Overcoming the Unexpected

A case report that demonstrates the unforeseen challenges and complications that can be encountered when treating thoracoabdominal aortic aneurysms.

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Since Dake et al described the transluminal implantation of thoracic stent grafts in 13 patients in 1994,[1] endovascular treatment for thoracoabdominal aortic aneurysms (TAAAs) has dramatically evolved. The improvements in stent graft technology, imaging techniques, and surgical skills have broadened the endovascular options for TAAAs, expanding the limitations and allowing treatment of very complex anatomies. TAAAs can be treated with custom-designed fenestrated and branched stent grafts, but more complicated stent graft placement comes with a wider range of complications, unexpected issues, and case-specific solutions.[2-4]

In this article, we report a case demonstrating the difficulties, complications, and unexpected solutions involved in thoracoabdominal branched endovascular stent graft placement.

CASE REPORT

A 69-year-old woman presented in 2008 with a 5.2-cm type III TAAA. Her medical history included hypertension, chronic obstructive pulmonary disease, and treat-

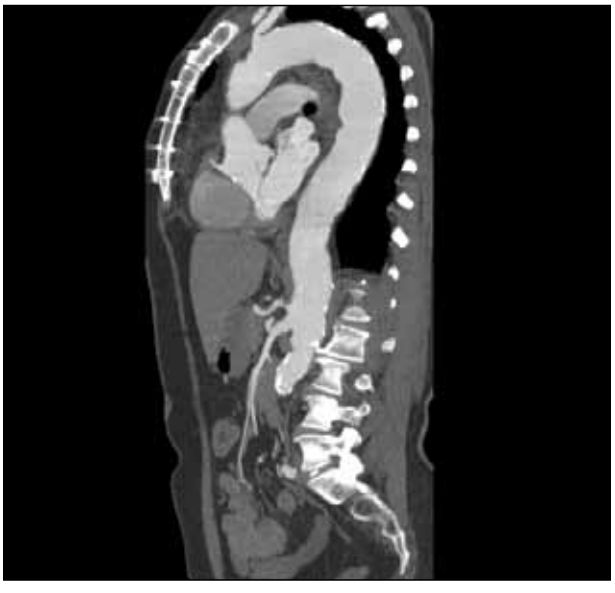

Figure 1. Sagittal CT scan showing an aberrant common hepatic artery.

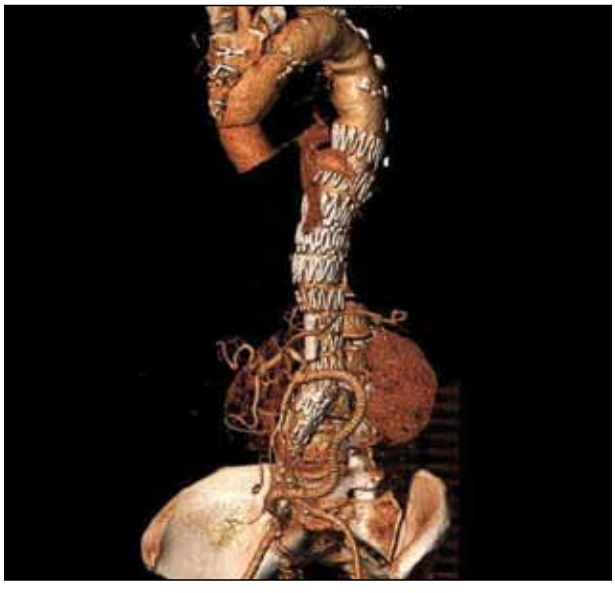

Figure 2. Three-dimensional reconstruction of the iliac-SMA bypass.

