

# Carotid Artery Stent Placement and Carotid Endarterectomy: A Challenge for Urgent Treatment after Stroke—Early and 12-Month Outcomes in a Comprehensive Stroke Center

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## ABSTRACT

**Purpose:** To compare feasibility, 12-month outcome, and periprocedural and postprocedural risks between carotid artery stent (CAS) placement and carotid endarterectomy (CEA) performed within 1 week after transient ischemic attack (TIA) or mild to severe stroke onset in a single comprehensive stroke center.

**Materials and Methods:** Retrospective analysis of prospective data collected from 1,148 patients with ischemic stroke admitted to a single stroke unit between January 2013 and July 2015 was conducted. Among 130 consecutive patients with symptomatic carotid stenosis, 110 (10 with TIA, 100 with stroke) with a National Institutes of Health Stroke Scale (NIHSS) score < 20 and a prestroke modified Rankin Scale (mRS) score < 2 were eligible for CAS placement or CEA and treated according to the preference of the patient or a surrogate. Periprocedural (< 48 h) and postprocedural complications, functional outcome, stroke, and death rate up to 12 months were analyzed.

**Results:** Sixty-two patients were treated with CAS placement and 48 were treated with CEA. Several patients presented with moderate or major stroke (45.8% CEA, 64.5% CAS). NIHSS scores indicated slightly greater severity at onset in patients treated with a CAS vs CEA ( $6.6 \pm 5.7$  vs  $4.2 \pm 3.4$ ;  $P = .08$ ). Complication rates were similar between groups. mRS scores showed a significant improvement over time and a significant interaction with age in both groups. Similar incidences of death or stroke were shown on survival analysis. A subanalysis in patients with NIHSS scores  $\geq 4$  showed no differences in complication rate and outcome.

**Conclusions:** CAS placement and CEA seem to offer early safe and feasible secondary stroke prevention treatments in experienced centers, even after major atherosclerotic stroke.

## ABBREVIATIONS

CAS = carotid artery stent, CEA = carotid endarterectomy, GLM = general linear model, ICA = internal carotid artery, NIHSS = National Institutes of Health Stroke Scale, mRS = modified Rankin scale, TIA = transient ischemic attack

The efficacy and safety of early carotid artery stent (CAS) placement compared with carotid endarterectomy (CEA) in patients with symptomatic carotid artery stenosis has been

questioned for several years (1,2). Although CEA has been found to be superior to CAS placement, new techniques and the effect of operator experience make CAS placement a

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Appendices A–C and Figure E1 are available online at [www.jvir.org](http://www.jvir.org).

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## EDITORS' RESEARCH HIGHLIGHTS

- This study is a nonrandomized comparison of 130 patients with ischemic stroke (including major stroke) and ipsilateral carotid artery stenosis ( $\geq 70\%$  or 50%–69% if ulcerated or containing thrombus) who received carotid endarterectomy (CEA;  $n = 62$ ) or carotid artery stent (CAS) placement ( $n = 48$ ) within 7 days of symptom onset. Patients or surrogates chose among options after counseling by a neurologist uninvolved in the study.
- CAS placement was associated with a significantly greater modified Rankin score at 1 month, but there was no difference at the other intervals (3, 6, and 12 mo). There were no significant differences in complication rates between CEA and CAS placement.
- CEA and CAS placement were equally safe and efficacious when performed in the early interval following even major stroke. Although no patient in this group received mechanical thrombectomy, it does provide some credence to a margin of safety should CAS placement be required to fully complete a stroke thrombectomy procedure.

possible alternative to CEA that should not be disregarded (3–6).

Compared with older studies, pooled analysis of randomized controlled trials on this topic are less discouraging concerning the use of a CAS, especially in younger subjects (7–11). Although CAS placement resulted in higher periprocedural stroke and death rates in female patients, symptomatic patients, and individuals older than 65 years (2,12,13), data on the safety of early intervention ( $< 7$  d from stroke onset) are scarce, refer only to cases of transient ischemic attack (TIA) or minor stroke, and often deal with the unavailability of both procedures in a single clinical setting (6,14–18).

Current guidelines for stroke management have not established a clear appropriateness of emergent or urgent CEA or CAS treatment, especially in cases of major stroke (19), whereas guidelines for stroke prevention (20) suggest carotid revascularization within 2 weeks after stroke in the absence of contraindications. The choice between treatments is considered only in patients with low to average risk in the setting of intervention, and it depends on the percentage of stenosis and anatomic or medical conditions, with a preference for CEA in older patients with no clear recommendations about the appropriate timing (20). In this context, vascular surgery guidelines (21) make particular reference to the requirement of neurologically stable condition in symptomatic patients. Nonetheless, stroke neurologists are often faced with the hard decision to choose an appropriate treatment, albeit not necessarily in patients in stable condition or who have experienced a minor stroke, as they are well aware that the risk of recurrent stroke caused by symptomatic internal carotid artery (ICA) stenosis while

awaiting revascularization has been reported to increase steeply after stroke onset (22). Thanks to the advent of less invasive revascularization techniques with new-generation stents and the more efficient results recently obtained (23), it is possible for selected patients (based on age, stroke severity, clinical stability, and comorbidities) to benefit from a tailor-made therapy including CAS placement in the acute setting.

The present study aimed to compare feasibility (efficacy, safety, and practicability), periprocedural risks, and 12-month outcomes of early treatment with CAS placement versus CEA in patients admitted for an acute TIA or stroke, including major stroke attributable to an extracranial carotid artery stenosis.

## MATERIALS AND METHODS

Institutional review board approval for the study and written informed consent from all patients or surrogate decision-makers were obtained. A retrospective analysis of prospective data collected from consecutive patients with TIA or ischemic stroke admitted to a single comprehensive stroke unit between January 2013 and July 2015 was performed. Patients were evaluated in the acute phase by stroke neurologists and managed in accordance with the current international guidelines (24,25). Among the initial 1,148 patients, 130 had a symptomatic extracranial ICA stenosis. Color duplex ultrasound (US) imaging and/or multislice computed tomographic (CT) angiography examination were employed to define the site, length, and degree of stenosis as well as the structure of the plaque. An extensive diagnostic workup was performed to determine stroke etiology and specific secondary prevention treatment (Appendix A [available online at [www.jvir.org](http://www.jvir.org)]). TIA was defined as any neurologic dysfunction caused by focal brain or retinal ischemia without any lesion visible on neuroimaging (26), whereas an ischemic stroke was defined as any new, persistent neurologic deficit caused by disturbances in the blood supply to the brain with acute infarction visible on CT or magnetic resonance imaging.

Selection criteria for a possible revascularization procedure were the presence of (i) an atherosclerotic carotid artery lesion located on the clinically relevant side with a stenosis of  $\geq 70\%$  or (ii) an unstable 50%–69% stenosis (ie, ulcerated lesions and/or thrombus in the lumen). Only patients for whom both treatments were feasible were included (20 patients were excluded) according to the inclusion and exclusion criteria listed in Appendix B (available online at [www.jvir.org](http://www.jvir.org); 6,14–17). As a result, 110 patients (10 with TIA, 100 with stroke) were included in the statistical analysis: 62 patients received a CAS (mean age  $\pm$  standard deviation, 70.97 y  $\pm$  11.6) and 48 patients underwent CEA (age, 69.31 y  $\pm$  9.1); of these, 9 patients received intravenous recombinant tissue plasminogen activator (CEA,  $n = 3$ ; CAS,  $n = 6$ ), but no intra-arterial stroke therapy was required. The option of CAS

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