

From the New England Society for Vascular Surgery

Characterization of perioperative contralateral stroke after carotid endarterectomy

W. Darrin Clouse, MD, Emel A. Ergul, MS, Virendra I. Patel, MD, MPH, R. Todd Lancaster, MD, MPH, Glenn M. LaMuraglia, MD, Richard P. Cambria, MD, and Mark F. Conrad, MD, MMSc, Boston, Mass

ABSTRACT

Objective: Contralateral stroke is an infrequent cause of perioperative stroke after carotid endarterectomy (CEA). Whereas the risks of ipsilateral stroke complicating CEA have been discriminated, factors that lead to contralateral stroke are poorly defined. The purpose of this study was to identify the risk of perioperative (30-day) contralateral stroke after CEA as well as predisposing preoperative and operative factors. Its specific effect on long-term survival was interrogated.

Methods: The Vascular Study Group of New England (VSGNE) was queried from April 1, 2003, to February 29, 2016, for all CEAs. Duplicated patients and those without complete data were excluded. Patients sustaining contralateral stroke after CEA in the 30-day postoperative period were identified. Demographic, preoperative, and operative factors were analyzed to identify discriminators between those with and those without contralateral stroke. Logistic regression modeling was performed to identify factors independently associated with contralateral stroke. The effect of contralateral stroke on 5-year survival was compared with patients with ipsilateral stroke and no stroke using the Kaplan-Meier method. Log-rank testing compared survival curves.

Results: There were 10,837 CEAs performed during the study. Average age was 70.4 ± 9.3 years; 6605 (61%) patients were male, and 40% ($n = 4324$) were performed for symptoms. Most were current or former smokers ($n = 8619$ [80%]). Coronary artery disease and congestive heart failure were identified in 31% and 8.6%, respectively. Overall, there were 190 strokes within 30 days of CEA (1.8%); 131 were ipsilateral (1.3%), and 59 (0.5%) patients were identified as having contralateral perioperative stroke. Thirteen patients sustained bilateral stroke (0.1%). Significant univariate associations included urgency ($P = .0001$), ipsilateral stenosis severity ($P = .004$), length of operation ($P = .0001$), CEA with coronary artery bypass graft ($P = .0001$), CEA with other arterial surgery ($P = .01$), and CEA with proximal endovascular procedure ($P = .03$). Contralateral occlusion ($P = .06$) and degree of contralateral carotid stenosis ($P = .14$) did not correlate. After logistic regression analysis of significant univariate anatomic and operative factors, length of procedure (odds ratio [OR], 1.08/15 minutes; 95% confidence interval [CI], 1.01-1.15; $P = .02$), urgency of operation (OR, 2.5; 95% CI, 1.3-4.6; $P = .006$), and concomitant proximal endovascular intervention (OR, 8.7; 95% CI, 4.5-31.2; $P = .001$) remained predictors of contralateral stroke after CEA. Occurrence of both ipsilateral ($P < .001$) and contralateral ($P = .023$) stroke significantly reduced 5-year survival compared with those without stroke. There was no difference in the negative survival effect based on laterality of stroke ($P = .24$).

Conclusions: Contralateral stroke after CEA is rare, affecting 0.5% of patients. Traditional risk reduction medical therapy does not affect occurrence. Degree of contralateral stenosis, including contralateral occlusion, does not predict perioperative contralateral stroke. Urgency of operation, length of operation, and performance of concomitant, ipsilateral endovascular intervention predict contralateral stroke risk with CEA. Contralateral stroke affects long-term survival similar to ipsilateral stroke after CEA. (J Vasc Surg 2017;■:1-7.)

From the Division of Vascular and Endovascular Surgery, Massachusetts General Hospital, Harvard Medical School.

Author conflict of interest: none.

Presented at the Forty-third Annual Meeting of the New England Society for Vascular Surgery, Stowe, Vt, September 23-25, 2016.

Correspondence: W. Darrin Clouse, MD, Associate Professor of Surgery, Division of Vascular and Endovascular Surgery, Harvard Medical School, Massachusetts General Hospital, 15 Parkman St, WACC #440, Boston, MA 02114-3117 (e-mail: wclouse@partners.org).