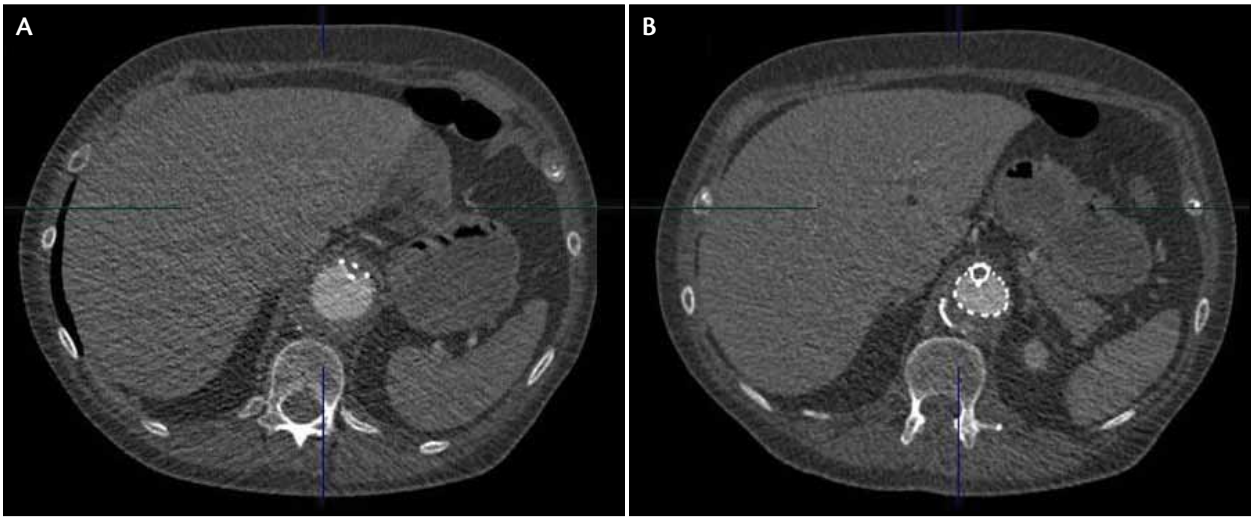

Figure 3. Axial CT scan showing an occluded celiac trunk branch (A) and SMA stent (B).

ment of her ascending aorta and aortic valve due to a 6-cm aneurysm and aortic valve insufficiency. Over the years, progressive growth of the TAAA of 6.2 cm was discovered. Her father had died from a ruptured aneurysm, she had several episodes of nonspecific abdominal and back pain, and therefore, strongly desired treatment of the aneurysm by endovascular means.

The maximal diameter of the aneurysm was at the level of the diaphragm, with the diameter returning to normal (21 mm) halfway through the infrarenal aorta. At the level of the celiac trunk and superior mesenteric artery (SMA), the aneurysm was 3.6 cm. Also of note was that the common hepatic artery originated from the SMA (Figure 1), a known anatomical variation occurring in < 5% of cases.[5]

A custom-made device was designed and ordered, including two fenestrations for the renal arteries and two branches for the celiac trunk and the SMA (custom-made Zenith endograft, Cook Medical, Bloomington, IN). The first part of the implantation procedure was straightforward: the device was introduced through the right femoral artery and oriented to both renal arteries. After angiography was performed, the stent was partially deployed, and via the left femoral artery, two Terumo wires (Terumo Interventional Systems, Inc., Somerset, NJ) were advanced into the separate renal arteries. A 7-F Ansel sheath (Cook Medical) was placed in both renal arteries followed by a 6- X 22-mm covered Atrium stent. Diameter-reducing ties were removed, the stent was deployed completely, and both Atrium stents were flared using a 12-mm X 2-cm percutaneous transluminal angioplasty balloon.

Next, the left brachial artery was dissected, and a 12-F ANL sheath was advanced into the thoracic aorta. The guidewire was placed through the branch into the celiac trunk with difficulty but would not advance further than a few centimeters, and no catheter could be advanced over the wire. After several attempts, we decided to address the SMA first. After cannulating the branch and SMA, the Terumo wire was replaced by an Amplatz Super Stiff wire (Boston Scientific Corporation, Natick, MA), over which a 12-F ANL sheath was introduced. Detailed angiography was performed to confirm the exact location of the origin of the common hepatic artery 16 mm distal from the origin of the SMA. Distal sealing of the deployed 10- X 59-mm Atrium stent failed due to the slightly conical nature of the distal landing zone in the SMA. Deployment of a second stent more distally failed for the same reason. Because we did not want to cover the only arterial supply to the liver, we decided not to deploy a third Atrium stent more distally. Further attempts to cannulate the celiac trunk were unsuccessful.

Control angiography showed good proximal and distal sealing in the aorta, good flow to both renal arteries, and obvious persistent leakage in the aneurysm due to an open branch toward the celiac trunk and a nonsealing Atrium stent in the SMA. At this stage, the procedure was ended in order to consider alternative plans.

After discussing all of the options with our patient, the decision was made to plan a further two-stage hybrid repair to complete the total exclusion of the TAAA. First, an 8-mm Propaten expanded polytetrafluoroethylene bypass graft (Gore & Associates, Flagstaff, AZ) was surgically implanted from the right common iliac artery to the SMA. The SMA was immediately ligated proximal

to the origin of the common hepatic artery. The operation was uneventful (Figure 2), the patient recovered well, and the second stage of the repair was planned. The strategy was to place an Amplatzer vascular plug (St. Jude Medical, Inc., St. Paul, MN) into the celiac trunk as well as in the branch toward the SMA via brachial access to occlude antegrade flow into the aneurysm sac. To execute the second stage optimally, computed tomographic angiography (CTA) was performed, which surprisingly showed significant shrinkage of the TAAA to a maximal diameter of 49 mm (1 year after stent implantation). The nonstented celiac branch was likely occluded as a result of a severely stenosed origin. The SMA stent turned out to be occluded, although it ended distally in the aneurysm sac (Figure 3). Some contrast was seen in the aneurysm sac due to retrograde leakage from the lumbar arteries and the celiac trunk (Figure 4). Of course, we decided to postpone further treatment.

