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Anesthesia-Based Evaluation of Outcomes of Lower-Extremity Vascular Bypass Procedures

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Abstract

Background—This report examines the effects of regional versus general anesthesia for infrainguinal bypass procedures performed in the treatment of critical limb ischemia (CLI).

Methods—Nonemergent infrainguinal bypass procedures for CLI (defined as rest pain or tissue loss) were identified using the 2005 to 2008 American College of Surgeons National Surgical Quality Improvement Program database using International Classification of Disease, ninth edition, and Current Procedure Terminology codes. Patients were classified according to National Surgical Quality Improvement Program data as receiving either general anesthesia or regional anesthesia. The regional anesthesia group included those specified as having regional, spinal, or epidural anesthesia. Demographic, medical, risk factor, operative, and outcomes data were abstracted for the study sample. Individual outcomes were evaluated according to the following morbidity categories: wound, pulmonary, venous thromboembolic, genitourinary, cardiovascular, and operative. Length of stay, total morbidity, and mortality were also evaluated. Associations between anesthesia types and outcomes were evaluated using linear or logistic regression.

Results—A total of 5,462 inpatient hospital visits involving infrainguinal bypasses for CLI were identified. Mean patient age was 69 ± 12 years; 69% were Caucasian; and 39% were female. In all, 4,768 procedures were performed using general anesthesia and 694 with regional anesthesia.

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Patients receiving general anesthesia were younger and significantly more likely to have a history of smoking, previous lower-extremity bypass, previous amputation, previous stroke, and a history of a bleeding diathesis including the use of warfarin. Patients receiving regional anesthesia had a higher prevalence of chronic obstructive pulmonary disease.

Tibial-level bypasses were performed in 51% of procedures, whereas 49% of procedures were popliteal-level bypasses. Cases performed using general anesthesia demonstrated a higher rate of resident involvement, need for blood transfusion, and operative time. There was no difference in the rate of popliteal-level and infrapopliteal-level bypasses between groups. Infrapopliteal bypass procedures performed using general anesthesia were more likely to involve prosthetic grafts and composite vein. Mortality occurred in 157 patients (3%). The overall morbidity rate was 37%. Mean and median lengths of stay were 7.5 days (±8.1) and 6.0 days (Q1: 4.0, Q3: 8.0), respectively. Multivariate analyses demonstrated no significant differences by anesthesia type in the incidence of morbidity, mortality, or length of stay.

Conclusion—These results provide no evidence to support the systematic avoidance of general anesthesia for lower-extremity bypass procedures. These data suggest that anesthetic choice should be governed by local expertise and practice patterns.

INTRODUCTION

Open surgical bypass is a common procedure in vascular surgical practice, with > 70,000 procedures performed annually to treat critical lower-limb ischemia.[1] Given the morbidities inherent to patients requiring such procedures, optimization of perioperative care is important. There have been multiple studies investigating the potential effects of anesthetic type on outcome of lower-extremity bypass procedures.

In 1993, the Perioperative Ischemia Randomized Anesthesia Trial study group randomized 100 patients undergoing lower-extremity revascularization to general anesthesia or epidural anesthesia.[2] The resulting data demonstrated that there was no significant difference according to anesthetic type in outcomes, including cardiac events, mortality, infection, or pulmonary complications, but did demonstrate a significant increase in the need for graft revision or embolectomy among patients undergoing general anesthesia. The increased rate of reintervention was postulated by the authors to be secondary to differences in circulating catecholamine and Cortisol levels. Several single-institution studies have reported contradictory findings, demonstrating no association between anesthesia type and lower-extremity bypass outcomes.[2–4] The only multi-institution study was reported by Singh et al., who echoed the findings of increased morbidity associated with the use of general anesthesia in veterans undergoing lower-extremity bypass.[5] To examine the issue further, this study examined a large sample of North American vascular surgery procedures to evaluate possible associations between anesthesia type and outcomes after lower-extremity bypass for critical limb ischemia (CLI) in contemporary practice.

