

# Medical Therapy for Asymptomatic Patients and Stent Placement for Symptomatic Patients Presenting with Carotid Artery Near-Occlusion with Full Collapse

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## ABSTRACT

**Purpose:** To report long-term results of stent placement and medical therapy for symptomatic and asymptomatic patients, respectively, with carotid artery near-occlusion with full collapse.

**Materials and Methods:** Between January 2008 and December 2010, 204 carotid arteries diagnosed by duplex scanning as exhibiting complete occlusion were re-examined with CT angiography; 46 arteries in 46 patients were patent with threadlike lumens and were reclassified as exhibiting near-occlusion with full collapse. Asymptomatic patients ( $n = 22$ ) received best medical therapy (BMT) alone, and symptomatic patients ( $n = 24$ ) were referred for carotid artery stent (CAS) placement plus BMT. Patients underwent clinical follow-up for 63.9 months  $\pm$  23.6 and duplex surveillance.

**Results:** None of the 22 asymptomatic patients treated with BMT alone experienced neurologic events during the follow-up interval. Four died of unrelated causes, resulting in a cumulative survival rate of 81.8%. Technical failure occurred in 5 of 24 symptomatic patients, but none had perioperative complications related to inability to cross the near-occlusion. Of the 19 patients with procedural success, 1 developed immediate upper limb monoparesis; none had periprocedural myocardial infarction, and none died. At 60-month follow-up, patients who underwent successful CAS placement had neurologic event-free and cumulative survival rates of 89.4% and 89.4%; patients with failed recanalization had neurologic event-free and cumulative survival rates of 0% and 40.0% ( $P = .01$ ).

**Conclusions:** Asymptomatic patients with carotid near-occlusion with full collapse experienced good outcomes with BMT alone. Symptomatic patients who underwent CAS placement demonstrated long-term survival and freedom from neurologic event rates comparable to those of asymptomatic patients.

## ABBREVIATIONS

BMT = best medical therapy, CAS = carotid artery stent, CEA = carotid endarterectomy, ICA = internal carotid artery, NASCET = North American Symptomatic Carotid Endarterectomy Trial, TIA = transient ischemic attack

Stenotic lesions of the carotid bulb can be severe enough to substantially reduce distal flow, leading to chronic pressure loss in the ipsilateral internal carotid artery (ICA) followed by vessel narrowing. This condition is referred to as near-occlusion (1). In extreme conditions, ICA narrowing can

be very pronounced, with imaging examinations showing only a threadlike lumen, which was previously defined as the string sign (2). More recently, Johansson and Fox (3) recommended the term near-occlusion with full collapse to describe the threadlike appearance caused by an atherosclerotic lesion at the carotid bifurcation because string sign and other terms, such as slim sign and pseudo-occlusion, are commonly used for other entities, such as dissection and radiation-induced carotid disease (4,5), and to inaccurately describe proximal stenotic lesions without any distal narrowing (6). Near-occlusion without full collapse manifests with a lumen that appears normal, albeit reduced in size. The prevalence of carotid near-occlusion with and without full collapse is estimated at 0.5%–10% of all patients treated with carotid endarterectomy (CEA) or recruited into prospective related investigations (7). The finding of

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**Table 1.** Clinical Characteristics of Asymptomatic and Symptomatic Groups

Characteristic	Overall	Asymptomatic	Symptomatic	P
Age, y	65.7 ± 10.8	66.1 ± 12.5	65.3 ± 9.12	.86
Male sex	30 (65.2)	12 (54.5)	18 (75.0)	.25
Left side	24 (52.2)	11 (50.0)	13 (54.2)	1.0
Contralateral occlusion	3 (6.5)	0	3 (12.5)	.23
Arterial hypertension	40 (87.0)	18 (81.8)	22 (91.7)	.29
Diabetes	16 (34.8)	9 (40.9)	7 (29.2)	.53
Active smoker	29 (69.0)	12 (54.5)	17 (85.0)	.07
Hypercholesterolemia	35 (76.1)	16 (72.7)	19 (79.2)	.86
Serum creatinine, mmol/L	90.2 ± 16.8	84.9 ± 14.1	96.4 ± 17.7	.03
Body mass index	24.8 ± 3.2	24.0 ± 3.2	25.6 ± 3.0	.15

Note—Quantitative values are presented as mean ± SD; qualitative data are presented as number (%).

carotid near-occlusion with full collapse is even more infrequent (8).

