

From the Midwestern Vascular Surgical Society

Carotid occlusion is associated with more frequent neurovascular events than moderately severe carotid stenosis

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ABSTRACT

Objective: Asymptomatic internal carotid artery occlusion (CO) presents a clinical dilemma, and presently, the natural history, stroke risk, and optimal management remain ill defined. This study compared outcomes, including neurovascular events (NVEs) and health care costs, between patients with CO and patients with asymptomatic carotid artery stenosis (CS).

Methods: A prospectively maintained database was queried to identify patients with CO and CS with at least >50% carotid stenosis by duplex. We identified and reviewed 622 consecutive patients with asymptomatic carotid artery disease at one academic medical center between 2011 and 2013. Patients with CO (n = 97) were identified and propensity matched by age and gender in a 1:2 ratio with CS patients (n = 194) for further analyses. Univariate and multivariate models were used to analyze baseline characteristics, clinical variables, and 1-year follow-up data from the date of diagnosis. Multivariate analysis was performed by multiple linear regression modeling. Institutional Review Board approval was obtained.

Results: Follow-up data were available for 99% of matched patients. CO patients were younger (72 vs 75 years; $P < .01$) and more likely male (67% vs 53%; $P = .01$) compared with CS patients. After propensity matching, baseline characteristics were similar between groups, with a trend toward higher use of statin therapy among patients with CO. Antiplatelet therapy was used in 79% of patients with CS and in 74% of patients with CO ($P = .45$). The rate of NVE among CO patients was higher than among CS patients at 1 year of follow-up (14% vs 7%; $P = .03$). Among those with NVE, neither antiplatelet therapy (64% vs 77%; $P = .49$) nor statin therapy (86% vs 77%; $P = .58$) appeared to have a significant effect. Health care costs (\$14,361 vs \$12,142; $P = .44$) and hospital admission rate (63% vs 71%; $P = .18$) were similar between groups. Not surprisingly, the rate of vascular procedures was higher in the CS group (55% vs 27%; $P = .04$).

Conclusions: Patients with asymptomatic CO experience more NVEs compared with similar patients with moderately severe CS. Further study of preventative strategies, including intensity of medical therapy, is warranted. (*J Vasc Surg* 2017;■:1-5.)

Asymptomatic internal carotid artery occlusion (CO) is a condition with a variable natural history and unclear clinical significance. Neurovascular event rates among these patients have been reported as low as 0% at 6 years¹⁻⁴ and as high as 26% at 2.6 years of follow-up.⁵ More recently, Grubb et al⁶ reported that the annual risk of

any stroke in the setting of CO is somewhere between 5% and 7%, with a 2% to 6% risk of stroke per year occurring ipsilateral to the occluded carotid. Although CO is found in ~15% of all patients presenting with cerebral infarction (stroke),⁷ the true prevalence of CO remains unknown.⁸

The quality and quantity of evidence to aid clinical management of CO is relatively low compared with that for asymptomatic internal carotid artery stenosis (CS).^{5,9} Most studies evaluating the risk of CO have focused on symptomatic patients because CO has been deemed to have a generally benign course.¹⁰ The current treatment paradigm for patients with established CO prioritizes risk factor modification and medical management over any operative intervention.⁸ For example, no stroke or survival benefit was found among patients with symptomatic CO who underwent intracranial bypass compared with medical therapy.¹¹ The purpose of this study was to compare outcomes, including neurovascular events (NVEs) and health care costs, between patients with CO and patients with CS. We

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hypothesized that NVEs and health care costs would both be higher in CO patients.

METHODS

Patient criteria. We identified patients with CO at an urban academic medical center between January 1, 2011, and December 31, 2013. Patients were identified using the General Surgical Outcomes Quality Improvement Database (SOCRATES) database, a prospectively collected and maintained general surgical outcomes quality improvement database designed to analyze processes and outcome measures. Inclusion criteria were based on duplex ultrasound imaging and lack of neurologic symptoms at time of carotid duplex. CS patients were included if they were noted to have a billing coding for asymptomatic moderately severe CS, which was defined as 50% to 79% (peak systolic velocity between 151 and 240 cm/s with marked spectral broadening), with varying degrees of simultaneous contralateral stenosis at time of duplex.^{12,13} These criteria were selected because asymptomatic patients with <80% CS are not routinely offered surgical intervention at our institution. CO patients were defined as those found to have unilateral occlusion with varying degrees of contralateral stenosis at time of duplex. None of the patients included in our analysis had bilateral CO.