METHODS

Data Source

This investigation used data from the America College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), which is a validated prospective database compiled through a systematic sampling of cases at participating U.S. hospitals. Data files are provided by year. These files included cases from 121 sites in 2005 with an increase to 211 sites by 2008. Available data elements included demographic information, preoperative data, intraoperative data, and postoperative data. A trained and quality-audited research nurse collected 141 variables for each patient at each site for sampled surgical procedures. Maximum follow-up in this program was 30 days. Definitions for the variables in the NSQIP database have been described in previous reports.[6–8] Long-term graft patency data were not available.

Study Sample

Nonemergent infrainguinal bypass procedures for CLI were identified using the 2005 to 2008 ACS NSQIP Participant Use Data File. CLI was defined as rest pain or tissue loss and included patients with Rutherford classifications of 4 to 6.[9] Patients were initially identified by Current Procedure Terminology codes (American Medical Association, Chicago, IL) indicating lower-extremity bypass procedure to the popliteal or tibial level (Table I). Inclusion also required the NSQIP variable for rest pain/gangrene to be “yes” or identification of at least one International Classification of Disease, ninth edition, code denoting CLI, including codes for rest pain, ulceration, or gangrene (Table I). Patients undergoing emergency procedures or undergoing concomitant surgical procedures requiring general anesthesia were excluded from further analyses.

Demographic and Medical Risk Factors

Demographic, medical, risk factor, operative, and outcomes data were abstracted for the study sample from the ACS NSQIP database. Race was considered as white or nonwhite. Age was considered as a continuous variable. The ACS NSQIP Participant Use Data File variable for age is a numerical value corresponding to the patient’s numeric age in years for all records except those with an age in excess of 90, who are coded as 90+ to minimize identifiable information within the record. Estimated glomerular filtration rate was used to assess renal function and was calculated using the abbreviated Modification of Diet in Renal Disease formula.[10] Body mass index was calculated using height and weight data.

Anesthesia Type

Data regarding the type of anesthetic were extracted from the ACS NSQIP for all identified elective lower-extremity bypass cases. Anesthesia type is designated in the ACS NSQIP as general, epidural, spinal, local, monitored anesthesia care, and other. Regional anesthesia was defined as spinal, epidural, and/or regional.

Outcomes

The outcomes for analysis were morbidity, mortality, and length of stay (LOS). Morbidity included the following morbidity classes considered individually as well as in aggregate: wound (superficial or deep surgical site infection), pulmonary (pneumonia, reintubation, or failure to wean from ventilator within 48 hours), venous thromboembolic (deep vein thrombosis, or pulmonary embolus), genitourinary (acute renal insufficiency, acute renal failure, or urinary tract infection), cardiovascular (myocardial infarction, cardiac arrest, or stroke), or operative (return to operating room, postoperative bleeding, or graft failure). Postoperative mortality was defined as death within 30 days or during the same acute care hospital stay. LOS was denned as the time from surgery to hospital discharge or death.

Preoperative characteristics, medical risk factors, and procedural data were described using mean ± standard deviation, count (%), or median (Q1, Q3). Characteristics were compared using univariate techniques, including χ^2 or Fisher exact test for categorical variables and *t* tests for continuous variables.

Morbidity and mortality associations were examined using logistic regression. LOS was log-transformed before analysis with linear regression to satisfy normality assumptions. The LOS comparison was back-transformed for presentation as percent difference. All multivariate analyses were adjusted for age, race, gender, operative time, and total work relative value units (RVUs) of the component Current Procedure Terminology codes defining the surgical procedure. Work RVUs were used as a surrogate marker for case complexity to address the concerns from earlier work that patients undergoing general anesthesia had more complex procedures. Additional covariates were included in the analyses of each of the grouped morbidity classes as well as mortality. Covariates for the multivariate analyses were chosen according to previous full-sample analyses of the ACS NSQIP by central ACS statistical faculty (which are available to each participating site) examining predictors for each of the morbidity classes detailed previously and mortality in vascular surgery patients. The covariates for each analysis are detailed in the tabulated results that follow this report. All analyses were performed using SAS software, version 9.2 (SAS Institute, Cary, NC).

