Intercostal artery stent grafting to prevent paraplegia during endovascular treatment of an intercostal loop graft aneurysm after thoracoabdominal aortic aneurysm repair

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A 3D reconstruction image of computed tomographic angiography of the chest and abdomen.

Central Message

Creative thinking can allow the use of off-the-shelf devices to treat patients with challenging anatomy. It is also key for vascular surgeons in treating patients with complex aortic pathologies.

See Commentary on page e131.

▶ Video clip is available online.

Aneurysmal degeneration of intercostal or visceral patches is a common complication of open thoracoabdominal aortic aneurysm surgery. It accounts for 6.8% of redo thoracoabdominal operations,¹ or as many as 18% in patients with connective tissue disorders.^{2,3} Past endovascular repairs have included exclusion of the involved patch and the associated branch vessels,⁴⁻⁶ debranching followed by endovascular exclusion,⁷ and the use of physician-modified grafts.⁸ We present the case of an intercostal loop graft (LG) aneurysm treated endovascularly with off-the-shelf devices by means of a technique that preserved flow through the intercostal artery (ICA). Institutional review board approval was not warranted for a single case report. The patient consented to publication of this case report.

CLINICAL SUMMARY

The patient was a 68-year-old man with a history of chronic obstructive pulmonary disease and multiple aortic operations. In 2009, he had undergone an open repair of an extent III thoracoabdominal aortic aneurysm with LG reattachment of ICAs 8, 9, and 10. In 2010, he underwent replacement of the ascending aorta and transverse arch. In 2012, the patient underwent an aortic valve and root replacement. In 2017, he underwent repair of an endovascular abdominal aortic aneurysm. In 2018, surveillance computed tomographic angiography demonstrated a 7.9-cm aneurysm involving the LG (Figure 1, A). Notably,

1 of the ICAs had hypertrophied (Figure 1, B) and supplied a rich network of spinal collaterals.

We wished to avoid another open operation while simultaneously preserving ICA perfusion. We planned an endovascular operation, which would begin with a trial of balloon occlusion of the LG and culminate in a parallel graft repair if needed.

With the patient under general anesthesia, a cerebrospinal fluid drain was placed. Bilateral femoral access was obtained, and the femoral arteries were closed percutaneously. Angiography demonstrated the intercostal patch aneurysm (Figure 1, C) and the large target ICA (Figure 1, D). A trial of LG balloon occlusion was performed, and motor evoked potentials were temporarily lost. In light of these findings, we elected to proceed with parallel graft reconstruction.

A 24F sheath was placed in the right femoral artery, and a 12F sheath was placed in the left. The 12F sheath was then advanced into the LG. An 11 × 100-mm Viabahn stent graft (W. L. Gore & Associates, Inc, Flagstaff, Ariz) was deployed into the distal ICA to secure the landing zone. Next, an additional 13 × 100-mm Viabahn stent graft and a 40 × 40 × 200-mm GORE TAG Conformable Thoracic Aortic Graft (W. L. Gore & Associates) were deployed in periscope parallel graft construction. An additional Viabahn

FIGURE 1. A and B, Axial image of computed tomographic angiography of the chest. A, An intercostal patch aneurysm measuring 7.8 cm. B, Intercostal artery (red arrow) arising from the aneurysm. C and D, Selective intraoperative angiography; intercostal loop graft with aneurysm (black arrow) feeding an intercostal artery (red arrow). E, A 3-dimensional reconstruction of preoperative computed tomographic angiography shown in lateral (L), anterior (A), and posterior (P) views.

stent graft was used to increase purchase into the distal ICA. Completion angiography confirmed an excellent result. (A more detailed description of surgical technique is given in the [Appendix](#).)

The patient had no complications, and the cerebrospinal fluid drain was clamped on postoperative day 1 and was removed on postoperative day 2. The patient was discharged home on postoperative day 3. One-month

FIGURE 2. Follow-up computed tomographic angiography. A, Axial image of computed tomographic angiography of the chest demonstrating an exclusion of the aneurysmal sac, with decrease in diameter to 6.6 cm, and a patent Viabahn stent graft (W. L. Gore & Associates, Inc, Flagstaff, Ariz) with contrast in its lumen. B and C, a 3-dimensional reconstruction image of computed tomographic angiography of the chest and abdomen demonstrating the positions of the thoracic stent graft, the Viabahn stent graft, and the previous bifurcated abdominal aortic stent graft.

