Single-Anesthetic Versus Staged Bilateral Total Hip Arthroplasty

A Matched Cohort Study

Matthew T. Houdek, MD, Cody C. Wyles, MD, Chad D. Watts, MD, Eric R. Wagner, MD, Rafael J. Sierra, MD, Robert T. Trousdale, MD, and Michael J. Taunton, MD

Investigation performed at the Mayo Clinic, Rochester, Minnesota

Background: There is debate regarding the role of single-anesthetic versus staged bilateral total hip arthroplasty (THA) for patients with end-stage bilateral osteoarthritis. Studies have shown that single-anesthetic bilateral THA is associated with systemic complications, but there are limited data comparing patient outcomes in a matched setting of bilateral THA.

Methods: We identified 94 patients (188 hips) who underwent single-anesthetic bilateral THA. Fifty-seven percent of the patients were male. Patients had a mean age of 52.2 years and body mass index of 27.1 kg/m^2. They were matched 1:1 on the basis of sex, age (±1 year), and year of surgery (±3 years) to a cohort of patients undergoing staged bilateral THA. In the staged group, there was <1 year between procedures (range, 5 days to 10 months). Mean follow-up was 4 years for each group.

Results: Patients in the single-anesthetic group experienced shorter total operating room time and length of stay. There was no difference (hazard ratio [HR] = 0.73, p = 0.50) in the overall revision-free survival in patients undergoing single-anesthetic or staged bilateral THA. The risks of reoperation (HR = 0.69, p = 0.40), complications (HR = 0.83, p = 0.48), and mortality (HR = 0.47, p = 0.10) were similar. Single-anesthetic bilateral THA reduced the total cost of care (by 27%, p = 0.0001).

Conclusions: In this matched cohort analysis, single-anesthetic bilateral THA was not associated with an increased risk of revision, reoperation, or postoperative complications, while decreasing cost. In our experience, single-anesthetic bilateral THA is a safe procedure that, for certain patients, offers an excellent means to deal with bilateral hip osteoarthritis.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

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Total hip arthroplasty (THA) is a reliable procedure for patients with osteoarthritis of the hip. However, as many as 97% of patients who present with bilateral osteoarthritis will ultimately require a contralateral THA after undergoing a unilateral procedure[1-6]. There has been some interest in performing single-anesthetic bilateral THA in select patients because of potentially improved rehabilitation, yet it accounts for <1% of all THA procedures[7-10], a finding likely related to a historically high perioperative complication profile[11,12].

In addition to improved functional and rehabilitation benefits, single-anesthetic bilateral THA subjects the patient to a single anesthetic exposure and is associated with a decreased total length of stay and subsequent cost savings related to the decreased length of stay[7,10-18]. These potential benefits have to be balanced against a slightly increased risk of systemic complications[7,10-18]. Currently there are insufficient data to determine if these systemic complications remain increased compared with matched patients who undergo staged arthroplasty. The purpose of this study was to compare the outcomes of matched patients undergoing either single-anesthetic or staged bilateral THA. Specifically, we aimed to evaluate (1) mortality and revision-free survival, (2) in-hospital and perioperative complications, (3) transfusion risk, (4) the cost of operating room time and hospital stay, and (5) discharge locations.

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TABLE I Patient, Hospital Stay, and Discharge Demographics of Patients Undergoing Bilateral THA

	Single-Anesthetic	Staged	P Value
Age* *(yr)*	52.2 ± 11.6	52.1 ± 11.8	0.94
BMI* *(kg/m²)*	27.1 ± 5.2	27.8 ± 4.4	0.11
Common diagnoses			
Osteoarthritis	152 (81%)	150 (80%)	0.89
Osteonecrosis	22 (12%)	26 (14%)	0.64
Rheumatoid arthritis	12 (6%)	8 (4%)	0.49
ASA score			
1	7 (7%)	7 (7%)	1.0
2	73 (78%)	75 (80%)	0.86
3	14 (15%)	12 (13%)	0.83
Surgical approach			
Anterolateral	20	54	0.0001
Posterior	148	120	0.002
Direct anterior	20	14	0.37
Femoral fixation			
Cemented	4	8	0.37
Uncemented	184	180	
Hospital admission demographics			
Total length of stay, mean (range) *(days)*	4.6 (2-17)	5.9 (4-13)	<0.0001
Total operating room time* *(min)*	176 ± 53	211 ± 72	0.0003
Total anesthesia time* *(min)*	255 ± 57	351 ± 75	<0.0001
Patients requiring blood transfusion	37 (39%)	32 (34%)	0.76
Total units RBC transfused, mean (range)†	2.0 (1-6)	1.9 (1-6)	0.70
Discharged to home, per procedure	76 (81%)	164 (87%)	0.21
Discharged to rehabilitation facility, per procedure	18 (19%)	24 (13%)	0.21

*The values are given as the mean and standard deviation. †RBC = red blood cells.