RESULTS

Patient Characteristics

A total of 5,462 lower-extremity bypass procedures for critical ischemia meeting the inclusion and exclusion criteria were identified. Demographic data are summarized in Table II. In all, 4,768 cases (87%) were done with general anesthesia, whereas 694 cases (13%) were done under regional anesthesia. The regional anesthesia group consisted of 273 (39%) cases using epidural anesthesia, 373 (54%) cases using spinal anesthesia, and 48 (7%) classified as “regional”. Thirty-nine percent of identified patients were female, and 69% were white.

Patients receiving general anesthesia had a higher baseline prevalence of current smoking, history of revascularization or amputation, history of stroke without disability, preoperative anticoagulation, and a higher glomerular filtration rate. Patients receiving regional anesthesia were older with a higher prevalence of chronic obstructive pulmonary disease and dependent preoperative functional status. The remaining demographic characteristics were similar among the two groups (see Table II).

Procedural Characteristics, by Anesthesia Type

Procedural details are summarized in Table III. Mean operative time was 237 minutes. Twenty percent of patients required transfusion, with a mean transfusion amount of 2 units. Tibial-level bypasses were performed in 2,787 (51%) of procedures, whereas 2,675 (49%) procedures were popliteal-level bypasses. Cases performed using general anesthesia demonstrated a higher rate of resident involvement, need for blood transfusion, and operative time. There was no difference in the rate of popliteal versus infrapopliteal bypasses between groups. Infrapopliteal bypass procedures performed using general anesthesia were more likely to involve prosthetic grafts and composite vein.

Outcomes, by Procedure Type

Morbidity by class, overall morbidity, mortality, and LOS results are displayed in Table IV. Mortality occurred in 157 patients (3%). The overall morbidity rate was 37%. Mean and median lengths of stay were 7.5 days (± 8.1) and 6.0 days (Q1: 4.0, Q3: 8.0), respectively. The most common morbidity observed was return to the operating room, which occurred in 22% of patients. In particular, graft thrombosis was found in 7.3% of patients, with an equal rate in both groups. Wound complications occurred in 12% of patients, infectious complications (including any septic morbidity) in 6% of patients, and pulmonary morbidity occurred in 4% of patients. The rate of cardiovascular complications was similar between groups, affecting 2.8% of general anesthesia patients and 2.2% of regional anesthesia patients. Genitourinary complications were the same in the two groups, with a rate of 1.2%. Venous thromboembolism rates were similar, affecting 0.9% of general anesthesia patients and 0.4% of regional anesthesia patients.

No significant differences were observed according to anesthetic type in the occurrence of individual morbidity classes, overall morbidity, mortality, or LOS. These observations were consistent across unadjusted and multivariate analyses (Table V).

DISCUSSION

This report represents a large observational analysis of patients with CLI undergoing lower-extremity bypass intended to investigate the effects of anesthesia technique on outcome. We found that regional anesthesia was used more frequently in patients with pulmonary disease. However, we found little difference in outcomes between patients undergoing bypass procedures using general anesthesia or regional anesthesia (Table IV). Specifically, there was no difference in rates of cardiac events, graft failure, postoperative pneumonia, or return to the operative room that were seen in previous studies. In contrast to previous reports, anesthetic type was not associated with postoperative complications or mortality in either unadjusted or multivariate analyses (Table V).

There has been considerable controversy regarding the optimal anesthetic method for performing lower-extremity bypass for the past 20 years. Proponents of regional anesthesia

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cite several potential advantages. The sympathetic blockade associated with subarachnoid and epidural anesthesia decreases circulating catecholamine levels and improves lower-extremity blood flow, with the potential to decrease the incidence of deep vein thrombosis and prevent lower-extremity arterial bypass thrombosis.[11–13] In addition, improved intraoperative and postoperative hemodynamic stability may be achieved with regional anesthesia,[14] potentially leading to decreased cardiac complications.[5] Finally, the lack of airway instrumentation may lead to improved postoperative pulmonary function.

