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The Direct Anterior Approach for 1-Stage Bilateral Total Hip Arthroplasty: Early Outcome Analysis of a Single-Surgeon Case Series

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A B S T R A C T

Background: One-stage bilateral total hip arthroplasty (B-THA) is rarely performed despite a 20% incidence of bilateral degenerative hip disease requiring surgical intervention.
Methods: We retrospectively evaluated functional outcomes in 22 consecutive patients undergoing B-THA with a matched cohort undergoing unilateral THA by the same surgeon using the direct anterior approach.
Results: Although there was a significant difference in blood loss ($P < .01$) and surgical time ($P < .001$), there was no difference in length of hospital stay ($P = .09$), number of discharges to a rehabilitation facility ($P = .22$), or postoperative Harris Hip scores ($P = .75$).
Conclusions: Advances in blood loss and pain management protocols in association with the direct anterior approach should renew interest in the efficacy of 1-stage B-THA.

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Total hip arthroplasty (THA) has become 1 of the most successful orthopedic operations today for patients with chronic hip pain secondary to degenerative joint disease. It has been estimated that 15% to 25% of patients being considered for THA ultimately require bilateral procedures [1,2]. In patients with bilateral hip disease, optimal function is not entirely regained until both hips have been replaced [3].

The ideal timing of surgery in patients requiring bilateral THA remains a subject of discussion. The potential advantages of a 1-stage B-THA vs a 2-stage procedure include a shorter hospital stay [4,5], single anesthetic, lower hospital cost, and a potential earlier return to functionality. Critics of the simultaneous procedure have cited increased risks of venous thromboembolic events (VTEs), heterotopic ossification, higher blood transfusion requirements, and increased need for secondary rehabilitation facilities [2,6-11].

The surgical procedure for THA has undergone an evolution because it was initially introduced. A variety of surgical approaches to the hip have been described, most of which are performed through a posterolateral, direct lateral, or direct anterior approach (DAA). The DAA is advantageous in bilateral THA (B-THA) due to the inherent positioning difficulties and surgical site compromise in the lateral technique as well as avoidance of postoperative hip precautions. It has also been suggested that the DAA for THA reduces pain levels and improves early return of function [12-16].

There is little literature reviewing the use of DAA in B-THA. Two articles have described low and acceptable complication rates [17,18]; however, they do not include a comparison group, they do not evaluate functional outcome measures, and they do not use contemporary blood and pain management protocols. The purpose of this study was to retrospectively compare functional outcomes in patients undergoing B-THA vs unilateral THA (U-THA) using the DAA performed by a single surgeon.

Materials and Methods

After institutional review board approval, a retrospective review of inpatient medical records and preoperative and postoperative outpatient clinical charts was undertaken. Beginning in 2013, 22 consecutive patients who underwent 1-stage B-THA over a 20-month period were matched to 22 consecutive U-THA performed in the same period. Overall, the senior surgeon performed more than 200 elective primary THAs, using DAA in 95.1% of cases, and 10.1% were B-THA. Patients were considered candidates for DAA B-THA if they had degenerative joint disease of the hips that was clinically and radiographically symmetric and if the surgeon felt that patient would benefit from a simultaneous THA

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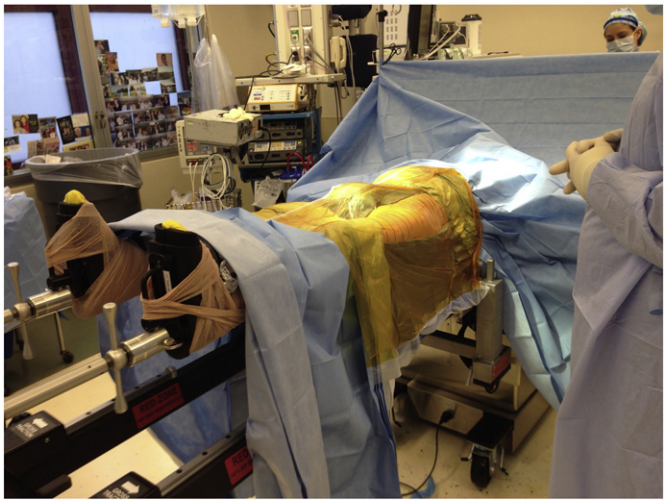

Fig. 1. Surgical positioning for 1-stage bilateral THA.

procedure given their pain and disability. Exclusion criteria for B-THA included older than 80 years, history of stroke, VTE, congestive heart failure, pulmonary hypertension, end-stage renal disease, or preoperative anemia.

