From the Society for Vascular Surgery

Anesthetic type and hospital outcomes after carotid endarterectomy from the Vascular Quality Initiative database

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ABSTRACT

Objective: Studies on the safety of carotid endarterectomy (CEA) under different anesthetic techniques are sometimes contradictory. The aim of this study was to compare real-world outcomes of CEA under general anesthesia (GA) vs regional or local anesthesia (RA/LA).

Methods: A retrospective analysis of the Vascular Quality Initiative database (2003-2017) was performed. Primary outcomes included perioperative stroke, death, and myocardial infarction (MI) occurring during the hospital stay. Univariate and multivariate analyses were used. To minimize selection bias and to evaluate comparable groups, patients were matched on baseline variables using coarsened exact matching.

Results: Of 75,319 CEA cases, 6684 (8.9%) were performed under RA/LA. These patients were more likely to be older (median age, 72 vs 71 years) and male (62.5% vs 60.2%), with higher American Society of Anesthesiologists class (class 3-5, 94.2% vs 93.0%) than those undergoing CEA-GA (all $P < .001$). CEA-GA had higher crude rates of in-hospital cardiac outcomes including MI mainly diagnosed clinically or on electrocardiography (0.5% vs 0.2%; $P = .01$), dysrhythmia (1.6% vs 1.2%; $P < .001$), acute congestive heart failure (CHF; 0.5% vs 0.2%; $P < .001$), and hemodynamic instability (27.0% vs 20.0%; $P < .001$) compared with CEA-RA/LA. No difference in perioperative stroke or death was seen between the two groups. On multivariate analysis, CEA-GA was associated with twice the odds of in-hospital MI (adjusted odds ratio [aOR], 1.95; 95% confidence interval [CI], 1.06-3.59; $P = .03$), 4 times the odds of acute CHF (aOR, 3.92; 95% CI, 1.84-8.34; $P < .001$), and 1.5 times the odds of hemodynamic instability (aOR, 1.54; 95% CI, 1.44-1.66; $P < .001$). Patients undergoing CEA-GA had 1.8 times the odds of staying in the hospital for >1 day (aOR, 1.80; 95% CI, 1.67-1.93; $P < .001$). Coarsened exact matching confirmed our results. Risk factors associated with increased cardiac complications (MI and CHF) under GA included female gender, increased age, Medicaid insurance, history of smoking, medical comorbidities (such as hypertension, diabetes, coronary artery disease, and CHF), prior ipsilateral carotid intervention, and urgent/emergent procedures.

Conclusions: Patients undergoing CEA under GA have higher odds of postoperative MI, acute CHF, and hemodynamic instability compared with those undergoing CEA under RA/LA. They are also more likely to stay in the hospital for >1 day. However, the overall risk of cardiac adverse events after CEA was low, which made the differences clinically irrelevant. The choice of anesthesia approach to CEA should be driven by the team's experience and the patient's risk factors and preference. (J Vasc Surg 2018;67:1419-28.)

Carotid endarterectomy (CEA) remains the "gold standard" approach for carotid revascularization and subsequent stroke prevention.[1,2] Anesthetic management during CEA varies among surgeons and different medical institutions. However, the ultimate goal is to maintain cerebral perfusion, to minimize perioperative complications (myocardial infarction [MI] and stroke), and to achieve timely neurologic monitoring and a quick recovery to baseline functional status. The question of the ideal choice of anesthesia for CEA has been a continuous debate.[3-10] Initially, CEA procedures employed local anesthesia (LA) as it facilitated close neurologic monitoring. The paradigm later shifted to general anesthesia (GA), which was shown to contribute to a reduction in cerebral metabolic rate and greater cerebral protection under ischemic conditions.[11,12]

Many studies investigated the influence of anesthesia type on postoperative outcomes; however, the results have been contradictory.[13-15] Whereas some studies suggested better outcomes of CEA with regional or local anesthesia (RA/LA),[8,9,16-19] other studies have found no significant differences between GA and RA/LA.[6,10,15,20,21]

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Author conflict of interest: none.