There have been a number of studies that have attempted to examine the clinical impact of these potential biologic advantages, which have yielded conflicting results. The Perioperative Ischemia Randomized Anesthesia Trial demonstrated an increased graft patency rate with regional anesthesia, which was supported in a subsequent subgroup analysis performed by Perler et al.[15] The hypothesis that general anesthesia had a negative outcome on lower-extremity revascularization was further supported with an analysis of the Veteran's Administration (VA) NSQIP data. The group found an increased risk of graft failure and higher rates of myocardial infarction and pneumonia in patients undergoing general anesthesia compared with spinal anesthesia.[5]

However, other studies of the effects of anesthetic type and outcome have not supported these results.[3,4] A prospective report by Pierce et al. found no differences among anesthetic groups for 30-day graft patency, death, amputation, or LOS. That study has been criticized for having a high participant exclusion rate, which could have confounded the results.[3] Another study by Bode et al. demonstrated no difference in cardiac morbidity based on anesthetic type.[16] The current study also suggests that there is no difference in complication rates associated with type of anesthesia for lower-extremity bypass.

Our study design and use of the NSQIP database is similar to the previous VA study performed by Singh et al.,[5] but we came to opposite conclusions. One potential explanation for the different conclusion is that gender is a confounding variable. Our study included approximately 40% women, whereas the VA study contained 99% men, although gender had no effect on outcome in our analysis. An alternative explanation is that the difference in group selection may account for the contradictory findings. In the previous study, patients undergoing regional anesthesia were subdivided into epidural and spinal groups, with spinal anesthesia used as the reference group. One criticism of the previous article was that the findings of decreased morbidity did not extend to the patients who had epidural anesthesia, despite having a similar causal pathway. Therefore, we combined patients with epidural anesthesia and those with spinal anesthesia under the heading of regional anesthesia. This group did not show a significant difference in morbidity when compared with patients undergoing general anesthesia. The results from our study failed to demonstrate a significant association between anesthesia type and graft failure. We believe that this lack of association reflects a real trend, rather than lack of statistical power, because of the large number of patients involved. In addition, it appears that more complex cases were performed preferentially under general anesthesia, given the increased work-related RVUs. The assumption of increased complexity is also supported by the observation of increased resident involvement, transfusion need, and operative time observed in those procedures performed using general anesthesia in this study. The lack of difference in outcome among patients undergoing regional anesthesia compared with general anesthesia may also reflect advances in anesthetic technique and improved medication safety profile.

It is important to note that this retrospective study has several inherent limitations. First, we attempted to account for case complexity by controlling for work RVUs and operative time. However, it is possible that this may provide incomplete adjustment, and confounding by case complexity may still persist. Second, this analysis was not randomized and is unable to protect from surgeon and/or anesthesiologist biases in selection of anesthesia. Long-term graft patency and survival were also not evaluated secondary to the absence of such data in the NSQIP database. Participation in the NSQIP is voluntary and is not a randomly collected sampling of institutions, so an institutional bias may persist as well. The ACS NSQIP database is a quality improvement database, which was not designed for critical assessment of specific issues related to vascular surgical procedure performance or anesthesia, such as those addressed herein. As is often the case, only a well-developed multicenter randomized trial or carefully constructed registry can appropriately address the questions at hand. Third, our study noted a high complication rate, which approached 37% in both treatment arms. This is in contrast to a previous study performed by LaMuraglia et al., who found a 19% rate of complications when they analyzed NSQIP data from 2005 to 2006.[8] The difference in complication rate may be accounted for by our more inclusive definition of morbidity and our selection of patients with CLI, who have a higher reoperation rate than patients with claudication.[17]

CONCLUSION

In summary, choice of anesthetic type did not appear to affect outcomes after lower-extremity bypass for CLI. The results suggest that there is no evidence to support the avoidance of general anesthesia over regional anesthetic modalities for this procedure. Anesthetic choice should be governed by local expertise and practice patterns.

