From the New England Society for Vascular Surgery

Contemporary comparison of supra-aortic trunk surgical reconstructions for occlusive disease

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Objective: **Open surgical reconstruction for supra-aortic trunk occlusive disease persists despite advances in endovascular therapy. Although extrathoracic reconstructions developed as a safer alternative to transthoracic reconstructions, contemporary national data evaluating relative rates of operative outcomes are lacking.**

Methods: **With use of the National Surgical Quality Improvement Program (2005-2011), patients who underwent transthoracic or extrathoracic reconstruction were evaluated. Patients with nonocclusive indications were excluded. The primary outcome was a composite end point of stroke/myocardial infarction (MI)/death. Secondary outcomes were 30-day postoperative complications. Univariate and multivariable regression analyses were performed.**

Results: **Overall, 83 patients (10.7%) underwent transthoracic reconstructions and 692 patients (89.3%) underwent extrathoracic reconstructions. Vascular surgeons performed most transthoracic (96%) and extrathoracic (97%) reconstructions. The most common extrathoracic reconstructions were carotid-subclavian bypass (68%), carotid-carotid bypass (14%), and subclavian transposition (7%). Less commonly, axillary-axillary bypass (6%), subclavian-axillary bypass (2%), subclavian-subclavian bypass (1%), and carotid transposition (1%) were performed. At the time of operation, 10% (transthoracic reconstructions) and 8% (extrathoracic reconstructions) of patients had a concurrent carotid endarterectomy ($P < .60$). Analysis of more than 20 characteristics showed that the groups did not differ significantly. The two groups had similar rates of postoperative stroke (1.2% in the transthoracic reconstruction group vs 2.2% in the extrathoracic reconstruction group; $P > .99$), MI (0% vs 1.3%; $P = .61$), death (2.4% vs 1.3%; $P = .33$), and stroke/MI/death (3.6% vs 3.8%; $P > .99$). Transthoracic reconstruction patients had longer hospital stays (6.3 days vs 4.0 days; $P < .0002$), received more transfusions (8.4% vs 2.5%; $P < .0096$), and had higher rates of postoperative sepsis (3.6% vs 0.3%; $P < .01$) and venous thromboembolic complications (3.6% vs 0.4%; $P < .02$). After adjustment for other factors, including surgical approach, stroke/MI/death was significantly associated with postoperative pneumonia (odds ratio [OR], 26.0; 95% confidence interval [CI], 6.29-108.28; $P < .0001$), postoperative ventilator dependence (OR, 12.45; 95% CI, 2.74-56.48; $P = .001$), and postoperative return to the operating room (OR, 4.75; 95% CI, 1.67-13.54; $P = .004$).**

Conclusions: **At U.S. hospitals, extrathoracic reconstruction is the more common reconstruction for supra-aortic trunk occlusive disease. Both approaches carry acceptably low rates of death, MI, and stroke. Transthoracic reconstruction results in more resource utilization because of its postoperative complications and greater complexity. (J Vasc Surg 2014;59:1577-82.)**

Occlusive disease of the supra-aortic trunk vessels is often asymptomatic; however, 18% to 62% of patients present with vertebrobasilar insufficiency and 13% to 69% with upper extremity ischemia.[1,2] The treatment of occlusive disease of the supra-aortic trunks has evolved during the years and currently includes open surgical reconstructions (transthoracic and extrathoracic) and endovascular interventions. Although endovascular techniques have become an increasingly popular treatment modality for occlusive disease of the supra-aortic trunks, open surgical reconstructions persist because of their better midterm freedom from failure and long-term patency compared with endovascular intervention.[2,3] In addition, open surgical reconstructions remain an effective secondary revascularization option after failure of initial endovascular treatment.[4]

Transthoracic reconstruction, which was first performed in 1957 by DeBakey[5] as bypass grafting from the aortic arch, resulted in long-term patency yet was also previously associated with significant morbidity and mortality rates ranging from 8% to 20%.[6-8] Extrathoracic reconstructions, such as carotid-subclavian bypass, carotid-carotid bypass, and subclavian transposition, developed as safer alternatives because of their decreased morbidity and mortality.[1,2,9] Although Takach et al[3] more recently reported no significant differences between transthoracic and extrathoracic reconstruction operative mortality rates (2.7% vs 2.3%) and stroke rates (2.7% vs 6.8%), this and other previous studies were limited to a single center, and some spanned more than 30 years because of the small number of patients included.

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A wide range of rates of perioperative stroke and mortality have been reported for both approaches.[1-3,6,9,10] Contemporary national data may be more generalizable than high-volume single-center reports. The aim of the current work was to evaluate operative outcomes of transthoracic reconstructions compared with extrathoracic reconstructions for occlusive disease of the supra-aortic trunks by use of a comprehensive, national data set.

