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Technical and Clinical Success and Long-Term Durability of Endovascular Treatment for Atherosclerotic Aortic Arch Branch Origin Obstruction: Evaluation of 144 Procedures

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WHAT THIS PAPER ADDS

In literature, large series evaluating the mid-term and or long-term results of endovascular treatment for aortic arch branch origin (AABO) obstruction are scarce. This study evaluated the mid-term and long-term results of AABO to show that endovascular treatment of arch branch origin obstruction is a procedure of acceptable safety with good mid-term results.

Objectives: Endovascular treatment of atherosclerotic obstruction of aortic arch branch origins (AABO) has largely replaced open surgery, but long-term outcome data are lacking. This study evaluated mid-term and long-term results of these procedures.

Design: Retrospective cohort study.

Materials and methods: Patients underwent endovascular treatment for symptomatic atherosclerotic stenosis of AABO between 1995 and 2012. Technical success was defined as uncomplicated revascularization and residual stenosis $\leq$30%. The primary end point was freedom from restenosis $\geq$50% on Duplex ultrasonography or magnetic resonance angiography. Secondary end points were freedom from target lesion revascularization or recurrent symptoms.

Results: 144 lesions were treated in 114 patients (75 female; mean age 66.3 years), by percutaneous transluminal angioplasty (PTA) in 20 patients and PTA and stent in 117 patients (brachiocephalic artery [BCA] 9/54; left common carotid artery [LCCA] 0/7; left subclavian artery [LSA] 11/56). The lesion could not be passed in four patients, and in three patients the intervention was terminated before angioplasty. The 30-day technical success was 94.4%, without deaths or strokes. Mean follow-up was 52.0 months (range 2–163 months). Restenosis-free survival was 95.6%, 92.9%, 87.6%, and 83.2% at 12, 24, 48, and 60 months, respectively. Log-rank test showed no significant difference between PTA only and PTA with additional stent placement at any point ($p = .375$), nor between BCA ($n = 51$), LCCA ($n = 6$), or LSA ($n = 57$). During follow-up, 27 patients (23.7%) became symptomatic (15 BCA, 1 LCCA, and 11 LSA); 19 patients with a restenosis of the target lesion (mean 56.7 months). Symptom-free survival was 94.7%, 92.0%, 82.3%, and 77.9% at 12, 24, 48, and 60 months, respectively.

Conclusion: Endovascular treatment of aortic arch branch origin obstruction is safe and efficacious in experienced hands and can be considered as the preferred treatment, with good mid-term durability. Recurrent symptomatic lesions can be treated safely by renewed endovascular means.

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INTRODUCTION

In the general population, the incidence of significant stenosis or occlusion at an aortic arch branch origin (AABO) ranges from 0.5% to 6.4%, with higher occurrence in the brachiocephalic artery (BCA) and left subclavian artery (LSA) compared with the left common carotid artery (LCCA).[1,2] Until 30 years ago, AABO steno-occlusive disease could be treated only with open surgery.[3,4] Despite high long-term

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patency, open surgery has been associated with substantial morbidity and mortality rates.[3,4]

Nowadays, PTA, with or without stenting, is considered feasible and safe and is accepted by most specialists as the first line of treatment for AABO lesions.[3,4] However, reported adverse effects are significant residual stenosis, a high rate of restenosis, and dissection, resulting in limited durability and, ultimately, the need for additional vascular interventions.[5]

Published reports on endovascular treatment of atherosclerotic stenosis or occlusion of the AABO are relatively scarce, with a limited numbers of cases, including only four reports of more than 50 procedures.[2,6–8] Furthermore, these studies are mostly limited to initial success or short-term outcome only. The aim of the present cohort study was to evaluate the mid-term and long-term benefit of endovascular treatment of clinically significant stenosis or occlusion of the AABO.

MATERIALS AND METHODS

Patients and lesions

The study included all patients with symptomatic atherosclerotic lesions of the AABO who received primary endovascular therapy in two large tertiary referral vascular centers in the Netherlands (St. Antonius Hospital, Nieuwegein: 64 patients, 77 interventions, and University Medical Center Utrecht: 50 patients, 67 interventions) between September 1995 and March 2012. The institutional review boards of both hospitals approved this retrospective case cohort analysis.

