Perfect and Least Invasive Sealing Technique on the Lesser Curvature of the Aortic Arch: Application of a Novel Stent Graft to an Aneurysm Developing on a Postoperative Ductus Arteriosus

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A 78-year-old woman who underwent an operation for a patent ductus arteriosus (PDA) about thirty years ago developed an aneurysm on the aortic side of the remnant ductal tissue. To avoid risky, open surgery, we performed endovascular aortic therapy using a novel stent graft (SG), which was pre-curved, fenestrated and custom-made type. This graft was designed to configure to the patient’s whole aortic arch anatomy, and was capable of accurately adjusting its fenestrations to the arch branch orifices during the procedure. The operation was successful, and the patient was discharged uneventfully on 16th postoperative day. The advantage of this fenestrated SG is close sealing, especially over the lesser curvature of the arch. This device could be a simple and effective option to deal with an otherwise normal aortic arch with such a ductus-related localized lesion.

Keywords: aortic arch, aneurysm, ductus, stents, endovascular

Introduction

There are a considerable number of reports on the treatment of aneurysms that apparently originate from ductal tissue (or diverticulum), by conventional open surgical techniques, or open stent grafting with or without arch repair. Such invasive methods can be successfully accomplished in most cases, but may still have risks that cannot be avoided. On the other hand, even if less invasive endovascular therapies such as SG repair are considered in such cases, the safety and efficacy of techniques may be questionable with conventional stents on the curved portion in the presence of vital branches on the contralateral side which must be preserved. In this patient, we thought it would be prudent to simply insert the newly-developed SG inside the whole arch to widely seal the lesser curvature lesion without manipulating the arch branches.

Case Report

A 78-year-old woman consulted the otolaryngology department of our hospital with a complaint of continued hoarseness over the preceding 7 weeks. On laryngoscopy, left laryngeal nerve palsy was observed. A screening CT revealed the presence of a thoracic aortic aneurysm, and she was then referred to our department. For her past history, she underwent surgery to close the PDA via a left thoracotomy approach at another hospital when she was 49 years old. The details of that surgery were unavailable. On auscultation, no murmur was detected. Nothing remarkable was observed in the physical and laboratory examinations...
except for hypercholesterolemia (250 mg/dl). Enhanced CT showed no other abnormalities of the aorta or its major branches (Fig. 1). Since this saccular aneurysm (diameter, 50 mm including the aorta; 34 × 33 × 40 mm, substantial aneurysmal body size) seemed threatening in size and shape to rupture, several therapies were considered. The least invasive method using our novel SG seemed feasible and the most appropriate for this lesion. Preoperative examinations for other risk factors, such as cardiac diseases including coronary artery lesions, carotid artery disease, and cerebrovascular abnormalities were evaluated using cardiac catheterization, echography, and magnetic resonance imaging, respectively, with no significant findings.

Under general anesthesia, the operation was performed as follows. First, folding and mounting of the custom-made SG was performed on the inner rod of a 22F J-shaped special delivery sheath, which was approximately adapted to the form of the arch curvature. The right femoral artery exposure and transcutaneous puncture of the right brachial artery were performed at the same time. A 6F dual-lumen sheath was then inserted into the brachial artery for entry of a tag-of-wire and a 4F pigtail angiographic catheter. After 0.5 mg/kg heparin had been injected, the Gore Tag stent graft of 37 mm diameter was introduced from the right femoral artery, and successfully deployed from Zone 3 downwards to ensure the distal landing of the subsequent arch graft. A small type I leakage was observed by a digital subtraction aortography (DSA) as anticipated. Next, under fluoroscopic guidance, a 0.032 inch, 400 cm tag-wire was introduced into the right brachial artery, advanced to the aortic arch, passed through the Gore Tag stent graft previously placed in the descending aorta, and reached the femoral artery via the abdominal and iliac arteries. After withdrawal of the wire from the groin, the delivery sheath with the pre-mounted SG was carefully pulled through the curved, narrow iliac artery on the guide wire. After reaching the arch, the wire was loosened within the ascending aorta, and expansion of the head portion of the SG was initiated. A DSA from the ascending aorta was performed to generate a roadmap of the arch and its branches on the display. The marker on the graft pointing to the edge of the third branch orifice could be adjusted with pin-point accuracy in situ to the target before full expansion. Finally, after complete release, the graft was pressed against the aortic wall completely by only blood pressure. After full deployment of the graft, any leakage was checked by DSA (Fig. 2). In this case, the operation time was 115
minutes. The postoperative recovery was uneventful with no complications. The patient was discharged on 16th postoperative day.

**Discussion**

The long-term prognosis of the residual degenerative tissue from the ductus may be problematic due to the generation of an aneurysm in the diverticulum, even after successful treatment with an obstructive catheter method or closure by open surgery as in this case. Several methods using SGs have proved to be effective in managing PDAs less invasively, and could also be applicable to a ductus aneurysm. Among these various exclusion techniques, the application of commercially-available SGs may be possible in some cases. To further secure the rich proximal landing zone, custom-made branched or pre-curved soft SGs would be better candidates. However, manipulating one or more branches, or intentionally blocking the flow to the third branch of the arch should be considered hazardous or at least difficult to perform, resulting in long X-ray exposures.

According to the above-mentioned scenario, it seemed far more advantageous to adopt this novel type of SG. The details of the SG used in this case were as follows: it was custom-made based on the patient’s specific arch anatomy using a three-dimensional CT angiogram. It consisted of a self-expandable Z stent and a pre-curved e-PTFE graft with customized fenestrations for the arch vessels as described elsewhere (Fig. 3). The main indication for this graft is distal arch aneurysms, and the implanations have actually achieved excellent results thus far in Japan in a huge number of patients. The stability of this graft could also be secured against the strong downward flow force, which minimizes the risk of serious complications such as migration of the graft because of the extensive binding area due to the ability of this SG to configure to the specific anatomy of the arch, and crucially important is the lack of interference with any of the three arch branches, thus avoiding potential or actual occlusion, embolism, or even paraplegia. This SG should be particularly effective for excluding lesions on the lesser curvature of the arch.

**Conclusions**

Using this novel SG, an aneurysm originating on the remnant ductal tissue was successfully excluded. Since this SG is simple to manipulate, stable in the arch position and likely to have the least risk potential, it could be a promising option to deal with lesions on the lesser curvature of the arch.

**Disclosure Statement**

The authors report no conflicts of interest.

**References**


