

Case Report

Zone 0 Aortic Arch Reconstruction Using the RelayBranch Thoracic Stent Graft

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ABSTRACT

Endovascular therapies have had a considerable impact on contemporary management of thoracic aortic disease. Still, with the anatomic challenges of the aortic arch, endovascular experience with devices that traverse the arch and deploy in the Zone 0 position remains limited. We report the first Canadian experience with the RelayBranch Thoracic Stent Graft (Terumo Aortic, Sunrise, FL) with Zone 0 deployment for total endovascular aortic arch repair in a patient at very high risk for redo open surgery. We demonstrate safe deployment of the device and successful treatment of a type 1A endoleak. Features of the RelayBranch design that mitigate challenges of arch deployment are also discussed.

RÉSUMÉ

Les traitements endovasculaires ont eu un impact considérable sur la gestion contemporaine des pathologies de l'aorte thoracique. Pourtant, en raison des contraintes anatomiques de la crosse aortique, l'expérience endovasculaire avec des dispositifs qui traversent la crosse et se déploient dans la zone 0 reste limitée. Nous rapportons la première expérience canadienne de l'endoprothèse thoracique *RelayBranch* avec déploiement (Terumo Aortic, Sunrise, FL) en zone 0 pour une réparation endovasculaire totale de la crosse aortique chez un patient présentant un risque très élevé de reprise de chirurgie ouverte. Nous décrivons le déploiement en toute sécurité du dispositif et le traitement réussi d'une endofuite de type 1A. Enfin, nous examinons les caractéristiques du système *RelayBranch* qui limitent les difficultés liées au déploiement du dispositif dans la crosse aortique.

The anatomic complexity of the aortic arch poses several challenges to endovascular treatment. Endovascular devices have to accommodate the tortuosity of the arch and may encounter intraluminal thrombus or plaque at either the landing zones or arch branch vessels that increase the risks for embolic stroke during deployment or branch cannulation, which can approach 10% in some early series.¹ The devices have to be properly oriented in relation to the branch vessels to facilitate cannulation, and they have to survive the intense hyperdynamic nature of the arch through the cardiac cycle while maintaining seal indefinitely. Although endoprotheses have been developed to treat aortic arch disease, the global experience with these devices remains limited.² We report Canada's first case experience with the RelayBranch Thoracic Stent Graft (Terumo Aortic, Sunrise, FL) for aortic arch pathology.

Case

A 74-year-old man with multiple prior open and endovascular aortic procedures presented with a 6.3-cm aneurysmal expansion of the proximal descending thoracic aorta secondary to a persistent type 1A endoleak (Fig. 1A). He had suffered an acute type A₁₀ aortic dissection 3 years prior (hemiparesis, seizures, and severe left ventricular dysfunction at presentation) and had an ascending hemi-arch with composite valved conduit root reconstruction (23-mm bioprosthesis). Ten months later, distal expansion of the residual dissected descending thoracic aorta led to a Zone 2 thoracic endovascular aortic repair with left carotid–subclavian artery bypass and coil embolization of the left subclavian artery. An open extent IV thoracoabdominal aortic repair was required 5 months later for distal aneurysmal degeneration.

Recovery after the last operation was tenuous. Postoperative heart failure and cardiogenic shock led to a prolonged intensive care unit and hospital stay. In addition to severe left ventricular dysfunction, other comorbidities included hypertension, dyslipidemia, amaurosis fugax, atrial fibrillation, renal insufficiency, and a smoking history.

Despite the protracted course, near full functional capacity was regained. Still, redo open total arch surgery to treat an endoleak was a very high-risk endeavor, so endovascular options were explored. A custom-made Relay Plus double-branched endoprosthesis (Terumo Aortic) was constructed.³

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Ethics Statement: The research reported has adhered to the relevant ethical guidelines.

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See page 1309 for disclosure information.



Figure 1. (A) Computed tomography scan showing 6.3-cm post-dissection proximal descending thoracic aortic aneurysm with persistent type 1A endoleak. Surgical and endovascular procedures to date were a composite valved conduit ascending aortic and aortic root reconstruction, Zone 2 thoracic endovascular aortic repair, left carotid–subclavian bypass, and left subclavian artery coil embolization. (B) A 3-month follow-up computed tomography scan post deployment of the RelayBranch Thoracic Stent Graft (Terumo Aortic, Sunrise, FL). There is complete resolution of the type 1A endoleak, as well as identifiable false lumen regression. The main-body has proximal seal at Zone 0 in the previously constructed surgical graft in the ascending aorta. Distal seal is within the previously inserted Zone 2 endovascular stent. Supra-aortic branch stents are visualized and are also well situated.