Presented in the Plenary Session of the 2017 Vascular Annual Meeting of the Society for Vascular Surgery, San Diego, Calif, May 31-June 3, 2017.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

https://doi.org/10.1016/j.jvs.2017.09.028

In 2008, the largest multicenter randomized clinical trial comparing GA with LA for carotid surgery, the General Anesthesia vs Local Anesthesia (GALA) trial, showed no difference in outcomes such as stroke, death, and MI after carotid surgery between the two anesthetic techniques.[6] The latest study from the Carotid Revascularization Endarterectomy vs Stenting Trial (CREST) showed a similar risk of periprocedural MI between CEA-RA and carotid artery stenting (CAS) and twice the risk between CEA-GA and CAS.[8] The study concluded that RA should be seriously considered for patients undergoing CEA and that periprocedural MI is especially one of the few variables favoring CAS over CEA.[8]

As CEA continues to be the most common procedure performed for carotid revascularization and stroke prevention, it is critical to minimize any unfavorable postoperative outcome. This study uses the Vascular Quality Initiative (VQI) database to compare more recent real-world outcomes of GA and LA/RA in patients undergoing CEA.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected Vascular Quality Initiative data
- **Take Home Message:** In 75,319 carotid endarterectomies, those performed under general anesthesia (GA; 91.1%) had a 1.2% rate of perioperative stroke and death, identical to those performed under local/regional anesthesia (LA/RA). GA patients had more frequent postoperative myocardial infarction, acute congestive heart failure, and hemodynamic instability and longer hospital stay than LA/RA patients. The overall risk of cardiac adverse events was low.
- **Recommendation:** This study suggests that there is no difference in perioperative stroke or death after carotid endarterectomy according to the type of anesthesia, but GA was associated with slightly higher rates of cardiac events than LA/RA.

METHODS

Data source. A retrospective analysis of the VQI database was performed including all patients who underwent CEA between January 2003 and February 2017. Patients undergoing concomitant vascular procedures were excluded. The VQI is a prospectively maintained database containing patient- and procedure-specific data from multiple sites across all regions of the United States.[22] At the end of the study period, there were >420 participating centers with >3200 physicians in the VQI. The present study was approved by the VQI Research Advisory Committee. The Johns Hopkins Institutional Review Board waived the need for consent of individual patients under the provisions for deidentified human subject and quality improvement research.

Outcomes. Patients who underwent CEA under GA or RA were identified from variables recorded in the VQI database. Baseline demographics, relevant medical history, and operative information are shown in Tables I and II. Symptomatic status was defined as presence of ipsilateral cortical or ocular symptoms (transient ischemic attack [TIA] or stroke) before surgery. Primary outcomes included perioperative in-hospital neurologic events (TIA or stroke), death, and MI. Protocol MI was defined as the presence of clinical symptoms (chest pain or shortness of breath) or electrocardiographic changes plus a rise of cardiac biomarkers (preferably troponin). Total MI included both protocol MI and troponin-positive only MI. Troponin rise alone was reported if there was a rise in cardiac biomarker values (preferably cardiac troponin) with at least one value above the 99th percentile upper reference limit and in the absence of the six qualifying criteria for MI or sudden death as defined by the VQI. However, troponin levels are not routinely measured in most asymptomatic VQI patients, which should be taken into consideration in interpreting the results. Secondary outcomes included total length of hospital stay (LOS); dysrhythmia requiring treatment with medications or cardioversion; acute congestive heart failure (CHF) necessitating monitoring or treatment in the intensive care or step-down unit; reperfusion syndrome (seizures associated with headache or hemorrhage on computed tomography or magnetic resonance imaging); and hemodynamic instability, defined as the need for more than one dose or continuous infusion (≥15 minutes) of intravenous medication >1 hour after surgery to control hypotension or hypertension.

Statistical analysis. Descriptive statistics were reported as mean (standard deviation) or median (interquartile range [IQR]) for continuous variables and as count (percentage) for categorical variables. Comparison of continuous variables was done using Student *t*-test or Wilcoxon rank sum test, and comparison of categorical variables was performed using Fisher exact or Pearson χ^2 test. Multivariate logistic models were used to evaluate risk-adjusted in-hospital perioperative outcomes after accounting for patients' demographics (gender, age, race, ethnicity, and insurance coverage), symptomatic status, medical comorbidities (smoking, hypertension, diabetes, coronary artery disease [CAD], and CHF), American Society of Anesthesiologists (ASA) classification of physical status class, CEA type (conventional or eversion), and urgency of the procedure. In addition, we performed 1:1 and 1-to-many coarsened exact matching (CEM) based on these variables to validate our results by comparing two similar groups. CEM "coarsens" the pretreatment covariates into categories on the basis of their distribution or natural or intuitive divisions and then finds