Periprocedural Outcomes of Carotid Artery Stenting in Elderly Patients

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Background: Carotid artery stenting has emerged as an alternative to carotid endarterectomy especially in patients with high risk of carotid endarterectomy. Older age (≥80 years old) was recognized as one of the high risk factors of carotid endarterectomy. However, the association between older age and increased risk of adverse events for carotid artery stenting has been reported. The purpose of this study was to evaluate the association between age and periprocedural outcomes after carotid artery stenting. *Methods:* A total of 126 symptomatic and asymptomatic cases of carotid artery stenosis were treated with tailored carotid artery stenting. The type of stents and embolic protection devices were chosen according to clinical and morphologic characteristics of the patients. Procedural, imaging, and clinical outcomes were retrospectively assessed and compared between the elderly patients group (≥80 years old) and the non-elderly patients group (<80 years old). *Results:* Clinical and morphologic characteristics except for dyslipidemia were not significantly different between the 2 groups. Periprocedural neurologic complications were not significantly different between the 2 groups ($P = .095$). Minor stroke occurred more frequently in the elderly patients group ($P = .021$). However, the frequency of major stroke was not significantly different between the 2 groups ($P = 1$). Presence of new ischemic lesions on postprocedural examination was not significantly different between the 2 groups ($P = .84$). Myocardial infarction and death did not occur in either group. *Conclusions:* Carotid artery stenting can be performed safely in elderly patients, comparable with non-elderly patients. **Key Words:** Periprocedural outcomes—carotid artery stenosis—carotid artery stenting—elderly patients.

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Introduction

Recent developments in neurointerventional techniques and devices have led to carotid artery stenting (CAS) being a viable option in carotid endarterectomy (CEA). Recent data from the Carotid Revascularization Endarterectomy versus Stenting Trial (CREST) demonstrated similar outcomes and safety for both CAS and CEA.[1] There were no significant differences in the rate of the postprocedural ipsilateral stroke over the 10 years' follow-up between the CAS group and the CEA group.[2] However, CAS tended to show greater efficacy at younger ages, and CEA at older ages in the CREST study. The CAS-to-CEA risk was reported to increase with advancing age.[3] The increasing CAS-to-CEA risk at older ages was associated with increasing stroke event rate for those treated with CAS, but not in those treated with CEA. The CREST lead-in phase showed that octogenarians treated with CAS had a higher 30-day periprocedural stroke or death rate than nonoctogenarians.[4] On the other hand, CAS performed by experienced operators in careful patients and lesion selection resulted in low periprocedural stroke and death rate (3.3%), and CAS in anatomically suitable elderly patients could be performed with low adverse event rates comparable with those achieved in a younger population.[5] After the periprocedural period, the incidence of ipsilateral stroke was similarly low with CAS and CEA,[1] and age-related arterial changes may contribute to the occurrence of stroke.

In this study, we compared the periprocedural outcomes following tailored CAS between the elderly patients group (≥80 years old) and the non-elderly patients group (<80 years old), and evaluated an interaction between age and stroke at the periprocedural period.

Materials and Methods

We retrospectively analyzed the medical records of patients who underwent tailored CAS for symptomatic and asymptomatic carotid artery stenosis at our institution from April 2010 to December 2015. During this period, 130 cases were treated with CAS. Among them, 4 cases who suffered progressive stroke and were treated in acute phase were excluded from this study. Finally, 126 cases were included in this study. Clinical and imaging periprocedural outcomes were assessed and compared between the elderly patients group and the non-elderly patients group.

Morphologic characteristics of the carotid artery lesion were evaluated on digital subtraction angiography, magnetic resonance (MR) plaque imaging, 3-dimensional computed tomography angiography, and carotid duplex ultrasound. Vulnerable plaque was defined as higher intensity area in the plaque compared with the sternocleidomastoid muscle detected by MR plaque imaging or echolucent plaque detected by carotid duplex ultrasound. The degree of stenosis was measured according to the North American Symptomatic Carotid Endarterectomy Trial criteria.[6] Pseudo-occlusion was defined according to the criteria reported by Hirata et al.[7] Existence of coronary artery disease (CAD) was examined before the CAS procedure. Modalities of CAD detection including coronary computed tomography angiography, myocardial perfusion scintigraphy, and coronary angiography were cardiologists' discretion. The CAD was treated before the CAS if the lesion was judged to be under necessity of treatment by cardiologist. In symptomatic cases, the timing of CAS procedure was more than 3-4 weeks after symptom onset. The indications of CAS were carotid artery stenosis greater than or equal to 50% in symptomatic patients and greater than or equal to 80% in asymptomatic patients.

CAS Procedure and Periprocedural Management

All patients received statins at least 14 days before the procedure and dual antiplatelet therapy with aspirin and clopidogrel, aspirin and cilostazol, or clopidogrel and cilostazol at least 7 days before the procedure.

All CAS procedures were performed by specialized neuroendovascular physicians under local anesthesia and intravenous sedation. Under adequate systemic heparin administration, predilatation, self-expandable stent placement, and postdilatation, if necessary, were performed using embolic protection devices (EPDs). CAS technique including most appropriate EDP and stent type was at operator's discretion according to the morphologic and clinical characteristics. EPDs included distal filter protection, distal balloon protection, and proximal protection as a flow reversal technique. For a case with tight stenosis, vulnerable plaque, or thrombus-containing plaque, proximal protection was preferentially used. Our stent selection strategy was as follows: closed-cell stent (Carotid Wallstent Monorail, Boston Scientific, Natick, MA) is suitable for cases of vulnerable plaque and straight lesions. Open-cell stent (Precise, Cordis Corporation, Miami, Lakes, FL; and Protégé, ev3 Inc., Plymouth, MN) is suitable for cases of tortuous lesions and fibrous or calcified lesions. The diameter of the stent was 1-2 mm larger than the diameter of carotid artery lumen proximally to the stenosis. Atropine was administered prophylactically just before predilatation in all cases. Blood pressure, heart rate, and neurologic symptoms were closely monitored after the CAS procedure. Vasopressor was administrated intravenously when systolic blood pressure was decreased under 80 mm Hg and sustained. Postprocedural diffusion-weighted (DW) MRI was performed within 72 hours after the CAS procedure, and was evaluated for the presence of new ischemic lesions in the ipsilateral hemisphere compared with DW-MRI before the CAS procedure.

We compared baseline characteristics of the patients, procedural characteristics, and periprocedural major adverse events, which included any stroke, myocardial infarction