Materials and Methods

After obtaining approval from our institutional review board, we conducted a single-center, matched, retrospective cohort analysis using our institution's total joint registry. Over a 14-year period (2000 to 2013), 14,732 THAs were performed at our institution. Of these, 1,882 (13%) THAs (941 patients) were bilateral procedures, with 208 THAs (1.4%, 104 patients) performed under a single anesthetic. Ten patients (20 hips) were lost to follow-up prior to the 2-year clinical visit, leaving a cohort of 188 hips (94 patients).

All surgical procedures were performed by high-volume adult reconstruction subspecialty surgeons in accordance with their preferred surgical approach. Patients in the single-anesthetic group were more likely to undergo a posterior approach compared with the staged group (Table I). For patients undergoing an anterolateral or posterior approach, the first hip arthroplasty is completed, closure is performed, and the dressing is applied. The patient is then turned onto the contralateral side under the same anesthetic and the operative procedure on that side is commenced. For patients undergoing a direct anterior procedure, the wound on the first hip can be closed as the second hip surgery is commenced. Once the second procedure is completed, the sterile surgical dressings are applied.

Over the course of the study, all patients were treated with an uncemented acetabular component. Femoral fixation was most commonly obtained using an uncemented femoral component on the basis of the surgeon's implant preference and the femoral anatomy. Four hips in the single-anesthetic group and 8 hips in the staged bilateral group received cemented femoral components because of patient anatomy and bone quality. There was no difference between groups in the proportion of patients receiving a cemented rather than an uncemented femoral component (p = 0.37).

The patients in the single-anesthetic group had a mean age of 52.2 years (range, 20 to 69 years) and body mass index (BMI) of 27.1 kg/m² (range, 17.5 to 39.1 kg/m²); 54 (57%) were male and 40 (43%) were female. Patients were matched 1:1 on the basis of sex, age (±1 year), year of surgery (±3 years), BMI (±5 kg/m²), diagnosis, and American Society of Anesthesiologists (ASA) classification to a group of patients undergoing staged bilateral THA (Table I).

In the staged group, there was <1 year between THAs, with a mean of 3 months (range, 5 days to 10 months). Patients were followed longitudinally to the time of implant revision or death, with all patients having at least 2 years of follow-up. Mean follow-up was 4 years in each group (range, 2 to 15 years). Revision was defined as subsequent removal or exchange of any component(s), and reoperation was defined as any subsequent surgical procedure on a hip in which the components were retained.

Statistical Analysis

The unpaired Student t test was used to assess continuous variables, and the Fisher exact test was used to compare categorical variables. Survival estimates for mortality, implant revision, and reoperation were made with use of the Kaplan-Meier method. Comparisons of groups were made with use of the

TABLE II Risk Comparison of Outcomes of Single-Anesthetic and Staged Bilateral THA

Outcome	Hazard Ratio*	P Value
Revision-free survival	0.73 (0.27-1.80)	0.50
Reoperation-free survival	0.69 (0.27-1.61)	0.40
Postop. complication	0.83 (0.49-1.39)	0.48
Overall mortality	0.47 (0.16-1.15)	0.10

*The values are given as the hazard ratio, with the 95% confidence interval in parentheses.

log-rank test. A p value of <0.05 was considered significant. Each hip was counted as a single hip in the analyses of implant revision, reoperation, and complications. If 1 hip was censored, it did not remove the contralateral hip from being included in analyses at subsequent times. Patient outcomes were not known at the time of matching.

