Thoracic Endovascular Aortic Repair for Challenging Aortic Arch Diseases Using Fenestrated Stent Grafts From Zone 0

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Background. **Although previous reports have described the repair of distal aortic arch aneurysms through debranching and chimney techniques, these methods invariably involve surgical management of the carotid artery. We report clinical results of thoracic endovascular aortic repair (TEVAR) using fenestrated stent grafts in the treatment of aortic arch aneurysms located less than 15 mm from the left common carotid artery.**

Methods. **A semi-custom-made fenestrated stent graft designed to fit aortic arch tortuosity and preserve blood flow at least into the brachiocephalic and left common carotid arteries was placed from zone 0.**

Results. **From 2007 through 2013, TEVAR from zone 0 was performed on 37 high-risk patients for open surgery (mean age 78.2 years). The mean length between the left common carotid artery and aortic aneurysm was 11.1 mm (range, 5 to 15 mm). The left subclavian artery was preserved for 26 patients (70.3%) through surgical reconstruction (n = 19) and graft fenestration (n = 7). The early mortality rate was 0%. Postoperative strokes and spinal cord ischemia occurred in 2 (5.4%) and 3 (8.1%) patients, respectively. Although type I endoleaks at discharge were noted in 12 (32.4%) patients, aneurysm enlargement was noted during follow-up in 6 (16.2%). Four patients (10.8%) underwent secondary interventions consisting of 3 coil embolization procedures; 2 re-TEVARs and 1 open conversion. There were no aorta-related late deaths. Survival and aorta-related event-free rates at 2 years were 86.3% and 88.8%, respectively.**

Conclusions. **Thoracic endovascular aortic repair using fenestrated stent graft from zone 0 can be considered as one of therapeutic options for high-risk patients with aortic arch diseases.**

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Based on studies indicating encouraging early and mid-term results [1, 2], thoracic endovascular aortic repair (TEVAR) has been employed as a first line surgical treatment for descending thoracic aortic aneurysms. However, in these studies the proximal end of the first generation TAG device (W.L. Gore & Associates, Inc, Flagstaff, AZ) or Zenith TX2 device (Cook Medical, Inc, Bloomington, IN) did not sufficiently conform to the curvature of the distal aortic arch. Moreover, it was also observed that there was a lack of graft fixation against the lesser curvature of the aortic arch for aneurysms located in the distal aortic arch or proximal descending aorta. To overcome these problems, endovascular industries have recently developed improved versions of TAG and TX2, such as conformable TAG and TX2 Pro-form, which show enhanced conformability to the acutely angled distal aortic arch [3]. However, it remains difficult to further expand an indication of simple TEVAR for distal aortic arch lesions because additional management of supra-aortic branches, particularly the brachiocephalic (BCA) and the left common carotid artery (LCCA), is necessary to ensure sufficient length of a proximal neck. In Japan, the Najuta fenestrated stent graft (SG) (Kawasumi, Inc, Tokyo, Japan) has been commercially available for distal aortic arch aneurysms since June 2013. According to the instructions for use of this SG, a proximal neck length of more than 20 mm between the LCCA and the distal aortic arch aneurysm is recommended to achieve satisfactory clinical outcomes. In light of the improved results presently being observed through the use of other currently available non-fenestrated SGs, it is expected that the Najuta fenestrated SG should also be able to treat more challenging aortic arch pathologies. In this study, we report early and mid-term results of TEVAR using the fenestrated SG as a semi-custom handmade devise for aortic arch aneurysm, and describe its clinical usefulness and limitations.