VIDEO 1. Intercostal artery (ICA) stent grafting to prevent paraplegia during endovascular treatment of an intercostal loop graft (LG) aneurysm after thoracoabdominal aortic aneurysm (TAAA) repair. CSF, Cerebrospinal fluid; MEP, motor evoked potential; SSEP, somatosensory evoked potential. Video available at: [https://www.jtcvs.org/article/S0022-5223\(19\)30781-0/fulltext](https://www.jtcvs.org/article/S0022-5223(19)30781-0/fulltext).

surveillance computed tomographic angiography demonstrated patency of the reconstruction, exclusion of the aneurysm, and a decrease in aneurysm size (Figure 2).

DISCUSSION

This simple technique allowed us to perform a minimally invasive repair that preserved branch vessel patency while

excluding the aneurysm (Video 1). Creative thinking can enable the use of off-the-shelf devices to treat patients with challenging anatomy like the one in this case. Creativity is also a key ability for vascular surgeons involved in the care of patients with complex aortic pathologies.

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APPENDIX

Detailed Description of the Surgical Technique

The patient was taken to the hybrid operating room. With the patient under general anesthesia, a cerebrospinal fluid drainage catheter was placed by the anesthetist. Bilateral femoral access was obtained, and ProGlide devices (Abbott Laboratories, Abbott Park, Ill) were used to close the femoral arteries.

An aortogram was obtained, demonstrating the intercostal patch aneurysm. The loop graft (LG) was cannulated with a hydrophilic wire, and an angled catheter was advanced into the LG. Selective angiography demonstrated the large target intercostal artery (Figure 1, C and D). The hydrophilic wire was exchanged to GLIDEWIRE ADVANTAGE guidewire (Terumo Interventional Systems, Somerset, NJ), and a second wire was advanced into the LG. An attempt to advance the balloons failed as a result of resistance at the distal anastomosis of the LG to the main body graft, most likely caused by angulation. There, an A12F GORE DrySeal sheath (W. L. Gore & Associates, Inc, Flagstaff, Ariz) was placed in the right common femoral artery, and a 24F GORE DrySeal sheath was placed in the left common femoral artery. The wires were exchanged to Meier Guidewire (Boston Scientific, Marlborough, Mass). Two 18-mm Atlas balloons (C. R. Bard, Inc, New Providence, NJ) were successfully positioned within the LG to occlude the inflow and outflow (LG diameter on preoperative computed tomographic angiography was 16-18 mm, so we had <10% oversize). At 3 minutes of occlusion time, motor evoked potentials in bilateral lower extremities were lost. They started recovering 1 minute after balloon deflation and were fully recovered back to baseline after 5 minutes. We oversized the balloon up to 10% beyond the size of the LG diameter to ensure complete

occlusion of the graft. In light of these findings, we elected to proceed with a parallel graft technique that used off-the-shelf, commercially available devices.

Through the femoral approach, a hydrophilic wire and angled catheter were used to select the intercostal artery. The 12F GORE DrySeal sheath was then advanced into the intercostal artery. An 11 × 100-mm Viabahn stent graft (W. L. Gore & Associates, Inc, Flagstaff, Ariz) was deployed into the distal aspect of the vessel, and an additional 13 × 100-mm Viabahn stent graft was placed proximally (caudally) into the visceral segment but not deployed. A 40 × 40 × 200-mm GORE TAG Conformable Thoracic Aortic Graft (W. L. Gore & Associates)—oversized 10% to 15% to ensure good wall opposition in the graft—was moved into position (10%-15% oversize). This graft had been prepared on the back table for sequential deployment and was deployed caudal-side first to facilitate precise placement above the celiac artery. The more cranial aspect of the GORE TAG Conformable Thoracic Aortic Graft was then deployed, as was the caudal Viabahn stent graft. Another 13 × 100-mm Viabahn stent graft was used to extend further below the GORE TAG Conformable Thoracic Aortic Graft, to ensure no compromise of the parallel graft. An aortogram demonstrated no filling of the patch aneurysm, but the parallel graft was suboptimally visualized. Selective contrast injection suggested a type Ib endoleak from the distal intercostal landing zone. An 11 × 20-mm Viabahn stent graft was used to extend the repair, and completion angiography demonstrated resolution of the endoleak. Motor evoked potentials had remained intact after the initial Atlas balloon deflations. Percutaneous groin closure was achieved, and the patient was extubated uneventfully.