The senior surgeon performed surgery on all patients using a uniform surgical technique and postoperative protocol. All surgeries were performed via the DAA using a Hana Table (Mizuho OSI) for positioning (Fig. 1). All patients received a standard titanium acetabular shell (Pinnacle; Depuy, Warsaw, IN); a highly cross-linked polyethylene liner (AltrX; Depuy); a press-fit, hydroxyapatite-coated, titanium femoral stem (Corail; Depuy); and a ceramic femoral head (Biolox; Ceramtec AG, Lauf, Germany). For B-THA, the first procedure was performed on the more symptomatic side, and after completion and closure of the wound, THA was performed on the contralateral hip.

Blood management protocols were the same for all patients, which consisted of giving 1 g of tranexamic acid (TXA) before incision and 1 g at closure, unless contraindicated. For patients undergoing B-THA, 1 g of TXA was administered before incision on each hip. No patient donated autologous blood or was given preoperative erythropoietin. Intraoperative red blood cell salvage was not used. A standard fluid management protocol was followed for all patients during and after surgery. Intravenous fluids were continued at a rate of 75 to 100 mL/h for 24 hours postoperatively and then variably discontinued depending on the level of oral intake.

A multimodal pain management protocol, both during and after surgery, was administered to all patients. A multimodal periarticular injection consisting of bupivacaine liposomal injectable suspension (Exparel; Pacira, La Jolla, CA), epinephrine, morphine, depomedrol, and cefazolin in 20-mL normal saline was given after implantation of components. Perioperatively, patients received 3 doses of intravenous acetaminophen (Ofirmev; Mallinckrodt, St. Louis, MO) and 2 doses of intravenous dexamethasone. The periarticular and intravenous steroid were held in patients with diabetes, which affected 2 B-THA patients and no U-THA patients. The postoperative pain protocol consisted of celecoxib, oxycodone hydrochloride extended-release (for 7 days only), and oxycodone for breakthrough pain. In addition, patients received 1 dose each of celecoxib, oxycodone hydrochloride extended-release, and gabapentin preoperatively the morning of surgery.

Patients were allowed to bear full weight immediately after surgery and were hospitalized for medical management, perioperative antibiotics for 24 hours, pain control, and physical therapy. Patients undergoing B-THA were started on 10 mg daily of rivaroxaban for a total of 30 days postoperatively as venous thromboembolism prophylaxis, whereas patients having U-THA were started on 325 mg of enteric-coated aspirin twice daily for 30 days.

The demographic information collected included age, sex, body mass index (BMI) (kilograms per square meter), reason for undergoing hip arthroplasty, comorbidities, preoperative Harris Hip Score (HHS), and the preoperative America Society of Anesthesia (ASA) physical classification system.

Postoperatively, patients were seen in the office at 3 weeks, 3 months, and then once a year after their surgery. All patients in this cohort were followed up for a minimum of 6 months, and the average follow-up time of the current study was 12.9 months. Primary outcome measures included length of hospital stay, discharge to home vs rehabilitation facility, need for a walking aid at 3 weeks postoperatively, and HHS at 3-month follow-up. Thromboembolic events and other complications in the 90-day postoperative period were recorded. In addition, blood loss during surgery, surgical time, and intraoperative complications were noted. The number of inhospital transfusions was collected. The decision to transfuse was based on threshold hemoglobin less than 7.0 g/dL or hypovolemic signs and symptoms unresponsive to fluid resuscitation.