Results

Osteoarthritis was the most common diagnosis (Table I), with no difference between groups (p = 0.89). Patients in the single-anesthetic group spent a mean of 4.6 days (range, 2 to 17 days) in the hospital, with 1 patient requiring a 1-night intensive care unit (ICU) stay. In the staged group, patients spent a mean of 3.1 days (range, 2 to 7 days) in the hospital

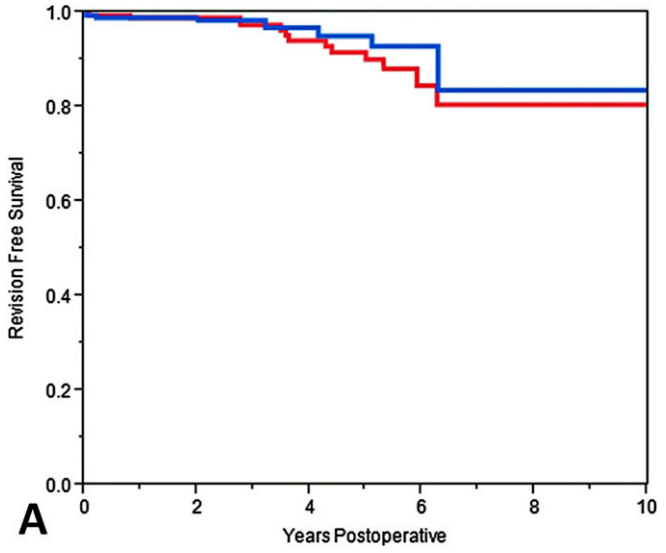

Fig. 1-A

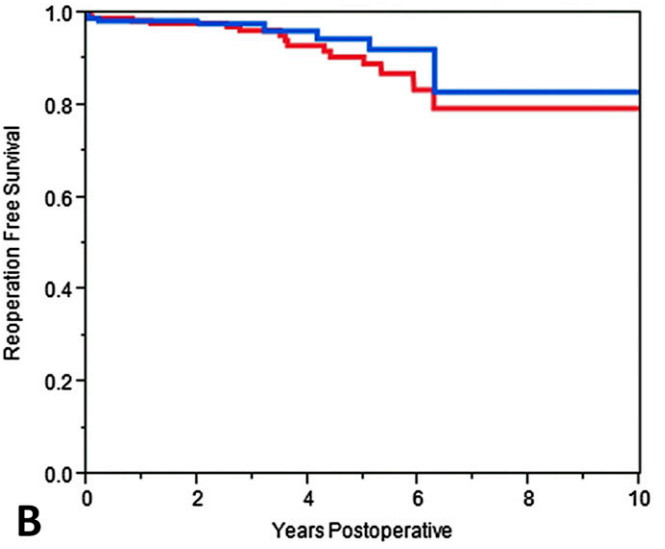

Fig. 1-B

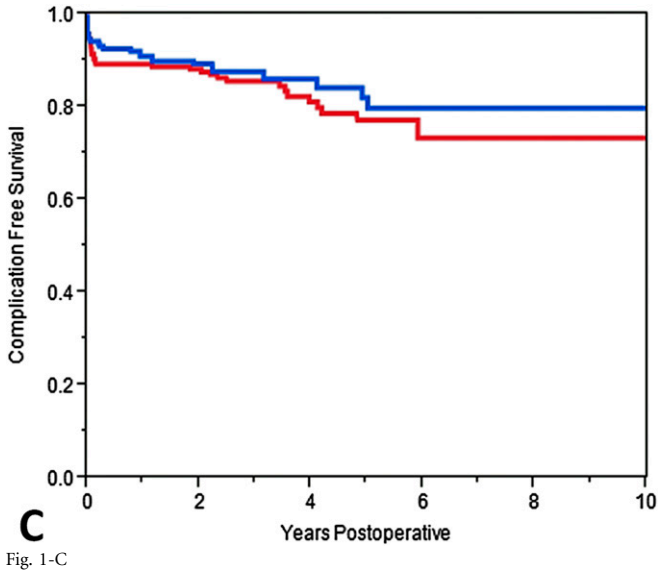

Fig. 1-C

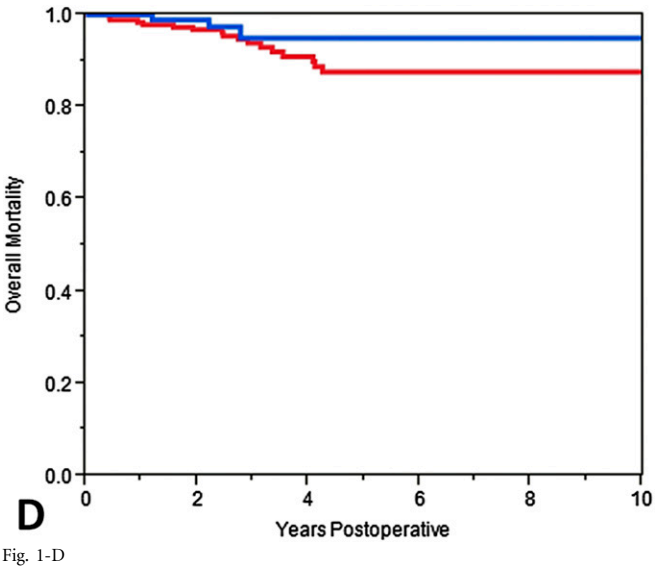

Fig. 1-D

Figs. 1-A through 1-D Comparison of patients undergoing single-anesthetic (blue) and staged (red) bilateral THA. There was no difference in outcomes in terms of implant survival (**Fig. 1-A**), need for reoperation (**Fig. 1-B**), postoperative complications (**Fig. 1-C**), and mortality (**Fig. 1-D**).

following the first THA, with 1 patient requiring a 1-night ICU stay. Patients spent a mean of 2.8 days (range, 2 to 7 days) in the hospital after the second THA, with 1 patient requiring a 1-night ICU stay. The mean total hospital stay for patients undergoing staged THA was 5.9 days (range, 4 to 13 days). Patients in the staged group had a significantly greater total stay compared with patients undergoing a single-anesthetic procedure (5.9 compared with 4.6 days, $p < 0.0001$). In-hospital complications occurred in 8 patients in the single-anesthetic group and 7 patients in the staged group ($p = 1.0$).

Autologous blood recovery was used in a greater proportion of patients in the single-anesthetic group (29% compared with 5%, $p < 0.0001$). Allogenic transfusion occurred following 37 (39%) of the procedures in the single-anesthetic group and 32 (34%) of the procedures in the staged group ($p = 0.76$). The mean amount transfused did not differ between the single-anesthetic and staged groups (2.0 compared with 1.9 units, $p = 0.70$). The mean anesthesia and operating room times for the single-anesthetic group were 255 minutes (range, 172 to 458 minutes) and 