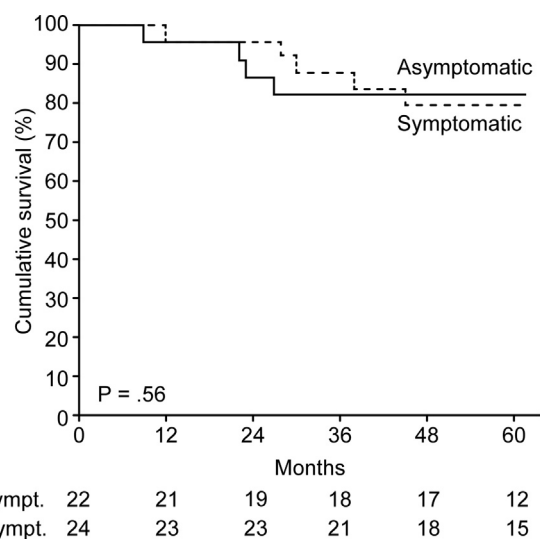
Therapeutic strategies for patients with internal carotid near-occlusion with full collapse are controversial. The North American Symptomatic Carotid Endarterectomy Trial (NASCET) (9) showed that CEA is beneficial for symptomatic patients. In contrast, the European Carotid Surgery Trial (10) indicated that medical therapy is the best choice for symptomatic patients with near-occlusion. Regarding asymptomatic patients with carotid near-occlusion with full collapse, the prognosis and natural history are unknown (8). The objective of this study was to present the long-term results of endovascular treatment for symptomatic patients with carotid near-occlusion with full collapse. Asymptomatic patients with this condition were treated with strict best medical therapy (BMT) to evaluate the prognosis and natural history of this patient population.

## MATERIALS AND METHODS

The institutional review board approved this study, and all patients provided informed consent for the procedure and research study. In a single-center prospective investigation, 195 patients with a diagnosis of carotid occlusion obtained by conventional duplex scanning (bilateral in 9 cases) were evaluated between January 2008 and December 2010. The patients underwent additional computed tomography (CT) angiography of the supra-aortic vessels.

CT angiography was performed with a multidetector helical CT scanner (MX 8000; Philips Medical Systems, Amsterdam, Netherlands) with 6-mm slices at a reconstruction interval of 0.5 mm. Slices were acquired after injection of a nonionic iodinated contrast agent, which was administered at a flow rate of 4 mL/s to a maximum volume of 100 mL. To guarantee uniform and adequate flow, the contrast agent was administered with an injection pump, and a radiologist who was experienced in bolus tracking supervised all examinations.

Based on CT angiography, 46 patients (46 ICAs) had carotid artery near-occlusion with full collapse in the distal segment and no intracranial vessel obstruction. These



**Figure 1.** Similar overall cumulative survival of symptomatic (dotted line) and asymptomatic (solid line) patients after 60 months.

patients formed the cohort of this study and were followed until December 2015. The mean follow-up duration was 63.9 months ± 23.6. Occlusion of the other 158 ICAs was confirmed, and the patients were treated medically and excluded from analysis.

The patients were classified according to their clinical status (11) as determined by an independent neurologist. Symptomatic patients (24 cases) had a history of ipsilateral transient ischemic attack (TIA), ipsilateral minor or major stroke (modified Rankin Scale score < 3 or ≥ 3), or symptoms related to low central nervous system blood flow (global cerebral hypoperfusion) (12) for up to 6 months before the initial evaluation. Asymptomatic individuals (22 cases) had no history of ischemic or low-flow symptoms (8 cases) or had previous events 13–90 months before the initial evaluation (14 cases).

The clinical and epidemiologic characteristics of the patients are presented in **Table 1**. There were no significant differences in age, sex, affected side, contralateral carotid occlusion, body mass index, hypertension, diabetes mellitus,

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