Data for the B-THA and the U-THA group were analyzed using R software (R-project.org) for statistical analysis. Demographic and outcome measures were compared between the 2 groups using *t* tests for continuous outcome measures and χ^2 test for the binary outcome measures. In addition, multiple logistic linear regression analysis was performed to examine outcome differences between groups by controlling for other covariates, which represented the conditions of the surgery and patient demographics. Power analysis of outcome measures showed that, with the sample size of 22 for each of the 2 groups, there should be a 90% power to yield a statistically significant result, assuming a 2-sided error rate of 5%.

Results

The demographics for each cohort are listed in Table 1. The mean age for bilateral THA was 59 years old as compared with 65 years old for the unilateral ($P = .06$), which approached statistical significance but was not significant. Differences in other demographics, including BMI ($P = .27$), ASA ($P = .13$), preoperative HHS ($P = .16$), and sex ($P = 1.0$), were not significant, despite power analysis demonstrating an 86.4% power to detect a 0.5-point difference in ASA between groups. All patients carried a diagnosis of osteoarthritis, except for 1 B-THA patient with degenerative hip disease secondary to osteonecrosis.

The operative time was significantly longer for bilateral THA (mean, 180 vs 101 minutes; $P < .001$). In addition, intraoperative blood loss was significantly higher in the bilateral THA group (mean, 473 vs 201 mL; $P < .01$). The transfusion rate was higher in the bilateral group ($P = .04$). In the B-THA group, 5 (23%) of 22 patients received a transfusion, with an average of 1.4 units per patient. In the unilateral THA group, 1 (5%) of 22 patients received a transfusion, which was a single unit.

There was no difference in intraoperative complications, with 1 event occurring in each group. There was a calcar fracture in 1 of the bilateral patients treated with cerclage cable and allowed to weight bear immediately. In the unilateral THA group, 1 patient required return to operating room for removal of foreign body related to broken instrumentation that was identified on the postoperative x-ray. There were

Table 1
Patient Demographics.

	Bilateral Group	Unilateral Group	
	n = 22	n = 22	*P*
Sex			
Male/female	19/13	18/14	1.0
Age	58.6	65.2	.06
BMI	27.1	28.5	.27
ASA	2.0	2.3	.12
Preoperative HHS	44.7	48.9	.16

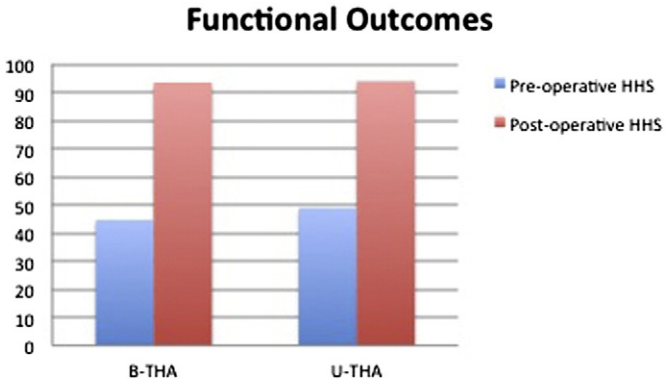

Fig. 2. Harris Hip Score in U-THA and B-THA.

no complications within the perioperative 90 days, and there were no VTE events in either group during this period.

Average length of hospital stay was slightly longer on average in the bilateral group, although it did not meet statistical significance (mean, 2.32 vs 1.95 days; $P = .08$). However, when controlling for covariates (including operative time, patient age, and intraoperative blood loss), our analysis indicates that difference in number of hospital days becomes significant ($P = .04$), and on average, hospital stay was 0.62 days longer for the bilateral THA group. A greater proportion of the unilateral THA group (16/22; 73%) went home as compared to the B-THA group (11/22; 50%); however, this difference was not significant ($P = .23$).

The preoperative HHS was similar between the B-THA and U-THA groups, mean, 44.7 and 48.9, respectively ($P = .16$). Postoperative HHS was nearly identical 3 months postoperatively between B-THA and U-THA groups (mean, 93.5 vs 94.0; $P = .75$). In addition, after applying linear regression models to the postoperative HHS outcome measure, there were no significant differences between the 2 groups despite controlling for covariates, including sex, preoperative HHS, operative time, patient age, and intraoperative blood loss ($P = .11$). Both groups demonstrated a significant improvement in scores after surgery ($P < .001$, Fig. 2).