176 minutes (range, 104 to 366 minutes), respectively. The total mean operating room and anesthesia times for the staged group were 351 minutes (range, 226 to 558 minutes) and 211 minutes (104 to 434 minutes). Patients in the staged group experienced a significantly greater total mean anesthesia time (351 compared with 255 minutes, $p < 0.0001$) and operating room time (211 compared with 176 minutes, $p = 0.0003$) compared with patients in the single-anesthetic group.

The costs per encounter were analyzed using total anesthesia time as a marker for how long the patient was in the operating room. There was a significant reduction (28%, $p < 0.0001$) in the cost of the operating room when a single-anesthetic procedure was performed. Costs were also analyzed using the inpatient cost of the hospitalization. Similarly, patients in the single-anesthetic group had a significantly reduced cost of hospitalization (27%, $p = 0.001$) compared with patients in the staged group.

In the single-anesthetic group, 18 patients were discharged to a rehabilitation facility, and 76 patients were discharged to home. In the staged group, 24 patients (14 after the first THA and 10 after the second THA) were discharged to a rehabilitation facility; the remaining patients were discharged to home. The proportion of patients discharged to a rehabilitation facility did not differ between the single-anesthetic and first-stage procedures ($p = 0.56$). On a per-procedure basis, there was no difference in the proportion of patients being discharged to a rehabilitation facility ($p = 0.21$).

Revision-Free Survival

There was no difference (hazard ratio [HR] = 0.73, $p = 0.50$) in the revision-free survival between the single-anesthetic and staged groups (Table II and Fig. 1-A). Revision surgery occurred in 7 (3.7%) of the hips in the single-anesthetic group and 13 (6.9%) of the hips in the staged group. Indications for revision in the single-anesthetic group were infection (n = 3), component loosening (n = 3), and periprosthetic fracture (n = 1).