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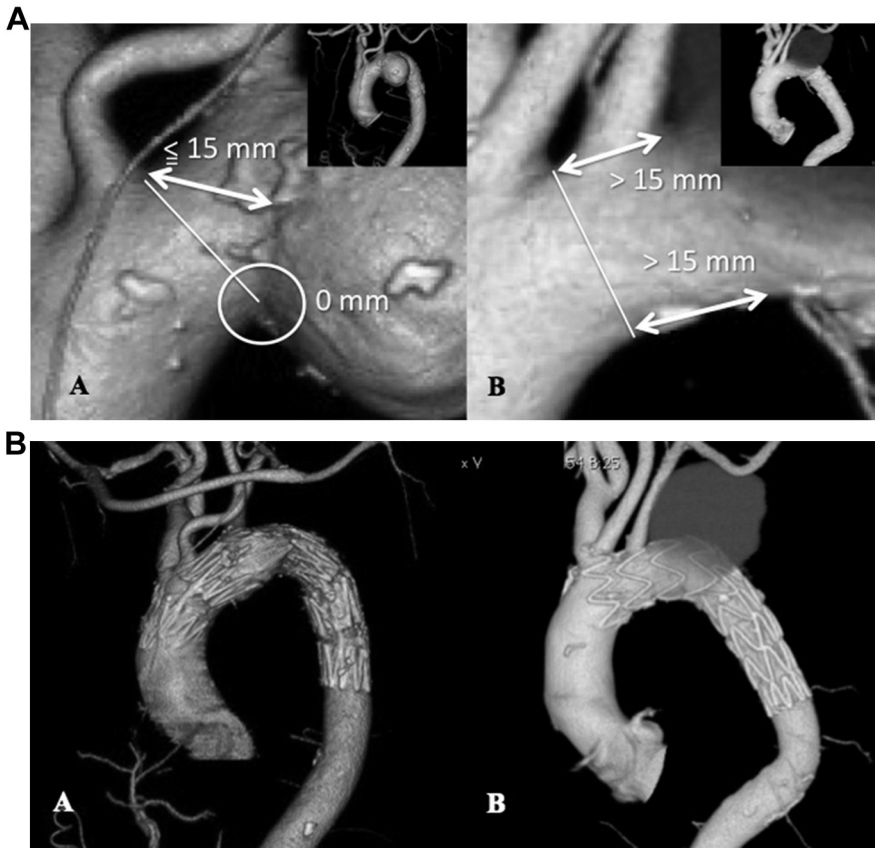

Fig 1. (A) Computed tomographic images regarding a proximal neck (PN) length. Although the PN length at the lesser curvature of the aortic arch is almost zero, this case was used in the present study because there is a PN length between the left common carotid artery and aortic arch aneurysm, A. The PN length at the greater and lesser curvature of the aortic arch is more than 15 mm. This type of aneurysm has been treated using a conventional non-fenestrated stent graft, which means that this case was not included in the present study, B. (B) Computed tomographic images after TEVAR. The case on the left, A, was treated using a fenestrated stent graft. The case on the right, B, which was not a subject in this study, was treated using a Valiant (Medtronic, Inc) modified to make a fenestration to preserve the left subclavian artery.

Material and Methods

Patient Selection

From July 2007 through March 2013, patients with aortic arch aneurysms located less than 15-mm away from the LCCA (Figs 1A, 1B) and proximal and distal aortic neck diameter of less than 40 mm were considered possible candidates for TEVAR using a fenestrated SG. Of these patients, those whose logistic EuroSCORE-predicted risk of mortality was more than 10%, and who accepted the terms provided through informed consent regarding TEVAR using a fenestrated handmade SG were the subjects of this study. The present research has been reviewed and approved by the ethics committee in our institution. Although a patient's consent for this study was waived because of the retrospective one, all patients accepted the informed consent regarding TEVAR using a fenestrated handmade SG.

Procedure Using a Fenestrated Stent Graft

The fenestrated SG used in this study was a semi-custom and handmade device (referred to as the Yokoi HIJ graft) a prototype model of Najuta. The details of this type of SG and procedure have been previously reported [4]. Briefly, the pre-curved fenestrated SG was fabricated through selection from several types of three-dimensional curved stainless stent skeletons and a fenestrated expanded polytetrafluoroethylene graft (Fig 2) based on each patient's preoperative three-dimensional computed tomographic (CT) images. The common femoral artery was primarily used as the access vessel. A brachial-wire

Fig 2. Illustration of a semi-custom-made fenestrated stent graft. The white arrow shows a fenestration made to preserve the left common carotid artery. Generally, both the second and proximal section of the third (white arrow) fenestrations preserve the brachiocephalic artery (BCA). A proximal fenestration was made to prevent the possibility of an unintentional distal migration of a stent graft covering BCA.