At 3 weeks postoperatively, 16 (73%) of 22 of B-THA patients required a walking aid vs 14 (64%) of 22 of U-THA required a walking aid ($P = .75$). At 3 months postoperatively, 2 (9%) of 22 B-THA patients required a walking aid vs 1 (5%) of 22 unilateral THA.

Discussion

Many studies have investigated the efficacy and economic utility of bilateral total knee arthroplasty (B-TKA) [19-21], and although there is variability in the literature regarding the risk of complications, B-TKA has become a common procedure. However, few studies have investigated outcome measures in 1-stage bilateral THA [4,6,10,18]. The relatively high proportion of patients undergoing unilateral THA who ultimately require contralateral hip arthroplasty highlights the need to further evaluate a 1-stage procedure that uses contemporary pain and blood management protocols.

This study used TXA intraoperatively, which has been shown to reduce transfusions after THA [22]. Despite the use of TXA, the B-THA group experienced both a significantly greater blood loss and higher transfusion rate as compared to the U-THA group. The B-THA transfusion rate was 23% (5/22 patients) with an average of 1.4 units per patient, which is similar to those reported by Mast et al [18]. This increased transfusion risk in B-THA is also comparable to the increased incidence of transfusion cited for 1-stage B-TKA [19-21]. Intraoperative red blood cell salvage may be beneficial in B-THA cases to reduce this high rate of transfusion.

Although studies suggest a correlation between blood transfusion and the risk for infection and cardiac events, the limited sample size in this study prevents accurate risk assessment for B-THA. A larger cohort would certainly offer a more thorough evaluation of adverse events related to B-THA given the overall low incidence of events, such as prosthetic joint infection and VTE. Prior studies on B-THA, which used pooled data such as the Swedish Registry, have not shown a significant increased risk for adverse events in B-THA [2-11,17,18].

Table 2
Outcome Measures.

	Bilateral Group	Unilateral Group	
	n = 22	n = 22	*P*
Surgical time (min)	180	101	<**.001**[a]
Blood loss (mL)	473	200	<**.001**[a]
Transfusions (units)	7	1	**.04**[a]
Length of stay (d)	2.3	2.0	.09
Discharge home	11/22	16/22	.22
Walking aid 3 wk	16/22	14/22	.75
Postoperative HHS	93.5	94.0	.75

[a] Indicates statistically significant value.

Our study provides insight on the early functional outcome of B-THA by examining parameters in the early postoperative period separate from adverse events (Table 2). Although 10% of patients in the study by Mast et al [18] were initially admitted to the surgical intensive care unit after surgery, none of our B-THA patients required higher levels of hospital care. Moreover, the bilateral group was hospitalized less than a day longer than the control group, and only 2.32 days on average, which is less than the Medicare-appointed 3 days for a standard U-THA. Hospital stay was not significantly longer ($P = .09$), unless controlling for covariates ($P = .04$), which suggests that B-THA does not significantly alter postoperative recovery, despite increased surgical time and blood loss. Mast et al reported a 4-day average length of stay, which is more than 1.5 days longer than our findings, and Bhan et al [4] reported 10-day average stay, although their study reported on patients in India, which has unique postoperative protocols. The short average hospital stay and its equivalence to U-THA demonstrate that patients were medically stable with acceptable functional profiles for discharge at this early time point. In addition, there was no difference in the proportion of patients going home vs rehabilitation, with 50% of B-THA patients discharged home. The absence of increased rehabilitation placement shows an early functional similarity with U-THA, which contrasts with studies comparing B-TKA vs unilateral total knee arthroplasty [19] but mirrors the findings by Mast et al [18]. Patient placement is determined in part by the physical therapists' evaluation and, therefore, may be viewed as an independent evaluation of patients' functional recovery.