TABLE III Risk Factors for Revision, Reoperation, and Complications in Single-Anesthetic and Staged Bilateral THA

	Revision*	P Value	Reoperation*	P Value	Complication*	P Value
Single-anesthetic						
Male sex	4.12 (0.71-80.22)	0.12	5.06 (0.89-94.76)	0.06	1.14 (0.52-2.61)	0.73
Age ≤50 yr	1.25 (0.27-6.40)	0.76	1.62 (0.39-7.95)	0.50	0.87 (0.39-1.89)	0.72
Osteoarthritis	1.93 (0.27-9.08)	0.45	3.01 (0.61-12.43)	0.15	1.74 (0.68-3.97)	0.23
Osteonecrosis	0.80 (0.13-15.27)	0.84	0.96 (0.16-17.79)	0.96	1.71 (0.50-10.67)	0.42
RA†	–	–	–	–	0.25 (0.08-1.09)	0.06
Obesity	1.37 (0.19-6.52)	0.71	1.07 (0.15-4.75)	0.93	0.32 (0.07-0.92)	0.03
ASA class 1	–	–	–	–	0.55 (0.03-2.62)	0.52
ASA class 2	–	–	–	–	1.21 (0.49-3.65)	0.68
ASA class 3	–	–	–	–	0.97 (0.28-2.55)	0.95
Staged bilateral						
Male sex	1.02 (0.37-2.79)	0.96	3.26 (1.02-11.88)	0.03	0.97 (0.49-1.94)	0.94
Age ≤50 yr	0.20 (0.04-0.62)	0.003	0.47 (0.15-1.23)	0.15	0.82 (0.40-1.62)	0.57
Osteoarthritis	2.06 (0.72-5.33)	0.16	3.15 (0.61-12.43)	0.15	2.14 (1.00-4.30)	0.04
Osteonecrosis	0.50 (0.17-1.82)	0.27	0.39 (0.13-1.27)	0.11	1.03 (0.43-3.04)	0.94
RA†	–	–	0.28 (0.09-1.27)	0.09	0.49 (0.19-1.65)	0.22
Obesity	2.11 (0.78-5.91)	0.13	1.41 (0.24-2.13)	0.52	0.89 (0.42-1.77)	0.75
ASA class 1	–	–	–	–	0.38 (0.02-1.79)	0.27
ASA class 2	–	–	–	–	1.77 (0.69-5.96)	0.24
ASA class 3	–	–	–	–	0.71 (0.17-2.01)	0.57

*The values are given as the hazard ratio, with the 95% confidence interval in parentheses. †RA = rheumatoid arthritis.

TABLE IV Comparison of Common Complications Between Single-Anesthetic and Staged Bilateral THA

	Single-Anesthetic	Staged	Odds Ratio*	P Value
Complication				
Hematoma	2 (1.1%)	2 (1.1%)	1.0 (0.13-7.17)	1.0
DVT/PE	2 (1.1%)	2 (1.1%)	1.0 (0.13-7.17)	1.0
Dislocation	5 (2.7%)	4 (2.1%)	1.25 (0.34-4.58)	0.99
Wound complication	2 (1.1%)	2 (1.1%)	1.0 (0.13-7.17)	1.0
Periprosthetic fracture	6 (3.2%)	7 (3.7%)	0.85 (0.29-2.50)	1.0
Heterotopic ossification	6 (3.2%)	7 (3.7%)	0.85 (0.29-2.50)	1.0
Deep infection	3 (1.6%)	3 (1.6%)	1.0 (0.13-7.17)	1.0
Chronic soft-tissue pain	0 (0%)	3 (1.6%)	–	0.24
Sciatic nerve palsy	0 (0%)	2 (1.1%)	–	0.49
Neuroma	0 (0%)	1 (0.5%)	–	0.99
Impingement	0 (0%)	1 (0.5%)	–	0.99
Postoperative mortality				
30-day	0 (0%)	0 (0%)	–	1.0
90-day	0 (0%)	0 (0%)	–	1.0

*The values are given as the odds ratio, with the 95% confidence interval in parentheses.

Indications in the staged group were component loosening (n = 7), infection (n = 3), and recurrent dislocations (n = 3). Younger age (≤50 years) was associated with a reduced risk of revision (p = 0.003). No additional analyzed risk factor was found to increase the risk of revision in the single-anesthetic or staged bilateral groups (Table III).

Reoperation-Free Survival

Including the patients who underwent a revision procedure, a total of 9 (4.8%) of the hips in the single-anesthetic group and 15 (8.0%) of the hips in the staged group underwent an additional surgical procedure. There was no difference (HR = 0.69, p = 0.40), in the reoperation-free survival between single-anesthetic and staged bilateral THA (Table II and Fig. 1-B). Excluding the revision procedures, irrigation and debridement was the most common reason for reoperation (n = 3 total for the 2 groups). In the staged bilateral group, male sex (HR = 3.26, p = 0.03) significantly increased the risk of reoperation (Table III).