Exclusion criteria included any occurrence of neurovascular phenomena, defined as transient ischemic attack (TIA), amaurosis fugax, stroke, or stroke lesions on imaging related to the ipsilateral carotid artery at or ≤ 1 year before presentation. Patients without at least 6 months of follow-up were also excluded from the study. After exclusions, patients were grouped by CO or CS (Fig 1). The Institutional Review Board reviewed and approved this human subjects study without the need for individual patient consent due to retrospective deidentified data collection and analysis.

Clinical variables. Baseline characteristics included age, gender, race, history of carotid endarterectomy (CEA), antiplatelet and statin medication documentation, and degree of contralateral stenosis. Follow-up data were gathered up to 1 year from presentation duplex assessment. Data included total cost accrued, number of hospital readmissions, general invasive procedures, vascular invasive procedures, and number of NVEs. All patients had comprehensive workup for events where appropriate, including hypercoagulability tests and echocardiography. A procedure defined as a vascular procedure in the database was a procedure performed by a vascular surgeon using a vascular billing code (ie, CEA) and did not include cardiac operations. There were no interventions on an occluded carotid artery directly. Vascular invasive procedures were not specific to carotid disease but rather included all procedures performed by a vascular surgeon during the 1-year follow-up period.

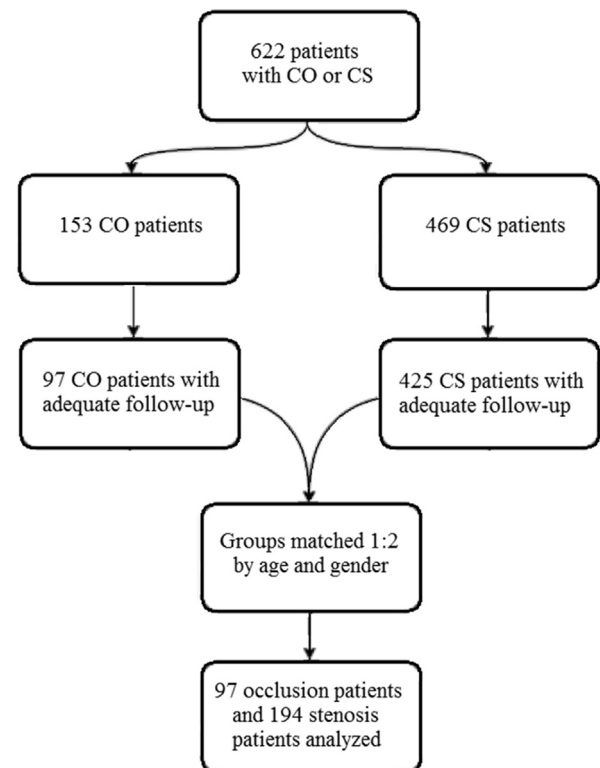


Fig 1. Consolidated Standards of Reporting Trials diagram of study patients. CO, Carotid occlusion; CS, carotid stenosis.

Patients were grouped according to the medication regimen that was documented for most of the follow-up period. The dollar figures quoted are revenue dollars collected against insurance claims.

Statistics. Statistical analyses were performed using R 3.2.5 software (R Foundation for Statistical Computing, Vienna, Austria). Baseline characteristics were summarized using descriptive statistics comparing the groups of patients with CO or CS using Student *t*-tests. A probability value $P < .05$ or 95% confidence interval that did not include 1.0 was considered statistically significant. To control for age and gender differences, CO patients were propensity matched with CS patients by the nearest-neighbor method. Multivariate analysis was performed by multiple linear regression modeling. Nonparametric Mann-Whitney analysis was used if groups did not satisfy the central limit theorem of at least 30 patients in each group in the analysis.

RESULTS

We identified 622 patients from our database who met inclusion criteria. Baseline characteristics of CO patients were compared with all CS patients (Table I), and several significant differences were observed between the groups. In our unadjusted sample, CO patients were

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