Hybrid Interventions in the Case of Combined Stenosis of the Carotid Bifurcations and Supra-Aortic Arteries

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Objectives: The purpose of our study is to describe the technique, safety, and efficacy of hybrid carotid revascularization for the treatment of combined occlusive lesions of the carotid bifurcations and supra-aortic arteries. *Materials and Methods:* We monitored the results of hybrid surgical interventions including carotid endarterectomy (CEA) and stenting either the common carotid artery (CCA) or the brachiocephalic trunk (BCT) in 12 patients. Nine men and 3 women with occlusive atherosclerosis made up the cohort. All surgical interventions were performed with local anesthesia by means of standard operative access to the bifurcation of the carotid artery. After the correction of the proximal stenosis of the CCA or BCT with subsequent angiography, the CEA was performed. The mean follow-up was 33.5 months (range, 6-48). *Result:* Ten patients underwent left CCA stenting in combination with CEA. Among the 10 patients, CEA was performed using the eversion technique in 5 cases and patch angioplasty in the other 5 cases. In the remaining 2 cases, the patients underwent CEA with patch angioplasty of the right internal carotid artery in combination with stenting of the BCT critical stenosis. During the early postoperative period and follow-up to 48 months, a stroke was not registered. *Conclusion:* Hybrid interventions (CEA and stenting of the CCA or BCT) allow combination of the advantages of each method in the treatment of multilevel vascular disease. This study confirms the safety and efficacy of hybrid interventions in a small cohort of patients while emphasizing the need for future randomized controlled trials in larger populations. **Key Words:** Carotid artery—tandem lesions—hybrid procedure—carotid endarterectomy—carotid bifurcations—supra-aortic arteries.

Introduction

Combined lesions of the carotid bifurcations and supra-aortic arteries (common carotid artery [CCA] and brachiocephalic trunk [BCT]) that are suitable for hybrid techniques do not frequently occur. Approximately 1%-2% of patients will have hemodynamically significant inflow disease at the supra-aortic arteries and carotid bifurcation.[1-3]

The management of this anatomic distribution of multilevel disease can be a challenge to plan and perform for clinicians. The incorporation of endovascular technique as a part of a hybrid surgical approach to these combined vascular lesions has introduced a safe and successful management option in this challenging subset of patients. It is in this anatomic context that combined carotid endarterectomy (CEA) and retrograde CCA or BCT stenting may potentially represent the best option for intervention. Over the past decade, only a few studies addressing this subject were published with only a small number of patients included in the analyses.[3-5] The technical success of the hybrid approach combining CEA and retrograde CCA stenting is 97% in reported cases. In the absence of a randomized controlled trial, we rely on data from individual case reports and small series to extrapolate

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reasonable conclusions. Three different management strategies address the problem of tandem lesions: (1) extra-anatomic bypass for inflow combined with CEA, (2) proximal CCA stenting combined with CEA, and (3) a completely endovascular approach of the proximal CCA and carotid bifurcation stent placement.[2,6]

The purpose of our study is to describe the technique, while evaluating the safety and efficacy of hybrid carotid revascularization in the context of combined stenosis of the carotid bifurcation and supra-aortic arteries (CCA and BCT).

Materials and Methods

This is a single-center prospective cohort study, including all patients undergoing hybrid carotid revascularization from 2010 to 2014. All patients entered the study after procedure with informed consent. A total of 12 patients were included in our cohort; no patients were excluded. There were 9 men and 3 women, with an average age of 59 ± 6.5 years. Atherosclerosis was the presumed etiology of arterial stenosis in all of the cases. Every patient in the cohort carried a history of arterial hypertension, while 7 (58.3%) patients' anamnesis included coronary heart disease, and 3 patients had suffered an ischemic stroke prior to their presentation with residual symptoms. In 2 cases diabetes mellitus was diagnosed. All patients were smoking or had smoking in anamnesis. Before the hybrid surgery procedure, all patients were investigated with color Doppler ultrasonography and multidetector computed tomographic angiography. The degree of carotid artery stenosis was measured according to the recommended methods of the North American Symptomatic Carotid Endarterectomy Trial and the European Carotid Surgery Trial (ECST).[7,8]

All surgical interventions were performed with local anesthesia by means of standard operative access to the carotid artery bifurcation. After administering heparin, the internal carotid artery (ICA) was clamped distal to the diseased segment of the artery, thus reducing the risk of distal embolization. A 6F sheath was placed in the femoral artery and a pigtail catheter was positioned in the aortic arch so that positioning can be confirmed before stent placement. A retrograde puncture of the CCA was performed at the proximal end of the future arteriotomy site, proximal to the level of the bifurcation lesion. The stenting of the CCA or BCT was then performed, depending on the clinical situation. We performed retrograde arteriogram to confirm the appropriate position of the stent, extending 2 mm into the aortic arch. After the correction of the proximal stenosis of the CCA or BCT and the performance of the angiography for confirmation of position, the CEA was performed using either the eversion technique (n = 5) or patch angioplasty (n = 7). The endovascular procedures were carried out in an angiography suite under the control of GE Innova IGS 630 (GE OEC Medical Systems, Inc., USA). All patients received perioperative anticoagulation with heparin 5000 IU (with a goal ACT of 300). After operations, aspirin (100 mg per day) and clopidogrel (75 mg per day) were prescribed for 6 months. After 6 months, aspirin (100 mg per day) was recommended for the lifelong use. Carotid shunt was used in 1 case.

The patients were then followed up at 6, 12, 24, 36, and 48 months after hybrid procedure. Follow-up visits consisted of a symptomatic evaluation, clinical assessment with physical examination, complete neurological evaluation, and serial color Doppler ultrasonography.

Statistical Analysis

The quantitative data are presented as mean and standard deviation. For testing the statistical hypothesis, the significance level of .05 was selected. The survival estimates were determined using the Kaplan–Meier method.

Results

The patients' demographic and clinical characteristics are shown in Table 1. In 10 cases, hemodynamically significant stenosis of the left ICA of more than 70% (ECST) was found in combination with stenosis of more than 60% (ECST) of the left CCA (Fig 1). These patients underwent stenting of the left CCA stenosis in combination with CEA. Five patients underwent CEA using the eversion technique and 5 patients using patch angioplasty (Fig 2).

In 2 cases, patients had right ICA stenosis of more than 70% (ECST) combined with critical stenosis of the BCT

Table 1. *Clinical characteristics of patients*

Characteristics	Patients (n = 12)
Male	9 (75%)
Female	3 (25%)
Age, years	59 ± 6.5
Symptomatic patients	3 (25%)
Asymptomatic patients	9 (75%)
Arterial hypertension	12 (100%)
Coronary heart disease	7 (58.3)%
Stenosis of the left internal carotid artery and common carotid artery	10 (83.3%)
Stenosis of the right internal carotid artery and brachiocephalic trunk	2 (16.7%)