Unfortunately, 1 month later, the patient presented at the emergency department with sudden onset of thoracic pain and hypertension due to an aortic dissection. The entry tear was located at the level of the proximal stent of the endograft with retrograde flow in the false lumen (Figure 5). Toward the left subclavian artery (LSA), the image appeared more like an intramural hematoma (IMH) progressing up to the origin of the LSA (Figure 6). A conservative approach with aggressive medical treatment for hypertension was chosen, but a follow-up CTA 12 days after the acute onset of symptoms showed acute progression in aortic diameter of the affected aorta (47–55 mm). After careful consideration and discussion with the patient, conservative treatment was continued, including regular imaging studies.

DISCUSSION

There are several issues in this case report that can be discussed at length. Although the origin of the celiac trunk was nonstenosed and the vessel itself was not extremely tortuous, we did not succeed in properly advancing the wire in the splenic artery, nor could we advance any catheter into the vessel. Perhaps the branch ended too distally, creating a very steep angle and preventing the wire from advancing further into the target vessel.

Furthermore, we were not able to obtain a seal between the distal end of the Atrium stent and the first 16 mm of the SMA. This was likely due to a combination of the conical shape of the vessel and the rigidity of the balloon-expandable covered stent. We considered deploying the stent more distally, covering the origin of the common hepatic artery, but decided against

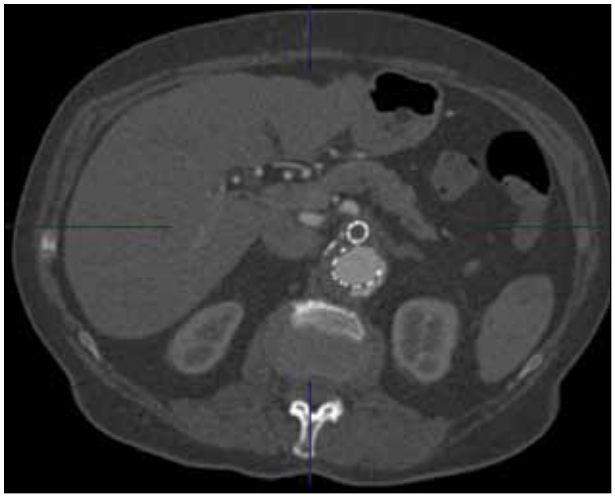

Figure 4. CT scan with contrast in the aneurysm sac.

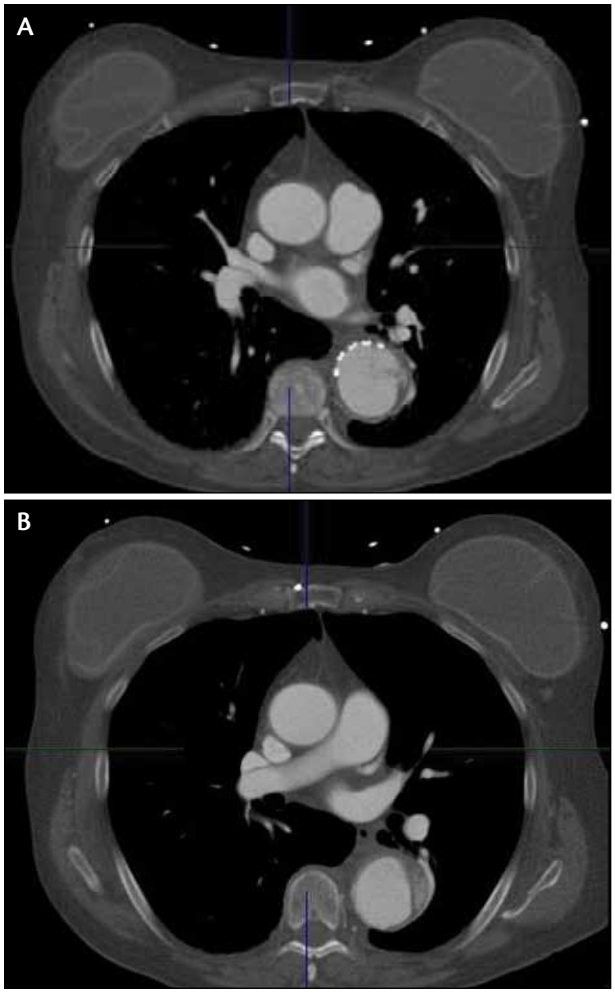

Figure 5. CT scan showing an aortic dissection with the entry tear at the level of the proximal stent of the endograft (A) and retrograde flow in the false lumen (B).

