# Totally endovascular aortic arch repair by branched stent graft placement

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**Several methods for endovascular aortic arch repair have been proposed to reduce the morbidity and mortality associated with conventional open surgery for aortic arch aneurysms. We report our experience with aortic arch aneurysm repair by a totally endovascular technique, that is, a "reversed" stent graft technique using branched stent grafts. (J Vasc Surg Cases 2015;1:279-82.)**

The treatment of aortic arch aneurysms remains challenging in patients with significant comorbidities. Recently, the application of endovascular aortic aneurysm repairs for the treatment of aortic arch aneurysms in high-risk patients has increased.[1-3] In this report, we describe a challenging case involving a branched stent graft that was positioned in the aortic arch by a totally endovascular technique. The patient gave informed consent for the publication of her data.

## CASE REPORT

An 81-year-old woman with a medical history of compression fractures of the lumbar spine was found to have an aortic arch aneurysm. On review of a computed tomography (CT) scan, we observed a saccular pseudoaneurysm of the aortic arch with a maximum diameter of 73 mm (Fig 1). The aortic arch aneurysm involved the origins of the innominate artery (IA), left common carotid artery (LCCA), and left subclavian artery (LSA) and protruded from the anterolateral aspect of the aortic arch. The ascending aorta was normal in appearance and 36 mm in diameter. Considering the aneurysm's shape and the patient's comorbidities, we decided to attempt a totally endovascular procedure for aortic arch repair.

Under general anesthesia, both common carotid arteries and right femoral arteries were exposed through bilateral cervical incisions and right femoral incisions. After systemic heparinization (100 IU/kg, activated clotting time >300 seconds), a 6F sheath was placed in the left femoral artery using the Seldinger technique. An angiographic pigtail catheter was inserted through the left femoral sheath, and angiography was performed to confirm an adequate landing zone. First, we planned a branched stent graft insertion through the right common carotid artery (RCCA). The diameter of the RCCA measured 8.9 mm on CT angiography. An 8-mm polyester graft (Gelweave; Vascutek, Inchinnan, Scotland) was anastomosed to the RCCA (end-to-side anastomosis). Then, a 22F introducer sheath (St. Jude Medical, Minnetonka, Minn) was inserted in the Dacron graft so as not to go over to the RCCA. A Lunderquist guidewire (Cook Medical, Bjaeverskov, Denmark) was inserted through the sheath and placed in the left ventricle. A first SEAL stent graft (S&G Biotech Inc, Seongnam, Korea; Fig 2, *A*) was introduced through the RCCA and advanced over the wire into the ascending aorta. The first SEAL stent graft was positioned just distal to the coronary arteries and was then deployed. The branch of the first SEAL stent graft was placed in the IA. A second SEAL stent graft (Fig 2, *B*) was deployed in the same manner as the first SEAL stent graft. The diameter of the LCCA measured 8.6 mm on CT angiography. An 8-mm polyester graft was anastomosed to the LCCA (end-to-side anastomosis), and an 18F introducer sheath was inserted in the polyester graft. The second SEAL stent graft was introduced in the LCCA and advanced into the descending aorta in a "reversed" position compared with the first SEAL stent graft. The second SEAL stent graft was deployed in the proximal descending aorta, and its branch was placed in the LCCA. The LSA was covered intentionally by the stent graft. The third SEAL stent graft (Fig 2, *C*) was introduced through the 18F introducer sheath in the right femoral artery and positioned between the two preexisting stent grafts. The third SEAL stent graft was deployed to overlap within the lumen of the branched stent grafts to exclude the aneurysm (Fig 3). The stent grafts were dilated onto the wall of the aortic arch by balloon inflation to ensure an adequate seal, especially at the orifice of the LCA to prevent a type II endoleak. Angiography confirmed complete exclusion of the aortic arch aneurysm and good flow through the IA and LCCA with no evidence of endoleak.

CT angiography acquired 1 month after the operation showed complete exclusion of the aneurysm with no complications. Follow-up CT angiography after 3 months showed a patent stent graft without endoleak.