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Table I

Procedural and diagnostic codes for inclusion

Lower-extremity vascular bypass CPT inclusion codes			ICD-9 inclusion codes	
Code	Conduit	Anatomic level	Code	Diagnosis
35556	Vein	Femoral to popliteal	440.22	Atherosclerosis of native arteries of the extremities with rest pain
35566	Vein	Femoral to tibial, peroneal, or other distal vessel	440.23	Atherosclerosis of native arteries of the extremities with ulceration
35570	Vein	Tibial to tibial, peroneal, or other distal vessel	440.24	Atherosclerosis of native arteries of the extremities with gangrene
35571	Vein	Popliteal to tibial, peroneal, or other distal vessel	707.06	Chronic ulcer of skin, ankle
35583	In situ vein	Femoral popliteal bypass	707.07	Chronic ulcer of skin, heel
35585	In situ vein	Femoral to tibial, peroneal, or other distal vessel	707.1	Ulcer of lower limb, except pressure ulcer
35587	In situ vein	Popliteal to tibial, peroneal, or other distal vessel	707.10	Unspecified ulcer of lower limb
35656	Graft[a]	Femoral popliteal bypass	707.12	Ulcer of calf
35666	Graft[a]	Femoral to tibial, peroneal, or other distal vessel	707.13	Ulcer of ankle
35671	Graft[a]	Popliteal to tibial, peroneal, or other distal vessel	707.14	Ulcer of heel and midfoot
			707.15	Ulcer of other part of foot
			707.19	Ulcer of other part of lower limb
			707.9	Chronic ulcer of unspecified site
			785.4	Gangrene

CPT, Current Procedure Terminology; ICD-9, International Classification of Disease, ninth edition.

CPT codes and ICD-9 codes used for case selection.

At least one CPT code from this table was required for patient inclusion in the study.

In absence of rest pain variable in NSQIP database being yes, at least one of the above ICD-9 codes was required for study inclusion.

[a]"Graft" denotes use of a graft other than vein for bypass conduit.

Table II

Selected demographic characteristics among entire sample and according to anesthetic group

Variable	Overall *n* = 5,462	General anesthesia *n* = 4,768	Regional anesthesia *n* = 694	*P* value[*]
Age (yr)	68.8 ± 12.0	68.3 ± 12.1	71.8 ± 11.5	<0.0001
Age ≥80 yr (%)	1,205 (22.1)	997 (20.9)	208 (30.0)	<0.0001
Nonwhite race	1,719 (31.5)	1,485 (31.2)	234 (33.7)	0.1728
Female gender	2,147 (39.3)	1,878 (39.4)	269 (38.8)	0.7521
BMI	27.0 ± 6.2	27.0 ± 6.0	26.8 ± 7.0	0.3606
Diabetes	2,657 (48.7)	2,308 (48.4)	349 (50.3)	0.3540
Current smoker	2,194 (40.2)	1,955 (41.0)	239 (34.4)	0.0010
Functional status				
Independent	4,189 (76.7)	3,682 (77.2)	507 (73.1)	0.0152
Partially/totally dependent	1,273 (23.3)	1,086 (22.8)	187 (27.0)	
History of				
COPD	728 (13.3)	617 (12.9)	111 (16.0)	0.0270
CHF	201 (3.7)	170 (3.6)	31 (4.5)	0.2386
MI	138 (2.5)	123 (2.6)	15 (2.2)	0.5118
Angina	131 (2.4)	118 (2.5)	13 (1.9)	0.3331
Previous CABG	1,407 (25.8)	1,237 (25.9)	170 (24.5)	0.4150
Previous PTCI	1,028 (18.8)	908 (19.0)	120 (17.3)	0.2698
HTN	4,633 (84.8)	4,044 (84.8)	589 (84.9)	0.9700
Revascularization or amputation	3,156 (57.8)	2,784 (58.4)	372 (53.6)	0.0171
Dialysis dependence	540 (9.9)	477 (10.0)	63 (9.1)	0.4449
TIA	375 (6.9)	323 (6.8)	52 (7.5)	0.4843
Stroke without residual disability	409 (7.5)	370 (7.8)	39 (5.6)	0.0453
Stroke with residual disability	491 (9.0)	428 (9.0)	63 (6.1)	0.9305
Bleeding disorder[a]	1,315 (24.1)	1,220 (25.6)	95 (13.7)	<0.0001
Preoperative sepsis (SIRS/sepsis/septic shock)	384 (7.0)	340 (7.1)	44 (6.3)	0.4464
10% or more weight loss in past 6 months	122 (2.2)	102 (2.1)	20 (2.9)	0.2161
Acute renal failure	109 (2.0)	93 (2.0)	16 (2.3)	0.5321
Transfer status				
Other hospital or facility	426 (7.8)	370 (7.8)	56 (8.1)	0.7766
Admitted directly from home	5,036 (92.2)	4,398 (82.2)	638 (91.9)	
ASA class				
No disturb, mild, severe (1–3)	4,297 (78.7)	3,742 (78.5)	555 (78.0)	0.3812
Life-threatening or moribund (4–5)	1,163 (21.3)	1,024 (21.5)	139 (20.0)	
eGFR (mL/min)	64.5 ± 34.2	64.9 ± 34.6	61.6 ± 31.0	0.0106
Chronic dyspnea	1,080 (19.8)	929 (19.5)	151 (21.8)	0.1600
Wound class >1[b]	834 (15.3)	711 (14.9)	123 (17.7)	0.0544
Chronic steroid use	260 (4.8)	234 (4.9)	26 (3.8)	0.1794
Rest pain/gangrene	4,244 (77.7)	3,713 (77.9)	531 (76.5)	0.4212