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

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Stroke after carotid endarterectomy (CEA) has been extensively evaluated in large institutional series, administrative databases, and prospective, randomized fashion. Most strokes after CEA are ipsilateral to the carotid artery that was operated on and are related to the technical conduct of the operation. Risk factors specifically related to ipsilateral or all strokes after CEA have been discriminated. However, infrequent but real risk of contralateral stroke has historically been appreciated in 0.3% of patients in the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and 0.4% of those in the Asymptomatic Carotid Atherosclerosis Study (ACAS).^{1,2} More recently, nonipsilateral stroke has been reported in the Carotid Revascularization

Endarterectomy versus Stenting Trial (CREST) and International Carotid Stenting Study (ICSS) as 0.6% and 0.2%, respectively.^{3,4} In our updated institutional series, contralateral stroke complicated 0.5% of 3014 CEAs.⁵ Yet, no dedicated analysis of features associated with contralateral stroke is available. Therefore, the aim of this study was to clarify the specific risk of perioperative contralateral stroke after CEA. Furthermore, we sought to identify factors predisposing to its occurrence as well as its specific effect on long-term survival.

METHODS

A retrospective, cohort assessment of the Vascular Study Group of New England (VSGNE) regional registry data on CEA was performed. The VSGNE is a regional quality initiative developed in 2002. This registry, the oldest regional component of the Vascular Quality Initiative of the Society for Vascular Surgery, has been well described and reviewed.⁶ Deidentified demographic, clinical, and procedural variables are collected on each patient at each of the participating institutions and centralized. Data are collected from the index procedure up to 1 year afterward. For this study's purposes, both the initial operative data and the initial surveillance visit were assessed. Long-term survival was estimated using VSGNE data linked to the Social Security Death Index Masterfile. Participation in this quality registry as a Patient Safety Organization and quality assurance tool for analysis was approved and direct informed consent waived by each participating center's Institutional Review Board. Specific approval for this data collection and assessment was granted after application to the VSGNE Research Advisory Committee.

Definitions and end points. All CEAs entered into the VSGNE registry between April 1, 2003, and February 29, 2016, were queried. Duplicated patients and those without complete data were excluded. Index CEA date was identified. To investigate contralateral stroke related to CEA, those patients undergoing contralateral carotid procedures within 30 days of the index CEA were excluded. Laterality and date of CEA were determined by index data entry review. Patients sustaining perioperative stroke after CEA were identified. This was defined as the occurrence of stroke within 30 days of operation. Date of stroke was obtained from registry data points describing the event. Laterality of stroke was determined by registry data point input as to side of perioperative event. Perioperative stroke was then delineated as ipsilateral or contralateral, with contralateral stroke the primary end point. Forty demographic, preoperative, operative, and postoperative factors were analyzed to identify discriminators between those with and those without contralateral stroke. The degree of ipsilateral and contralateral stenosis was considered categorically as <50%, 50% to 69%, or ≥70%. Contralateral occlusion

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of the prospectively collected Vascular Study Group of New England (VSGNE) database
- **Take Home Message:** After 10,837 carotid endarterectomies, 59 (0.5%) patients had contralateral stroke within 30 days, with reduced 5-year survival. Factors associated with contralateral stroke included procedure length, urgency of operation, and concomitant proximal endovascular procedures.
- **Recommendation:** This study suggests that contralateral stroke after carotid endarterectomy is rare and is associated with longer procedures, with urgent operations, and with concomitant proximal endovascular interventions.

was handled uniquely. Medicine use, both preoperatively and operatively, was considered dichotomously.

Statistical analysis. All statistical calculations were accomplished using SAS 9.2 software (SAS Institute, Cary, NC). Continuous variables are expressed as mean ± standard deviation. Dichotomous variables are described as the percentage of cohort. Univariate analysis was performed using two-tailed Student *t*-test or Wilcoxon rank sum testing for continuous variables. Dichotomous variables were compared using Pearson χ^2 test. Effect of the degree of ipsilateral and contralateral stenosis on contralateral stroke was assessed using Pearson χ^2 testing for multiple variables. A *P* value of < .05 was considered significant. Features significantly associated were considered for inclusion in logistic regression modeling. Given the small number of contralateral events, Bonferroni correction was used to prevent multitest error. Within the final model, only variables with corrected *P* values < .002 were added. Odds ratios (ORs) and 95% confidence intervals (CIs) were derived with *P* values < .05 and 95% CI exclusive of 1.0 representing significant independent factors. Kaplan-Meier actuarial methodology was used to calculate survival curves for patients without stroke, with ipsilateral stroke, and with contralateral stroke. Log-rank testing was used to compare curves.

RESULTS

Patients and stroke. From April 1, 2003, through February 29, 2016, there were 10,837 patients undergoing CEA with complete data identified in the VSGNE meeting inclusion criteria. Age was 70.4 ± 9.3 years. Gender was male in 6606 (61%); 4324 (40%) were symptomatic. There were 190 strokes within 30 days of CEA for an overall perioperative stroke rate of 1.8%. There were 10,778 patients who did not sustain perioperative contralateral stroke, whereas contralateral stroke occurred in 59 (0.5%)

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