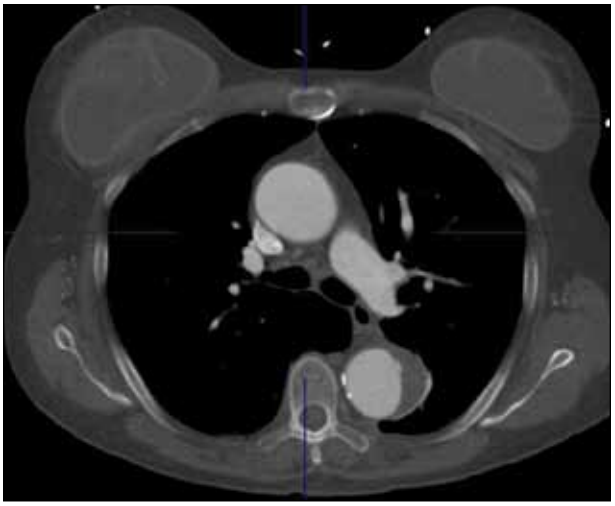

Figure 6. Axial CT scan showing the intramural hematoma.

it in this elective case. A possible solution may have been to use a different, more flexible covered stent or to first deploy a long open stent more distally followed by placing another covered stent inside it. Although the hepatic artery would be saved, it is doubtful that this construction would have resulted in an adequate distal seal. Furthermore, this would have made implantation of the surgical iliac-to-SMA bypass (and subsequent ligation of the SMA origin) much more difficult.

Possibly the most surprising part of this case was the unexpected spontaneous occlusion of both the celiac and SMA branches despite clear outflow in the splenic artery, aneurysm sac, and lumbar arteries, resulting in significant shrinkage of the TAAA (13 mm in 1 year).

Although intervention of the dissected section of the thoracic aorta was indicated, we decided to follow a conservative approach for several reasons: The patient had a presumably higher risk of spinal cord ischemia due to previous aortic interventions. Because most of the affected aorta shows an IMH, there is a realistic chance that at least part of that will resolve in the coming weeks/months, resulting in a potentially much smaller area of aorta that needs treatment. To have a sufficient proximal landing zone, coverage of the LSA would be necessary for this patient. Although that can be combined with a carotid-subclavian bypass, it will considerably increase the chance of covering the aberrant left vertebral artery that originates immediately proximal to the LSA, resulting in a higher chance of a posterior stroke.

CONCLUSION

This case started with a patient who had a type III TAAA that was treated with a custom-made fenestrated and branched stent graft. During various stages of treatment, we encountered several challenging issues—the celiac trunk could not be cannulated, and the SMA could not be sufficiently stented for which open bypass surgery was necessary. During follow-up, the size of the aneurysm surprisingly decreased in the presence of two known type III endoleaks. For unknown reasons, both branches spontaneously occluded in the presence of outflow vessels and type II endoleaks. Once the patient was reassured that her aneurysm was treated successfully, she suffered from an acute aortic dissection/IMH, most likely caused by repetitive injury of the wall by the proximal end of the stent graft. Despite optimal medical treatment, the affected portion of the aorta showed rapid dilatation. Overall, this was a challenging case with unforeseen twists. To be continued . . . ■

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1. Dake MD, Miller DC, Semba CP, et al. Transluminal placement of endovascular stent-grafts for the treatment of descending thoracic aortic aneurysms. N Engl J Med. 1994;331:1729-1734.
2. Brozzi NA, Roselli EE. Endovascular therapy for thoracic aortic aneurysms: state of the art in 2012. Curr Treat Options Cardiovasc Med. 2012;14:149-163.
3. Cross J, Raine R, Harris P, Richards T; FEVAR Consensus Working Group of the British Society of Endovascular Therapy. Fenestrated endovascular aneurysm repair. Br J Surg. 2012;99:152-159.
4. Sobocinski J, Resch T, Midulla M, et al. Fenestrated and branched technology: what's new? J Cardiovasc Surg (Torino). 2012;53(1 suppl 1);73-81.
5. Song SY, Chung JW, Yin YH, et al. Celiac axis and common hepatic artery variations in 5002 patients: systematic analysis with spiral CT and DSA. Radiology. 2010;255:278-288.