## DISCUSSION

Conventional open surgery has been the mainstay of treatment options for aortic arch aneurysms, but it requires cardiopulmonary bypass and deep hypothermic circulatory

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**Fig 1. A,** Computed tomography (CT) showing a 73-mm saccular pseudoaneurysm in the aortic arch. **B,** Postoperative CT angiography reconstruction showing branched stent graft implantation. The patent innominate artery (IA) and left common carotid artery (LCCA) are seen.

arrest, and it is associated with substantial morbidity and mortality.[4,5] For these reasons, hybrid endovascular aortic repair, in situ fenestration, and branched stent graft techniques have been attempted to treat aortic arch aneurysms in selected patients. However, these endovascular procedures have several disadvantages. For example, endovascular procedures are limited by technical challenges in complex anatomic disease, including an inappropriate landing zone, tortuosity of the aorta, and vascular access problems.[6] In situ fenestration requires a temporary bypass to perfuse the supra-aortic vessels during the procedure, and fenestrations made in the graft fabric may result in fabric tearing and deformation of the stent graft strut.[7,8] Finally, a branched stent graft is not readily available and requires a lot of time to manufacture.[9]

Inoue et al[10] reported a case of aortic arch aneurysm after Stanford type A aortic dissection that was treated with a triple-branched stent graft. This was the first aortic arch reconstruction by a totally endovascular technique. However, the Inoue stent graft was a custom device that is not readily available, and the implantation technique was difficult. Chuter et al[11] reported a new modular branched stent graft for aortic arch aneurysm repair. This method had a relatively easy implantation technique but needed extra-anatomic bypass grafting with carotid-carotid bypass and subclavian-carotid reimplantation, so the corresponding surgical risks remained.

We used modular stent graft implantation by a totally endovascular technique without extra-anatomic bypass grafting. The method consisted of three components: two branched stent grafts and one tubular stent graft. Component I was a branched stent graft, deployed in the ascending aorta through the RCCA. Component II was also a branched stent graft; however, it was deployed in the proximal descending aorta, like looking at a mirror image of component I (the "reversed" position), through the LCCA. This method was comparatively easy to perform and avoids technical difficulties, such as branch catheterization or a bailout procedure for occlusion of the supra-aortic arteries.[9] We used a polyester access conduit for the deployment of components I and II. The outer diameter of the delivery device was 21F for component I and 18F for component II . When the stent graft was advanced into the aorta, the introducer sheath remained in the access conduit, and only the main body of the stent graft was advanced into the aorta. In this way, the IA and LCCA

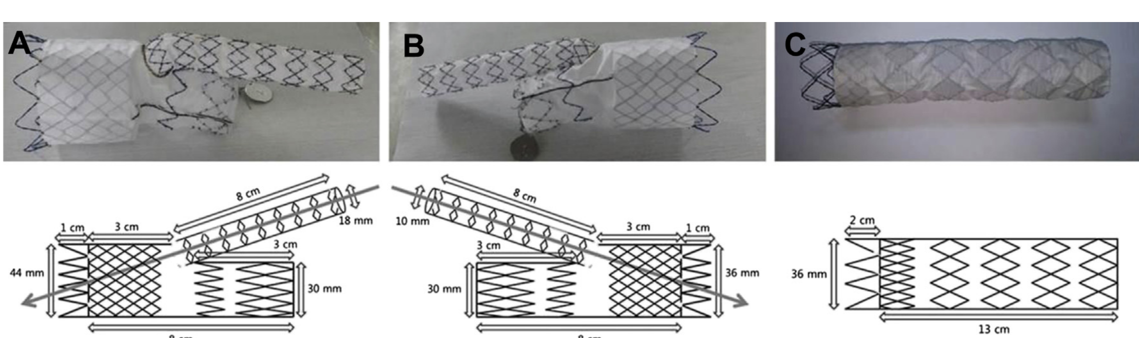


**Fig 2.** Components of the branched stent graft and its configuration. **A,** Component I. **B,** Component II. **C,** Component III.

