Endovascular repair of the thoracic aorta necessitating anchoring of the stent graft across the arch vessels

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Supplemental material is available online.

Objective: The purpose of the study was to determine technical and clinical results in endovascular repair of thoracic aortic diseases necessitating stent-graft anchoring across the arch vessels.

Methods: The causes for endovascular treatment in 58 patients (aged 20 to 84 years) were aneurysms (n = 32), acute type A (n = 2) and type B dissections (n = 17), posttraumatic transections (n = 4), iatrogenic dissection (n = 1), and penetrating ulcers with an intramural hematoma (n = 2). Surgical revascularization of arch vessels was performed in 26 patients before stent-graft implantation. Intentional overstenting of the left subclavian artery resulted in complete occlusion in 8 and was partial in 24 patients.

Results: The 30-day mortality rate was 3.4%. Overall, 19 major postprocedural complications occurred in 14 (24%) patients. Among patients with left subclavian artery occlusion, 2 patients had major (1 paraplegia, 1 critical arm ischemia), and 3 minor (2 temporary vertebrobasilary symptoms, 1 transient arm claudication) complications. Fourteen (25%) patients had an early endoleak, of whom 5 were treated successfully with a secondary endovascular procedure, 2 necessitated open surgical conversion, and 7 were treated conservatively, with spontaneous sealing of the endoleak in 3. In 53 (91%) in whom computed tomographic follow-up was longer than 3 months (mean, 30.1 months, range, 3 to 85), the aortic diameter along the stented segment decreased in 24, was stable in 19, and increased in 10 patients.

Conclusion: Fixation of the stent graft in the aortic arch can expand the applicability of endovascular repair. Intentional overstenting should be performed with caution to avoid ischemic problems after complete occlusion of left subclavian artery.

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Since the first endovascular application of a self-fixing synthetic prosthesis for the treatment of a traumatic thoracic aortic aneurysm by Volodos and associates[1] in 1988, this less invasive procedure became an alternative modality to open surgical repair in a selected population of patients. Several studies suggest that this endovascular treatment modality may reduce postoperative morbidity and mortality rates, as well as hospital stay.[2,3] However, successful stent-graft placement requires a satisfactory landing zone of at least 15 mm in length.[4] Although various pathologies begin just distal to the left subclavian artery (LSA) or include the distal arch, innovative techniques have extended endovascular treatment options. Overstenting of the left subclavian artery has been performed without acute adverse events to elongate the proximal landing zone.[5-7] However, delayed onset of vertebrobasilary insufficiency and arm ischemia has been reported.[8,9] Bypass surgery or transposition of aortic arch vessels before stent-graft repair is sometimes mandatory to preserve blood flow or to prevent type II endoleaks.[10,11] Alternatively, initial clinical experiences with branched stent grafts have been reported.[12,13]

Abbreviations and Acronyms
ASA = American Society of Anesthesiologists
CCA = common carotid artery
CT = computed tomography
CTA = computed tomography-angiography
IMH = intramural hematoma
LSA = left subclavian artery
PAU = penetrating atherosclerotic ulcer
VA = vertebral artery

This report presents the results of our experience with treatment of thoracic aortic diseases necessitating stent-graft placement across the origin of arch vessels. Evaluation was focused on management of aortic arch vessels and clinical consequences. Furthermore, frequency of endoleaks related to the landing zone and change of aortic size in the stented segment were evaluated.

Material and Methods

Patient Evaluation

Between November 1996 and April 2004, at total of 107 patients were treated with endovascular repair. Fifty-eight (54%) patients who required anchoring of the stent graft at the origin of arch vessels were included in this study. There were 13 women and 45 men with a mean age of 61.8 years (range, 20 to 84 years). The associated comorbidities are listed in Table 1. Fixation in the aortic arch was performed in 32 patients with aneurysms (25 atherosclerotic aneurysms, 4 chronic posttraumatic aneurysms, and 3 aneurysms related to previous surgery for coarctation). Furthermore, there were 2 patients with acute type A and 17 patients with acute type B dissections. One patient had an iatrogenic dissection, 4 patients had a posttraumatic transection, and 2 patients had penetrating atherosclerotic ulcers (PAUs) and an intramural hematoma (IMH).