Variable	**Overall** ***n* = 5,462**	**General anesthesia** ***n* = 4,768**	**Regional anesthesia** ***n* = 694**	***P* value***
WBC	8.6 ± 3.2	8.6 ± 3.2	8.4 ± 3.0	0.1130
HCT	36.2 ± 5.8	36.2 ± 5.8	36.0 ± 5.6	0.3879
Platelet count	275.0 ± 110.4	275.4 ± 110.4	272.0 ± 110.6	0.4520

ASA, American Society of Anesthesiologists; eGER, estimated glomerular filtration rate; MAC, monitored anesthesia care; PTCI, percutaneous transluminal coronary intervention; COPD, chronic obstructive pulmonary disorder; MI, myocardial infarction; CHF, congestive heart failure; CABG, coronary artery bypass graft; HTN, hypertension; TIA, transient ischemic attack; SIRS, systemic inflammatory response syndrome; WBC, white blood cell count; HCT, hematocrit; BMI, body mass index.

[a]Bleeding disorder denotes disorders that increase risk for bleeding, such as presence of hemophilia, thrombocytopenia, vitamin K deficiency, or long-term anticoagulation therapy that was not discontinued before surgery.

[b]Wound class ranges from 1 to 4, where 1 = clean, 2 = clean–contaminated, 3 = contaminated, and 4 = dirty.

[*]*P* values for tests of differences between general and regional anesthesia from χ^2 test for categorical variables or *t* test for continuous variables.

Table III

Selected procedural characteristics among entire sample and according to anesthetic group expressed as count (%) or mean ± SD