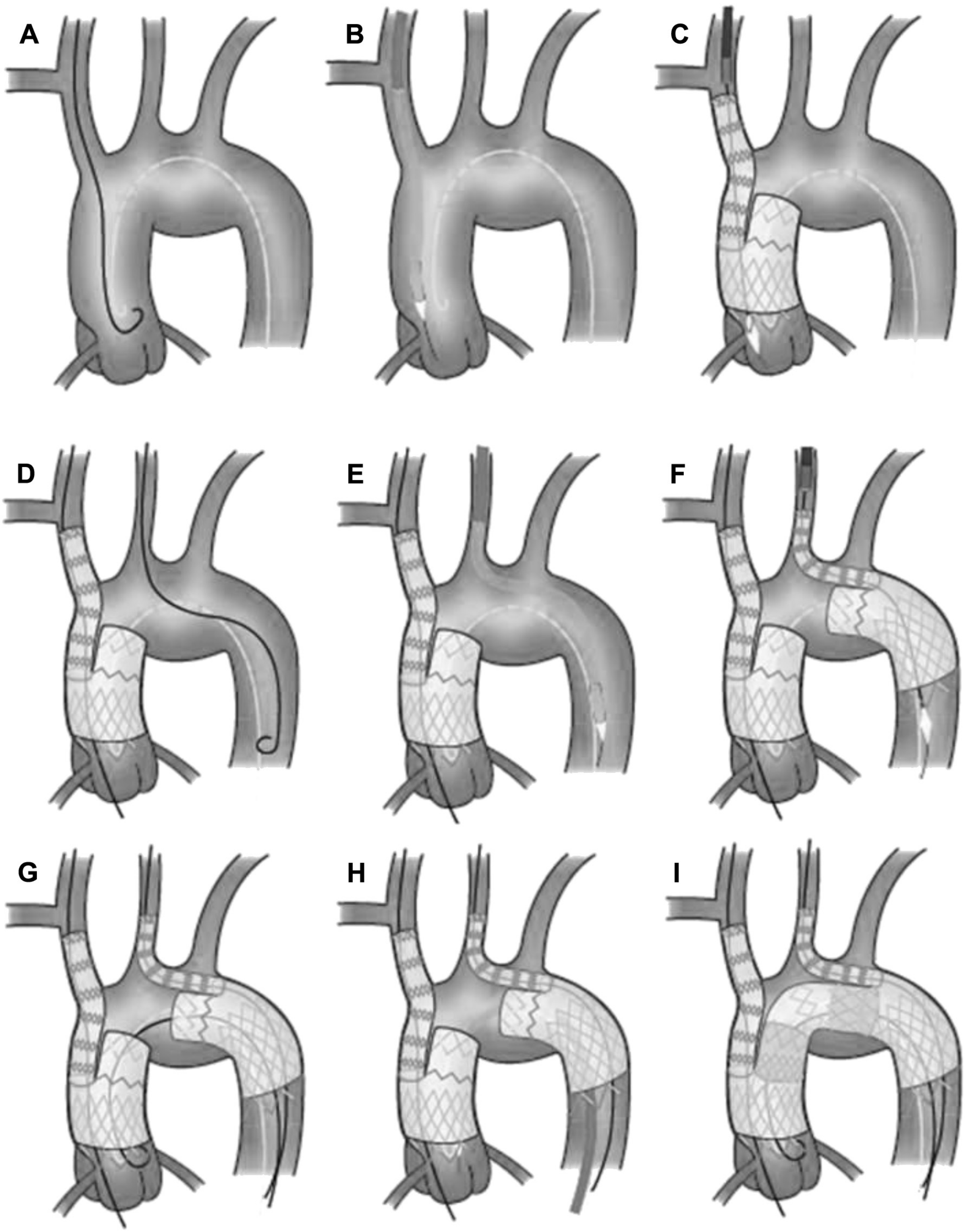


**Fig 3.** Schematic diagram of the procedure. **A**-**C,** Component I was deployed in the ascending aorta, and its branch was positioned in the innominate artery (IA). **D**-**F,** Component II was deployed in the descending aorta in a "reversed" position, and its branch was positioned in the left common carotid artery (LCCA). **G**-**I,** Component III was deployed between components I and II.

were not totally occluded because of the remaining space of the arterial cavity. Thus, brain perfusion might be reduced but not totally shut down during stent graft implantation. Component III was deployed between the two branched stent grafts, so that the aortic arch aneurysm was completely excluded. In this case, we occluded the LSA intentionally by the stent graft. This patient had a right-dominant vertebral artery and a normal vertebrobasilar system on preoperative brain CT angiography. The LSA can be covered safely without revascularization by means of a thorough preoperative evaluation of the cerebral circulation.[12,13]

## CONCLUSIONS

Our report demonstrates the feasibility of the totally endovascular repair of an aortic arch aneurysm with reversed stent graft implantation. This technique may be one way of providing a totally endovascular option for aortic arch aneurysm repair in select cases that are not appropriate for conventional open surgery.

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