single institution compared the use of a second set of sterile instruments for the second side vs the same set of instruments used sequentially with no increase in infection rates and no increased risk of surgery in the second side performed [34]. Although a continued point of contention, there are data to suggest the anterior approach is associated with a higher infection rate [35,36]. Many same-day bilateral THAs are performed through an anterior approach [37-39]. The increase in early PJI seen on univariate analysis may be a result of the increased use of anterior approach in this population. Parvizi et al found a low rate of infection in bilateral THA performed supine through an anterolateral approach [15], while Berend et al had an increased rate of infection and wound complications in their patients undergoing bilateral THA (1.8%) compared with those undergoing unilateral THA and cited lateral positioning on the fresh postoperative wound may account for some of the wound complications [11]. Della Valle et al also performed their study in the lateral position with no increase in the infection rate and no increased rate in wound complications on the first operative side compared with the second [34]. The NSQIP database does not record the approach or laterality performed first. Given the current information, it is important for surgeons to undertake appropriate precautions and counseling of increased risk of infection in those undergoing bilateral THA as opposed to unilateral THA.

We found that hospital LOS for bilateral THA was not significantly different from unilateral recipients; however, bilateral total hip recipients were less likely to be discharged home. Poultsides et al found decreased LOS in patients undergoing simultaneous bilateral THA, with more patients being discharged to inpatient rehab than patients undergoing staged THA [24]. In our study, 30-day unplanned readmission rates did not differ between unilateral and bilateral THAs. Reviewing the California State Registry,

Stavrakis did not find a difference in readmissions when comparing bilateral and unilateral THAs [2]. Surgeons should not be discouraged in the bundled payment era from performing bilateral THAs because of concerns of patient LOS but should expect an increased number of patients to be discharged to a rehabilitation facility and to have a discharge plan in place preoperatively.

Limitations of this study stem from the retrospective nature of review of a national inpatient database. There are limitations inherent to the included data including the inability to assess variables of importance to arthroplasty surgeons such as surgical approach, which laterality was performed first, prosthesis used, functional outcome scores, early dislocation, and events beyond 30 days. Owing to the constraints of the NSQIP database, the cumulative risk of staged bilateral THAs vs same-day bilateral THAs is unable to be assessed by our study. Despite these limitations, the NSQIP database provides reliable, audited, high-quality information on preoperative and postoperative variables on a larger number of patients than single-institution studies have been able to generate. Morcos et al recently published a study investigating similar questions using the NSQIP database with a four-to-one matched cohort of patients undergoing unilateral THA and bilateral THA; similar to our findings, they found bilateral THA was associated with the use of general anesthesia, postoperative transfusions, and discharge to a rehabilitation facility [7]. Our study demonstrated that while transfusions were higher in the bilateral cohort, there was no increase in infection on multivariate analysis, and longer term follow-up is needed. Furthermore, despite our large cohort, through the NSQIP database, we may be underpowered in the bilateral group to detect differences in rare outcomes.

Conclusions

Although bilateral total hip recipients are younger and have less preoperative comorbidities, bilateral THAs are associated with an increased rate of transfusion in a nationwide setting. There is an increased rate of deep infection on univariate analysis but not with multivariate analysis. With this knowledge, specific interventions should be instituted to target these procedure-specific risks.

Conflict of interest

The authors declare there are no conflicts of interest.

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