The initial diagnosis of AABO stenosis or occlusion was based on clinical symptoms and a physical examination. Additional imaging, including duplex ultrasonography (DUS), magnetic resonance arteriography (MRA), and/or computed tomography arteriography (CTA), revealed a ≥50% stenosis or occlusion. The diagnosis of subclavian steal syndrome was based on ipsilateral effort-related fatigue, a blood pressure gradient between the upper extremities, and DUS documented retrograde flow in the vertebral artery (VA) caused by significant stenosis of the subclavian artery.

Inclusion criteria for intervention and the present analysis were symptomatic primary stenosis ≥50% or occlusion at the AABO. All patients and indications for revascularization were discussed in multidisciplinary panels consisting of interventional radiologists, vascular surgeons, and vascular neurologists. Baseline patient characteristics are summarized in Table 1.

Table 1. Summary of patient, lesion, and procedure characteristics.

Patient characteristics	
Total number of patients	114 (100%)
Average age, years	66.3 (range 42–77)
Female	75 (65.8%)
Comorbidity	
Smoker	16 (14.0%)
Hypertension	34 (29.8%)
Hypercholesterolemia	29 (25.4%)
Diabetes mellitus type 2	13 (11.4%)
Preprocedural symptoms	**Total interventions: 144**
TIA	12 (8.3%)
Stroke	1 (0.7%)
Cerebrovascular insufficiency	14 (9.7%)
Amaurosis fugax	35 (24.3%)
Upper limp claudication	52 (36.1%)
Dizziness	26 (18.1%)
Subclavian steal syndrome	5 (3.5%)
Lesion characteristics	**Total interventions: 144**
<50% stenosis	0 (0.0%)
50–70% stenosis	71 (49.3%)
>70% stenosis	68 (47.2%)
Occlusion	5 (3.5%)
Procedure characteristics	**Total interventions: 144**
Technical success	136 (94.4%)
PTA alone	20 (13.9%)
PTA and stent placement	117 (81.2%)
Residual stenosis >30%	1 (0.7%)

Values are given as n (%), unless otherwise stated.
PTA = percutaneous transluminal angioplasty; TIA = transient ischemic attack.

Preinterventional and postinterventional imaging

The preprocedural examination consisted of color-coded DUS, MRA, or CTA of the AABO. At least two imaging studies were performed in 112 of 114 patients to confirm the diagnosis and prepare for an optimal intervention strategy. Also, two imaging studies were performed in all patients receiving endovascular reintervention or re-reintervention. Origin obstruction was defined as an occlusion or stenosis of ≥50% at the transition of the aortic arch to the supra-aortic branch arteries.

A DUS-based peak systolic velocity (PSV) measurement of more than 125 cm/s was the applied threshold for >50% stenosis and a PSV value of 210 cm/s was the threshold for >70% stenosis. Postprocedural imaging at follow-up was performed with DUS. Additional CTA imaging was performed in the event of renewed symptoms and suspicion of (in-stent) restenosis.

Endovascular procedure

All procedures (Fig. 1) were performed in the angiography suite under local anesthesia. Initial arterial access was gained through the common femoral artery with an 8F introduction sheath (Cook Medical Inc., Bloomington, IN, USA). If necessary, a brachial approach was gained through a 4F or 5F introducer sheath.

Angle-tip or straight-tip Terumo guidewires (Terumo Medical, Tokyo, Japan) with a 0.032-inch or 0.035-inch diameter were used to pass the lesion in the supra-aortic arteries. In occlusions, recanalization from a femoral approach was always attempted first. If the lesion could not be crossed, despite the use of selective catheters (e.g. super torque; Cordis, Johnson & Johnson, Fremont, CA, USA) with high support, a combined brachial and femoral approach was used.

When the lesion was passed, balloon angioplasty was performed as a primary angioplasty intervention or as

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