Validated functional outcome scores are another means of independent evaluation, and this study is the first to use this method to compare groups. The significant increase in HHS 3 months postoperatively (mean, 93.5; range, 78-100) shows the efficacy of B-THA in restoring function. There were no functional differences between the B-THA and U-THA groups ($P < .001$), and both demonstrated significant improvement from preoperative scores ($P < .001$) (Fig. 1). Although 72% (16/22) of B-THA patients were using a walking aid at their 3-week visit, only 9% (2/22 patients) continued to require a walker or cane for ambulation at 3 months, and there was no statistical difference in use of walking aid between groups ($P = .75$). The results suggest that B-THA via the DAA has a similar functional outcome as U-THA, despite requiring more surgical time and resulting in greater intraoperative blood loss. The equivalent outcomes in length of hospital stay, discharge to home, use of walking aid, and postoperative HHS demonstrate that B-THA is a surgery that permits early medical and physical recovery.

The pain management protocol used for all patients is partly responsible for the high functional status of patients after this procedure. The combination of multiple modalities, including intravenous Tylenol [23], multimodal periarticular blocks [24,25], dexamethasone [26], and

postoperative oral analgesics [25], has all been demonstrated to effectively lower patient-reported pain scores after THA.

Although blood and pain management protocols likely influenced the favorable early outcomes, the DAA used for all THA in this study is believed to have the greatest impact on the reported outcomes. Recently, multiple studies have highlighted the benefit of DAA in regard to early function. Zawadsky et al [27] compared DAA with the posterior approach and demonstrated a significant decreased length of hospital stay, pain control requirements, and increased functional score. Rodriguez et al [28] similarly compared approaches and found a modest benefit in functional recovery at 2 weeks postoperatively. In addition, Matta et al [15,16] have found that the DAA allows for earlier return to function and a lower dislocation rate.

The DAA additionally facilitates the bilateral procedure. One of the impediments to B-THA is the traditional posterolateral surgical approach, which requires patients to be in a lateral decubitus position and thus undergo repositioning and risk for contamination and wound dehiscence. The DAA appears to effectively resolve the intraoperative logistical difficulty of positioning patients undergoing B-THA. Our average surgical times are less per hip in B-THA group than U-THA, demonstrating that prepping, positioning, and draping were not an issue with B-THA.

The primary limitation of this study is the small sample size. Prior studies have reported on the safety of B-THA based on hundreds of cases pooled from multiple surgeons and medical centers. Although this type of analysis enables assessment of adverse events, the inherent variability in perioperative medical protocols, surgical experience, and technique limit the ability to accurately evaluate postoperative function. In contrast, our series is uniquely positioned to report on early functional outcomes due to the uniformity of surgical technique and patient care. This series of consecutive cases over a short time course by a single surgeon using a standardized intraoperative and postoperative protocol minimizes many clinical variables. Although 22 patients per group is not a large cohort, power analysis demonstrates that it is sufficient to establish outcomes that can be adequately analyzed.

The risk of selection bias is an additional limitation of the study, whereby the experimental group (B-THA) had stricter exclusion criteria than the control group (U-THA). It is important to determine whether functional similarities between the 2 procedures were a result of the surgical technique and perioperative protocols, rather than inherent differences in the patient groups. The ASA represents a standardized measure to assess global health, and there was no significant difference between groups ($P = .14$) despite adequate power. Other patient demographics such as age and BMI were also statistically equal, although the B-THA cohort was 6 years younger on average and nearly approached statistical significance. Additional concern for selection bias may be suggested for all DAA cases, which is a procedure that is facilitated in patients with lower BMI. However, this surgeon uses the DAA for more than 95% of primary THA cases, and thus, patient characteristics do not significantly influence patient selection.

Overall, the results suggest that B-THA does not lead to significant delays in recovery or early function in 1-stage B-THA as compared to U-THA. This study highlights the utility of B-THA in the 10% to 15% of patients who show signs of bilateral disease. Long-term studies are needed to determine the safety of 1-stage B-THA and to evaluate prosthetic-related complications such as loosening and osteolysis. The 1-stage procedure not only benefits the patient but also the economic burden of providing health care to an aging population [2,18].

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