Variable	Overall *n* = 5,462	General anesthesia *n* = 4,768	Regional anesthesia *n* = 694	*P* value[*]
Surgeon specialty				
Vascular surgeon	5,268 (96.5)	4,598 (96.4)	670 (96.5)	0.8866
Other	194 (3.6)	170 (3.6)	24 (3.5)	
Resident involved	3,651 (66.9)	3,243 (68.1)	408 (58.9)	<0.0001
Patients requiring transfusion (%)	1,092 (20.0)	1,001 (21.0)	91 (13.1)	<0.0001
Units transfused (among those >0)	2.0 ± 1.2	2.0 ± 1.2	2.0 ± 1.1	0.7365
Patients requiring >4 units transfused (%)	46 (0.8)	45 (0.9)	1 (0.1)	0.0312
Operative time (min)	237.0 ± 101.9	240.3 ± 103.2	214.6 ± 89.6	<0.0001
Total work RVUs	32.4 ± 12.5	32.4 ± 12.5	32.0 ± 11.9	0.4622
Infrapopliteal bypass	2,787 (51.0)	2,448 (51.3)	339 (48.9)	0.2193
Vein bypass	2,249 (41.2)	1,963 (41.2)	286 (41.2)	0.9840
Single vein bypass	2,146 (39.3)	1,862 (39.1)	284 (40.9)	0.3459
Composite vein	103 (1.9)	101 (2.1)	2 (0.3)	0.0009
Any prosthetic	538 (9.9)	485 (10.2)	53 (7.6)	0.0363
Prosthetic only	489 (9.0)	440 (9.2)	49 (7.1)	0.0617
Prosthetic and vein	49 (0.9)	45 (0.9)	4 (0.6)	0.3375
Popliteal bypass	2,675 (49.0)	2,320 (48.7)	355 (51.2)	0.2193
Vein bypass	1,563 (28.6)	1,341 (28.1)	222 (32.0)	0.0354
Single vein bypass	1,544 (28.3)	1,322 (27.7)	222 (32.0)	0.0198
Composite vein	19 (0.4)	19 (0.4)	0 (0)	0.1586[a]
Any prosthetic	1,112 (20.4)	979 (20.5)	133 (19.2)	0.4029
Prosthetic only	1,080 (19.8)	953 (20.0)	127 (18.3)	0.2970
Prosthetic and vein	32 (0.6)	26 (0.6)	6 (0.9)	0.3032[a]
Use of prosthetic graft	1,645 (30.1)	1,464 (30.7)	181 (26.1)	0.0131

RVU, relative value unit.

[a]Fisher exact test used in place of χ^2 test owing to low expected cell counts.

[*]*P* values for tests of differences between general and regional anesthesia from χ^2 test or Fisher exact test for categorical variables or from *t* test for continuous variables.

Table IV

Morbidity, mortality, and LOS results expressed as count (%) or mean ± SD

Variable	Overall *n* = 5,462	General anesthesia *n* = 4,768	Regional anesthesia *n* = 694
Morbidity (any type)	2,012 (36.8)	1,776 (37.3)	236 (34.0)
Wound problems			
Superficial wound infection	465 (8.5)	409 (8.6)	56 (8.1)
Deep wound infection	190 (3.5)	167 (3.5)	23 (3.3)
Organ space wound infection	30 (0.6)	27 (0.6)	3 (0.4)
Wound dehiscence	94 (1.7)	82 (1.7)	12 (1.7)
Any superficial or deep wound infection	645 (11.8)	566 (11.9)	79 (11.4)
Pulmonary			
Pneumonia	100 (1.8)	88 (1.9)	12 (1.7)
Unplanned reintubation	125 (2.3)	111 (2.3)	14 (2.0)
Failure to wean from ventilator	95 (1.7)	88 (1.9)	7 (1.0)
Any pulmonary morbidity	224 (4.1)	201 (4.2)	23 (3.3)
Venous thromboembolic			
Deep venous thrombosis	41 (0.8)	38 (0.8)	3 (0.4)
Pulmonary embolism	7 (0.1)	7 (0.2)	0 (0)
Any venous thromboembolic morbidity	48 (0.9)	45 (0.9)	3 (0.4)
Genitourinary			
Acute renal insufficiency	38 (0.7)	34 (0.7)	4 (0.6)
Acute renal failure	32 (0.6)	27 (0.6)	5 (0.7)
Urinary tract infection	146 (2.7)	130 (2.7)	16 (2.3)
Any renal insufficiency or renal failure	63 (1.2)	55 (1.2)	8 (1.2)
Cardiovascular			
Stroke	38 (0.7)	34 (0.7)	4 (0.6)
Cardiac arrest	67 (1.2)	59 (1.2)	8 (1.2)
Myocardial infarction	48 (0.9)	45 (0.9)	3 (0.4)
Any cardiovascular morbidity	146 (2.7)	131 (2.8)	15 (2.2)
Operative			
Postoperative hemorrhage	66 (1.2)	59 (1.2)	7 (1.0)
Graft failure	396 (7.3)	346 (7.3)	50 (7.2)
Return to operating room	1,214 (22.2)	1,078 (22.6)	136 (19.6)
Any operative morbidity	1,306 (23.9)	1,157 (24.3)	149 (21.5)
Septic			
Sepsis	223 (4.1)	200 (4.2)	23 (3.3)
Septic shock	114 (2.1)	100 (2.1)	14 (2.0)
Any septic morbidity	331 (6.1)	294 (6.2)	37 (5.3)
Mortality	157 (2.9)	137 (2.9)	20 (2.9)
Length of postoperative surgical stay (days)	7.5 ± 8.1	7.4 ± 7.7	7.6 ± 10.6
Length of postoperative surgical stay (days)[a]	6.0 (4.0, 8.0)	6.0 (4.0, 8.0)	5.0 (4.0, 8.0)