Of the 58 patients, 19 (32.8%) had associated complications. Eleven of the 19 (57.9%) required emergency stent grafting for treatment of aortic rupture (n = 1), contained rupture (n = 6), or compromised aortic branches (n = 4). The remaining 8 patients had complications that required urgent but not emergency treatment.

Indication for stent grafting in aneurysms (n = 32). Of 25 patients with atherosclerotic aneurysms, 3 (12%) presented with a contained rupture necessitating emergency stent grafting. In the remaining patients, an American Society of Anesthesiology (ASA) class of at least III was the indication for elective endovascular repair. Furthermore, 5 patients had a history of cardiac (n = 1) or thoracic aortic surgery (n = 4).

Indication for stent grafting in dissections (n = 20). In patients with a type A dissection (n = 2), additional stent grafting was required after surgical replacement of the ascending aorta because of a compromised iliac artery in 1 patient. To prevent further dilatation of the thoracic aortic diameter, we placed an additional stent graft in the second patient who presented with an aortic diameter of more than 40 mm, flow within the false lumen due to an intimal tear close to the left subclavian artery, and compression of the true lumen.

TABLE 1. Comorbidities in 58 patients with thoracic aortic aneurysm or dissection who were treated by endovascular repair

Associated medical problems	No. of patients	Percent
Hypertension	43	74
Coronary artery disease	7	12
Previous cardiac infarction	3	5
COPD	6	10
Renal impairment	15	26
Mild-moderate	11	19
Severe	4	7
Diabetes mellitus	12	21
One occluded internal carotid artery	2	3
Previous stroke	2	3
Malignancy	4	7
Previous cardiac or aortic surgery	7	12
ASA scores		
Class III	42	72
Class IV	8	14
Class V	8	14

COPD, Chronic obstructive pulmonary disease. Mild-moderate renal failure = serum creatinine concentration 1.4-2.5 mg/dL; severe renal failure = serum creatinine concentration >2.5 mg/dL.

Of patients with an acute type B dissection (n = 17), 13 (76.5%) were treated because of one or more associated complications (Table 2). In 4 asymptomatic acute type B dissections with an aortic diameter of more than 40 mm, a patent false lumen, and marked compression of the true lumen, stent grafting was performed to prevent progression of dissection and aneurysmal degeneration.

One patient with an iatrogenic dissection was treated to prevent progression of dissection.

Indication for stent grafting in other thoracic aortic diseases (n = 6). Patients with a posttraumatic transection (n = 4) presented with multiple serious injuries. Additionally, one patient had a contained rupture with a mediastinal hematoma. Among patients with a PAU/IMH (n = 2), 1 patient who had poorly manageable hypertension was treated to prevent deterioration and the other was treated for a contained rupture.

In our institution, endovascular repair of thoracic aortic diseases has been considered as an alternative treatment to surgical repair in high-risk patients since 1996. Written informed consent was obtained from all conscious patients. In emergency situations and with unconscious patients, endovascular treatment was an interdisciplinary decision.

Patients were selected for endovascular repair on the basis of contrast-enhanced computed tomography (CT)-angiography (CTA) using either a single-detector (Somatom Plus 4; Siemens, Erlangen, Germany) or a multidetector (Somatome Volume Zoom; Siemens) scanner. CT scanning ranged from the supra-aortic vessels to the common femoral arteries. Three-dimensional reconstruction (multiplanar reconstruction, curved planar reconstruction, maximum-intensity projection) were processed from each CT scan.

In 9 patients with atherosclerotic aneurysms, the origin of the LSA was in the aneurysm. The remaining patients had a distance