Postoperative Complications

Postoperative complications occurred in 26 (13.8%) of the hips in the single-anesthetic group and 34 (18.1%) of the hips in the staged group (HR = 0.83, p = 0.48; Table II and Fig. 1-C). There was no difference in the rates of periprosthetic fracture, hematoma, deep venous thrombosis (DVT) or pulmonary embolus (PE), dislocation, wound complications, heterotopic ossification, or deep postoperative infection between groups (Table IV). Preoperative ASA class had no effect on complications. In the single-anesthetic group, obesity was associated with a decreased risk of postoperative complications (HR = 0.32, p = 0.03). In the staged group, a diagnosis of osteoarthritis was associated with an increased risk of complications (HR = 2.14, p = 0.04; Table III).

Overall Mortality

Six (6.4%) of the patients in the single-anesthetic group and 18 (19%) of the patients in the staged THA group died during the follow-up period. There was no difference in this overall mortality (HR = 0.47, p = 0.10, Table II) or in the 30 and 90-day mortality (p = 1.0 for both; Table IV) between single-anesthetic and staged bilateral THA (Fig. 1-D).

Discussion

Over 2 million THAs were performed in the United States between 2002 and 2010, with <1% of these procedures being single-anesthetic bilateral procedures[10]. Although as many as one-third of patients undergoing unilateral THA have symptoms sufficient to warrant bilateral procedures[5,6], there remains hesitation in using single-anesthetic bilateral THA for severe bilateral coxarthrosis. Historically, the use of single-anesthetic THA was associated with an increased risk of systemic complications[12,19-21]. With advances in perioperative medical management, more recent studies have shown no difference in systemic complications between single-anesthetic and staged bilateral procedures[10,22-25]. A major flaw with existing studies is the lack of patient matching. The goals of this study were to evaluate the outcomes of single-anesthetic and staged bilateral THA, in terms of in-hospital data, hospital discharge data, revision and reoperation, and postoperative complications (including mortality), in matched patients.

Similar to previous reports, this study showed that length of stay was longer for patients undergoing single-anesthetic bilateral THA compared with patients undergoing unilateral THA, but the total length of stay was less compared with patients undergoing staged bilateral THA, contributing to a decreased cost of care associated with a single-anesthetic

procedure[7,10,14-16,26]. At our institution, the use of single-anesthetic bilateral THA was associated with significant reductions in the total costs of the operating room (by 28%) and hospitalization (by 27%) compared with staged bilateral procedures.

Similar cost-containment issues are associated with in-hospital and early postoperative complications, which place a substantial strain on the health-care system[27-29]. Retrospective, unmatched cohorts have shown an increased risk of DVT/PE following single-anesthetic bilateral THA[12,19,21]. This finding was not supported in the present matched cohort study, in which there was no difference in the rate of DVT/PE. The present study also showed no difference in other complications such as dislocation, periprosthetic fracture, and infection. This is similar to a recent review of the U.S. Nationwide Inpatient Sample (NIS) database by Rasouli et al.[10], which showed no increase in the rate of complications in patients undergoing single-anesthetic bilateral THA.

In addition to higher rates of pulmonary complications, Berend et al.[20] reported higher rates of reoperation, infection, dislocation, and wound complications following single-anesthetic bilateral THA. Likewise, that study reported a reoperation rate of 3.9%, dislocation rate of 1.2%, and wound complication/infection rate of 1.8%, which were significantly greater than the rates in their staged bilateral cohort[20]. However, the present study revealed no difference in the rate of these complications between matched patients undergoing single-anesthetic or staged bilateral THA.

Patient disposition following THA is related to the patient's ability to participate in physical therapy and mobilize following the procedure. In the present study, there was no difference in the proportion of patients discharged to home versus a rehabilitation facility following single-anesthetic or staged bilateral THA, with a majority of patients discharged to home. This is in contrast to the findings by Parvizi et al.[30], who noted a 96% rate of transfer to a rehabilitation center following single-anesthetic bilateral THA. In a study by Lindberg-Larsen et al.[24], all patients undergoing bilateral THA (both staged and single-anesthetic) were discharged to home after a mean of 6 days (staged) or 4 days (single-anesthetic) on a fast-track rehabilitation program. We attribute our low rate of transfer to a rehabilitation facility to our institution's advanced pain management program, rapid integration of physical therapy, and preoperative patient education protocols.

