Prognostic factors for aorta remodeling after thoracic endovascular aortic repair of complicated chronic DeBakey IIIb aneurysms

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Objectives: The use of thoracic endovascular aortic repair (TEVAR) for chronic DeBakey III type b (CDIIIb) aneurysms is controversial. We analyzed the potential prognostic factors affecting aorta remodeling after this procedure.

Methods: A total of 20 patients with CDIIIb aneurysms underwent TEVAR, with full coverage of reentry tears at the descending thoracic aorta. The potential factors affecting false lumen (FL) remodeling were analyzed, including reentry tears (communicating channels visible on the computed tomography angiogram), large intimal tears below the stent graft (≥2 consecutive axial cuts on the computed tomography angiogram), visceral branches arising from the FL, and intercostal arteries (ICAs) arising from the FL.

Results: All the patients had uneventful in-hospital courses; 2 patients (10%) required reintervention during the follow-up period. Thirteen patients (65%) had complete thrombosis of the FL at stent graft segment. Compared with the complete thrombosis group, the partial thrombosis group had more reentry tears (1.8 vs 2.3, $P = .48$), large intimal tears (0.8 vs 1.7, $P < .05$), visceral branches arising from the FL (1.2 vs 2.3, $P < .05$), and ICAs arising from the FL (3.8 vs 5.1, $P = .35$). Reentry tears, visceral branches, and ICAs from the FL were significant negative prognostic factors for FL shrinkage ($P < .05$).

Conclusions: Although reentry tears above the celiac trunk were fully covered, the visceral branches and ICAs from the FL and all communicating channels below the celiac trunk kept the FL pressurized and were unfavorable prognostic factors for aorta remodeling after TEVAR for CDIIIb aneurysms. (J Thorac Cardiovasc Surg 2014;148:925-33)

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The ideal treatment of patients with chronic DeBakey III (CDIII) aortic dissections remains controversial. The optimal medical therapy of anti-impulse treatment has been used in most patients, and selective open or endovascular repair has been used for complicated chronic cases, such as those involving aneurysmal degeneration, malperfusion, persistent pain, or rupture. Although recent series have suggested thoracic endovascular aortic repair (TEVAR) as a promising treatment of acute, complicated type B aortic dissections,[1,2] outcome studies of TEVAR-treated CDIII aneurysms have been primarily retrospective, single-center experiences involving heterogeneous cohorts with various operative indications and different strategies.

Open surgery for CDIII aneurysms has been associated with substantial morbidity and mortality.[3,4] In light of the success of TEVAR in patients with degenerative aneurysms, this therapy offers an attractive alternative to open surgery for CDIII aneurysms.[5,6] However, several issues also mitigate against the use of TEVAR in these patients. The presence of a mature, rigid dissection flap, and multiple reentry tears have been thought to potentiate failure of endovascular therapy, and the long-term durability of endovascular management remains uncertain.[7]

The primary aim of managing CDIII aneurysms is to avoid death from aortic rupture. This clinical endpoint has frequently been associated with the ability of TEVAR to trigger favorable aortic remodeling, an important outcome predictor of false lumen (FL) patency.[8,9]

Although the results of TEVAR for CDIII type a (CDIIIa) aneurysms have been exciting, concerns regarding the use

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Abbreviations and Acronyms

CDIII = chronic DeBakey III
CDIIIa = chronic DeBakey III type a
CDIIIb = chronic DeBakey III type b
CTA = computed tomography angiogram
FL = false lumen
ICA = intercostal artery
SCI = spinal cord ischemia
TEVAR = thoracic endovascular aortic repair

of this technique in patients with CDIII type b (CDIIIb) aneurysms remain, including concerns about the precipitation of retrograde dissection or visceral ischemia.[10,11]

The present study investigated the prognostic factors for aorta remodeling after TEVAR for complicated CDIIIb aneurysms.

METHODS

Patient Population

The institutional review board at the Gangnam Severance Hospital, Yonsei University College of Medicine (Yonsei institutional review board no. 3-2012-0259) approved the present study. A prospectively maintained endovascular aortic registry was queried for all patients undergoing TEVAR from May 2012 to April 2013.