METHODS

Database. The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from 2005 to 2011 was analyzed for this study. The NSQIP is a national, multi-institutional clinical database that prospectively collects risk-adjusted data to facilitate quality control review of outcomes. These processes have been described in detail,[11] and data validity has been previously shown.[12] The NSQIP database has grown considerably since the conclusion of its pilot study in 2004, and the most recent annual installment (2011) includes 252 variables on 442,149 cases from 315 participating sites.[11]

Cohort. Patients undergoing transthoracic reconstructions or extrathoracic reconstructions were first identified from the NSQIP data sets by use of the primary Current Procedural Terminology (American Medical Association, Chicago, Ill) code for the procedure (Appendix A, online only). The cohort was then limited, by use of International Classification of Diseases, Ninth Revision codes, to exclusively those patients who had a primary discharge diagnosis related to an appropriate occlusive indication (Appendix B, online only).

Preoperative data included demographics (age, sex, race) and comorbid conditions. Comorbid conditions included smoking and alcohol use, diabetes, hypertension, rest pain or gangrene, pneumonia, esophageal varices, ascites, dialysis dependence, ventilator dependence, steroid use for chronic condition, history of transient ischemic attack or cerebrovascular accident (CVA), history of angina 1 month before surgery or myocardial infarction (MI) 6 months before surgery, history of severe chronic obstructive pulmonary disease, and history of congestive heart failure. Other patient characteristics analyzed by NSQIP variables were previous percutaneous intervention, previous cardiac surgery, previous revascularization or amputation for peripheral vascular disease, prior operation within 30 days, >4 units of blood in 72 hours before the surgery, and American Society of Anesthesiologists (ASA) physical status classification. Preoperative laboratory variables analyzed included blood urea nitrogen, creatinine, hematocrit, platelets, and international normalized ratio. Intraoperative data analyzed included total operation time, red blood cell units given, surgeon's training, and concurrent carotid endarterectomy.

Outcomes. The primary outcome measure was a composite end point of 30-day CVA/MI/death. According to the NSQIP, CVA is defined as an embolic, thrombotic, or hemorrhagic vascular accident or stroke with motor, sensory, or cognitive dysfunction that persists for 24 hours or more. The NSQIP definition for MI changed throughout the time course of the study. Before 2008, MI was defined as a new transmural acute MI occurring during surgery or within 30 days as manifested by new Q waves on electrocardiography; after 2008, MI was defined as electrocardiographic changes (ST elevation > 1 mm in two or more contiguous leads, new left bundle branch, or new Q wave in two or more contiguous leads), new elevation of troponin more than three times the upper level of the reference range in the setting of myocardial ischemia, or physician diagnosis of MI. Secondary outcomes were 30-day postoperative complications, which included blood transfusions (intraoperative or postoperative use of ≥5 units), superficial surgical site infection, deep surgical site infection, organ/space surgical site infection, pneumonia, pulmonary embolism, ventilator dependence (>48 hours), progressive renal insufficiency, acute renal failure, septic shock, graft failure, deep venous thrombosis or thrombophlebitis, and return to operating room. Hospital length of stay was also analyzed.

Statistical analysis. SAS 9.3 statistical software (SAS Institute, Cary, NC) was used to perform all statistical analyses. Categorical variables are presented as absolute numbers and percentage frequencies, with continuous data presented as mean values ± standard deviation. Categorical variables were analyzed by χ^2 or the Fisher exact test, as appropriate. Continuous variables were analyzed by the Wilcoxon rank sum test or two-tailed independent samples *t* test, as appropriate. Missing data were accounted for by complete case analysis of each variable, and a priori elimination of variables was performed if more than 35 data observations were missing from each variable. Multivariable logistic regression modeling was determined with a backward elimination approach. Regardless of univariable association, surgical approach was forced into the multivariable model as the primary exposure variable of interest. Statistical significance was defined as $P < .05$.

RESULTS

Baseline, patient, and operative factors. We identified 775 patients who underwent transthoracic or extrathoracic reconstructions for occlusive disease of the supra-aortic trunks in the NSQIP database from 2005 to 2011. Of the entire cohort, 83 patients (10.7%) underwent transthoracic reconstructions and 692 patients (89.3%) underwent extrathoracic reconstructions. The mean age of the cohort was 64.3 years, and the majority were white (92.4%) (Table I). Common comorbidities included hypertension requiring therapy (76.0%), history of transient ischemic attack or CVA (35.6%), diabetes (19.4%), and history of an attempted or successful percutaneous coronary intervention, which includes balloon dilation or stent placement (17.6%). Bivariate analysis of more than 20 characteristics showed that patients who underwent transthoracic reconstructions did not differ significantly from patients who underwent extrathoracic reconstructions (Table I). The most common extrathoracic reconstructions were carotid-subclavian bypass (68%), carotid-carotid bypass (14%), and subclavian transposition