The RelayBranch arch device has a number of novel features, including a “self-righting” outer sheath that aligns the large branch cannulation window to the outer curve and facilitates branch cannulation during repair. Open control of the native branch vessels during the procedure minimizes the risk for intraoperative embolic stroke. Moreover, the device can be configured with either antegrade or retrograde internal branches in varying diameters to optimize landing zone length and branch compatibility within the arch (Fig. 2).

Under general anesthesia, bilateral transverse incisions were made in the neck to expose the common carotid arteries. A groin cutdown exposed the right common femoral artery and vein. A 5-French sheath was inserted percutaneously into the left femoral artery for intraoperative angiography. After heparin administration (activated clotting time > 220 seconds), a 12-French DrySeal sheath was inserted into the right femoral vein over a Lunderquist wire. A Coda balloon (46 mm) was positioned at the inferior vena cava–right atrial junction for inflow occlusion and permissive hypotension at the time of device deployment.⁴ A pigtail catheter was placed within the aortic root for aortography. Through the right femoral artery over a Terumo guidewire, a Simmons catheter was advanced across the arch and into the left ventricle, crossing the bioprosthetic valve. After exchange for a Lunderquist wire, the RelayBranch main-body was advanced. The protective inner sheath traversed the arch with the nose cone positioned in the ventricle. Proper rotational orientation was confirmed, with the cannulation window of the brachiocephalic and left carotid inner branches positioned along the outer curve. The Coda balloon in the right atrium was inflated. When the systolic pressure dropped below 50 mm Hg, the device was deployed. The delivery system was then withdrawn.



Figure 2. The RelayBranch device (Terumo Aortic, Sunrise, FL). (a) The main-body is deployed first. (b) The large cannulation window maintains cerebral perfusion post main-body deployment. (c) Stenting of the supra-aortic branches occurs in sequence thereafter. Note the 2-branch configuration with antegrade internal branches. Reproduced with permission courtesy of Terumo Aortic.

Supra-aortic branch reconstruction was completed next. Using the above-mentioned carotid exposure, each carotid artery was sequentially punctured retrograde with micropuncture access and upsized to an 8-French 45-cm sheath (Terumo Medical, Somerset, NJ) over a stiff wire. Through the right carotid sheath, a guidewire was then used to access the posteriorly positioned inner branch of the RelayBranch main-body cannulation window, traversing retrograde through the brachiocephalic artery and on into the main-body device. The guidewire was then exchanged for a Rosen wire. To ensure that the correct inner branch had been cannulated, inflation of a 12-mm balloon within the posterior inner branch was performed as a confirmatory step. After the correct inner branch was cannulated satisfactorily, a VBX 11 mm × 79 mm stent (W.L. Gore, Flagstaff, AZ) was advanced, unsheathed, and deployed. A VBX 11 mm × 59 mm stent was deployed in overlap to achieve distal endoseal. The stent was post-dilated to 12 mm within the branch of the main-body. Following the same steps, the anteriorly positioned inner branch of the main-body was cannulated with a guidewire from the left carotid sheath. A VBX 8 mm × 79 mm stent was deployed, followed by a second VBX 8 mm × 59 mm stent in overlap. Completion angiography confirmed good position with no endoleak. The wires and sheaths were removed, and the carotid arteries were repaired primarily. Protamine sulfate was administered to reverse the effects of heparin, and the surgical incisions were closed.

The pre-discharge in-hospital computed tomography scan unexpectedly identified a small type 1A endoleak related to the stent overlap between the RelayBranch device and the previously placed stents in the distal arch and proximal descending thoracic aorta. The patient was returned to the operating room, and 2 Palmaz stents (Cordis Corp, Miami Lakes, FL) were placed in the main-body of the RelayBranch graft distal to the inner branches within the transverse arch. Resolution of the endoleak was achieved. At 3 months, the patient is clinically well, and computed tomographic imaging affirmed resolution of the type 1A endoleak (Fig. 1B).

Discussion

Although open surgical repair of the aortic arch is the gold standard, there are cases in which open surgery conveys considerable risk. Hybrid endovascular open repairs may provide a benefit in some patients, but they still require extensive reconstructions of the supra-aortic arch branch vessels and may not be suitable for high-risk patients. Zone 0 endovascular arch technology is an evolving area that may prove beneficial for a subset of patients.⁵ We have demonstrated safe use of the RelayBranch Thoracic Stent Graft to successfully treat a type 1A endoleak of the aortic arch in a complex patient.

Novel Teaching Points

- In highly select patients deemed too high risk to undergo open surgery, Zone 0 endovascular arch repair warrants consideration.
- Endovascular stents for the aortic arch need to incorporate special features that ensure safe deployment, successful endoseal, and anatomic versatility. The RelayBranch does address such issues and may prove promising. More experience is required.
- The first successful Canadian deployment of the RelayBranch Thoracic Stent Graft is described.
- A multidisciplinary aortic team is advocated for all total endovascular aortic arch cases.

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Disclosures

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