Patients treated for degenerative and trauma-related pathologic entities (including aneurysms, penetrating ulcers, atheromatous disease, pseudoaneurysms, and traumatic transections) were excluded. Patients with dissection-related indications were reviewed further, and only those undergoing elective procedures for chronic (>3 months after the diagnosis of acute aortic dissection) aneurysmal degeneration of descending aortic dissections extending to the abdominal aorta (CDIIIb) were included. The patients with dissecting aneurysms confined to the descending thoracic aorta (CDIIIa) were excluded. Although acute proximal dissections were not included, patients previously treated for type A dissections who had residual CDIIIb aneurysms were included. The indications for TEVAR included newly developed, continuing back pain, and aneurysmal degeneration (maximal thoracic aneurysm diameter $\geq$ 5.5 cm or a documented growth rate of 0.5 cm within 6 months seen on serial computed tomography angiograms [CTA]). The demographics, comorbidities, procedure-specific details, reinterventions, and complications were collected from the medical records.

Clinical Practice

A standardized treatment algorithm was used throughout the study period for patient selection and procedural conduct. All operations were performed electively with the patient under general anesthesia in a hybrid operating room. The need for perioperative adjuncts (eg, spinal drainage, carotid–subclavian bypass, open or percutaneous vessel access) were at the discretion of the attending surgeon and interventional radiologist.

All patients received systemic heparin (100 U/kg) to achieve an activated clotting time of more than 300 seconds. Devices were oversized 10% to 15%, relative to the diameter of the undissected aorta proximal to the dissection, using tapered stent grafts. At the beginning of study period, the distal landing zone was in the mid-descending thoracic aorta (group 3). However, for the remaining cases, the coverage length was selected to exclude the entire dissected thoracic aorta and all fenestrations (group 2). Our current practice has been for more aggressive aortic coverage (ie, we generally treat down to the celiac artery in patients with juxtaceliac fenestrations (group 1; Figure 1). In some cases, we have covered the celiac trunk, when backflow from the superior mesenteric artery was expected. Technical success was defined as endograft deployment at the intended aortic segment, with the absence of antegrade flow into the FL. Compliant balloon angioplasty of the proximal stent graft was selectively performed only in the event of type Ia endoleaks. Spinal cord ischemia (SCI) was defined as any new lower extremity motor and/or sensory deficit not attributable to intracranial pathologic features, peripheral neuropathy, or neuropraxia. The diagnosis was determined by the treating physician and confirmatory imaging.

Degree of FL Thrombosis

The degree of FL thrombosis was analyzed using precontrast, arterial, and delayed phases of postoperative CTA (3-mm-thick axial slices). It was classified as partial thrombosis if both flow and thrombus were present and as complete thrombosis if no flow was present at the level of the stent graft.[12]

Remodeling Analysis

Aorta remodeling after TEVAR was analyzed, as shown in Figure E1. The preoperative FL diameter was marked as "a," and the postoperative FL diameter was marked as "b." The measurements of "a" and "b" were performed at the level of the maximal descending thoracic aortic aneurysm. We sought to find risk factors affecting the FL ratio (b/a). If >2 CT scans had been performed after hospital discharge, the most recent image was used to determine the ratio. If an aortic segment had been subjected to repeated aortic procedures, the patient was excluded from additional FL diameter assessments. Postoperative surveillance was determined using a protocol of imaging before discharge, at 3 and 6 months after discharge, and annually thereafter. We also analyzed the relationship of the degree of FL thrombosis with the FL ratio.

Anatomic Factors

The maximum diameters of the thoracic aorta, thoracic FL, abdominal aorta, and abdominal FLs were measured on the preoperative CTAs. The following parameters were measured during postoperative CTAs before patient discharge by 2 experienced vascular radiologists: residual reentry tears were counted below the stent graft; large intimal tears were counted, as seen in $\geq$2 CTA axial cuts below the stent graft; the numbers of intercostal arteries (ICAs) and visceral arteries from the FL were counted; and the maximum diameters of the FLs were determined at the last follow-up CTAs.

Statistical Analysis

The categorical variables were summarized using frequencies and percentages. Continuous variables were analyzed using the mean and standard deviations, if they were normally distributed. Comparisons of patient- or procedure-related characteristics in subgroup analyses were performed using Fisher's exact tests or independent *t* tests. Variables with $P < .1$ on univariate analysis were included in the multivariate model, which was refined using stepwise backward binary logistic regression. The relationship between the FL ratios and patient variables was analyzed using Spearman's rank correlation and linear regression analysis. All statistical analyses were performed using the Statistical Package for Social Sciences, version 20, software (SPSS, Chicago, Ill).

RESULTS

The Gangnam Severance TEVAR registry (n = 103) identified 20 patients (19%), who had undergone elective TEVAR for the treatment of CDIIIb aneurysms from May 2012 to April 2013. The mean interval from the diagnosis of the acute dissection to TEVAR was 18.1 $\pm$ 11.9 months (range, 4-47). Most patients were men (n = 17 [85%]; mean