LOS, length of stay.

[a]LOS expressed as median (Q1, Q3).

Table V

Multivariate analysis of select morbidity classes, mortality, and LOS between the general and regional anesthetic groups

	General versus regional		
Outcomes	**OR**	**95% CI**	***P* value**
Any morbidity			
Unadjusted	1.15	0.97, 1.36	0.0982
Multivariate model[a]	1.12	0.93, 1.34	0.2382
Wound morbidity			
Unadjusted	1.05	0.82, 1.35	0.7100
Multivariate model[b]	0.96	0.73, 1.26	0.7812
Pulmonary morbidity			
Unadjusted	1.28	0.83, 1.99	0.2647
Multivariate model[c]	1.41	0.88, 2.26	0.1551
Cardiovascular morbidity			
Unadjusted	1.28	0.75, 2.20	0.3726
Multivariate model[d]	1.38	0.78, 2.43	0.2695
Operative morbidity			
Unadjusted	1.17	0.97, 1.42	0.1069
Multivariate model[e]	1.18	0.95, 1.45	0.1306
Mortality			
Unadjusted	1.00	0.62, 1.61	0.9900
Multivariate model[f]	1.21	0.72, 2.02	0.4649
	Ratio days	95% CI	*P* value
LOS			
Unadjusted	1.01	0.97, 1.06	0.6244
Multivariate model[a]	1.01	0.97, 1.06	0.6203

[a]Model covariates for any morbidity and LOS: age, gender, race, ASA class, work RVU, preoperative sepsis, functional status, revascularization/amputation, WBC, history of COPD, platelets, rest pain/gangrene, HCT, BMI, steroid use, dyspnea, wound class, current smoker, weight loss >10%, history of CHF, preoperative renal failure, eGFR, cerebrovascular accident, transfer status, operative time.

[b]Model covariates for wound: age, gender race, work RVU, revascularization/amputation, BMI, current smoker, history of PTCI, transfer status, history of COPD, platelets, WBC, return to operating room, graft failure, diabetes, operative time.

[c]Model covariates for pulmonary: age, gender, race, work RVU, functional status, ASA class, preoperative sepsis, history of COPD, wound class, WBC, preoperative cerebrovascular accident, dyspnea, red blood cell count >4, HCT, diabetes, return to operating room, operative time.

[d]Model covariates for cardiovascular: age, gender, race, ASA class, work RVU, functional status, WBC, HCT, platelets, revascularization/amputation, dyspnea, history of angina, history of PTCI, history of CABG, history of TIA, HTN, history of CHF, current smoker, operative time.

[e]Model covariates for operative: age, gender, race, infrapopliteal bypass, graft, work RVU, history of diabetes mellitus, bleeding disorder, platelets, sepsis, revascularization/amputation, history of PTCI, wound class, BMI, current smoker, functional status, ASA class, operative time.

[f]Model covariates for mortality: age, gender, race, functional status, ASA class, work RVU, WBC, dyspnea, platelets, BMI, history of CHF, dialysis, steroid use, preoperative sepsis, history of COPD, graft failure, return to operating room, operative time.