The optimal surgical approach for THA is controversial[31]. In the present study, the likelihood of undergoing a posterior approach was higher in the single-anesthetic bilateral THA group, whereas the likelihood of an anterolateral approach was higher in the staged THA group. This is related to the preference of the surgeons at our institution for the standard surgical approach and their willingness to perform a single-anesthetic bilateral THA. Two Cochrane reviews have not revealed any difference in patient outcome (dislocation, nerve injury, or presence of a Trendelenburg gait) between surgical approaches[31]. Palan et al.[32] reported no difference in patient-reported outcomes (Oxford hip score, dislocation rate, or need for revision surgery) between patients undergoing an anterolateral approach and a posterior approach. Similarly, in a recent study comparing the direct anterior and miniposterior approaches, there was no difference in early clinical results in terms of hospital course and discharge location[33]. We advocate for single-anesthetic bilateral THA to be performed by high-volume THA subspecialty surgeons, utilizing the surgical approach that they are most familiar with.

Because of the reported high risk of complications, the use of single-anesthetic bilateral THA had been reserved for patients with relatively "good" overall health[20,23]. The ASA score quantifies a patient's general overall health and has been used to separate patients into those with "low" (ASA 1 and 2) and "high" (ASA 3 and 4) risk[34]. In a matched study comparing single-anesthetic bilateral THA with unilateral THA, Swanson et al.[17] showed that the ASA score was predictive of perioperative complications. In the present study, preoperative ASA classification was not associated with an increased risk of postoperative complications. However, there were no patients in either group with an ASA classification of 4.

Allogenic blood transfusion has been shown to lead to immunosuppression and coagulopathy, and to have negative systemic effects in general, with multiple studies showing an increased transfusion rate in bilateral compared with unilateral THA procedures[7,20,35-38]. Although the change in hemoglobin level was not measured in the present study, we used the need for transfusion as a marker of blood loss. In our series, we noted a higher percentage of patients in the single-anesthetic group receiving autologous blood, while there was no difference in the amount of allogenic blood transfused. This is similar to a study by Alfaro-Adrián et al.[7] in which the authors noted no difference in the rate of transfusion between patients undergoing single-anesthetic or staged bilateral THA.

We acknowledge several study limitations. It should be stressed that <1.5% of the THAs performed at our institution were single-anesthetic bilateral procedures, leading to selection bias. Although the data in this study were collected prospectively by our registry, which may help to reduce recall and selection bias, they were examined retrospectively and we are unable to comment on variables not collected by the registry or patient records. Lastly, although patients had similar perioperative management in terms of anesthesia, pain control, and physical therapy, there was no standardized protocol for determining eligibility for single-anesthetic or staged bilateral THA, with multiple adult reconstruction subspecialty surgeons performing the surgical procedure. Therefore, the potential of selection bias is present.

In summary, single-anesthetic bilateral THA can be safely performed for patients with bilateral coxarthrosis. There was no difference in terms of patient outcomes with respect to revision, reoperation, complications, and perioperative mortality between matched patients undergoing single-anesthetic or staged bilateral THA. Single-anesthetic bilateral THA resulted in lower overall operating room utilization and hospital length of stay. We currently consider single-anesthetic bilateral THA for patients who have clinical and radiographic changes that would warrant a THA in each hip, are <70 years of age, are

relatively healthy, and/or have bilateral hip flexion contractures that would make rehabilitation difficult. ■

Matthew T. Houdek, MD[1]
Cody C. Wyles, MD[1]
Chad D. Watts, MD[1]
Eric R. Wagner, MD[1]
Rafael J. Sierra, MD[1]
Robert T. Trousdale, MD[1]
Michael J. Taunton, MD[1]

[1]Mayo Clinic, Rochester, Minnesota

E-mail address for M.T. Houdek: Houdek.matthew@mayo.edu
E-mail address for C.C. Wyles: Wyles.cody@mayo.edu
E-mail address for C.D. Watts: Watts.chad@mayo.edu
E-mail address for E.R. Wagner: Wagner.eric@mayo.edu
E-mail address for R.J. Sierra: Sierra.rafael@mayo.edu
E-mail address for R.T. Trousdale: Trousdale.robert@mayo.edu
E-mail address for M.J. Taunton: Taunton.michael@mayo.edu

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