Hybrid zone zero debranching thoracic endovascular aortic repair of ascending aortic injury after surgery and radiotherapy for breast cancer

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ABSTRACT

Thoracic endovascular aortic repair of the ascending aorta remains challenging. We have reported the case of an 81-year-old woman with ascending aortic injury who underwent a life-saving hybrid repair. The patient had previously undergone extended radical mastectomy and postoperative radiotherapy for breast cancer, which had resulted in a right thoracic wall defect and bone exposure and osteonecrosis of the sternum. Therefore, the ascending aorta was directly compressed by the sternum at the level of the brachiocephalic artery bifurcation, causing persistent bleeding from the thoracic wall. Hybrid zone 0 debranching thoracic endovascular aortic repair with a left subclavian artery inflow was emergently performed and achieved hemostasis. (J Vasc Surg Cases and Innovative Techniques 2021;7:93-6.)

Keywords: Aortic diseases; Breast neoplasms; Hemostasis; Hybrid repair

Thoracic endovascular aortic repair (TEVAR) is a well-established first-line treatment of descending thoracic aortic disease.[1,2] However, open repair is usually chosen to treat ascending aortic disease owing to anatomic considerations and the lack of suitable available devices. We have reported the successfully treated case of ascending aortic injury with persistent bleeding from the thoracic wall. The patient provided written informed consent for the report of her case.

CASE REPORT

An 81-year-old woman had been admitted emergently because of arterial bleeding from the thoracic wall. At age 52, she had undergone extended radical mastectomy with concomitant resection of the pectoral muscles and postoperative radiotherapy for advanced breast cancer. Subsequently, because of late radiation injuries, thoracic wall defects and exposure of the sternum and ribs with osteonecrosis had progressed. She had previously been admitted to a different hospital because of persistent bleeding emanating from the sternum. The bleeding-associated anemia did not improve, and blood transfusion was required intermittently. She was considered difficult to treat and was transferred to our hospital with external sternal compression, which allowed for temporary hemostasis (Fig 1, *a*). On arrival, her systolic blood pressure was 80 to 100 mm Hg. On releasing the compression, active bleeding caused a decrease of 20 to 30 mm Hg. Contrast-enhanced computed tomography (CT) showed that the ascending aorta (AAo) was directly compressed by the sternum at the level of the brachiocephalic artery (BCA) bifurcation, which was determined to be the source of the bleeding (Fig 1, *b*).

Open repair was considered high risk owing to the patient's conditions, including the thoracic wall defect and a high level of frailty with wound infection risk. We planned to perform hybrid zone 0 debranching TEVAR covering the BCA and left common carotid artery (CCA) and revascularization of bilateral CCAs with left subclavian artery (LSCA) inflow. Perioperatively, broad-spectrum antibiotics were administered to prevent infection.

With the patient under general anesthesia, the bilateral CCA and LSCA were exposed through a supraclavicular incision, and a LSCA–left CCA–right CCA bypass was constructed with a bifurcated Dacron graft (10 × 8 mm; Gelsoft; Terumo, Tokyo, Japan). The right common iliac artery was exposed because of bilateral external iliac artery stenosis. The measurements (TeraRecon System; TeraRecon Inc, San Mateo, Calif) showed that it was 90 mm from the sinotubular junction to the LSCA bifurcation. The diameters of the proximal AAo and BCA bifurcation were 31 mm and 29 mm, respectively. We selected a Zenith TX2 proximal extension (34 mm × 77 mm; Cook Medical, Bloomington, Ind). However, we were concerned that the nose cone (NC) would cause left ventricular (LV) injury if the device was inserted into the AAo. Thus, the NC was trimmed in advance (Fig 2, *a*). An aortogram revealed an extravascular leak (Fig 2, *b*), and the device was deployed in zone 0 under intravenous administration of adenosine triphosphate, to cover the BCA and left CCA. An aortogram revealed a bird-beak configuration

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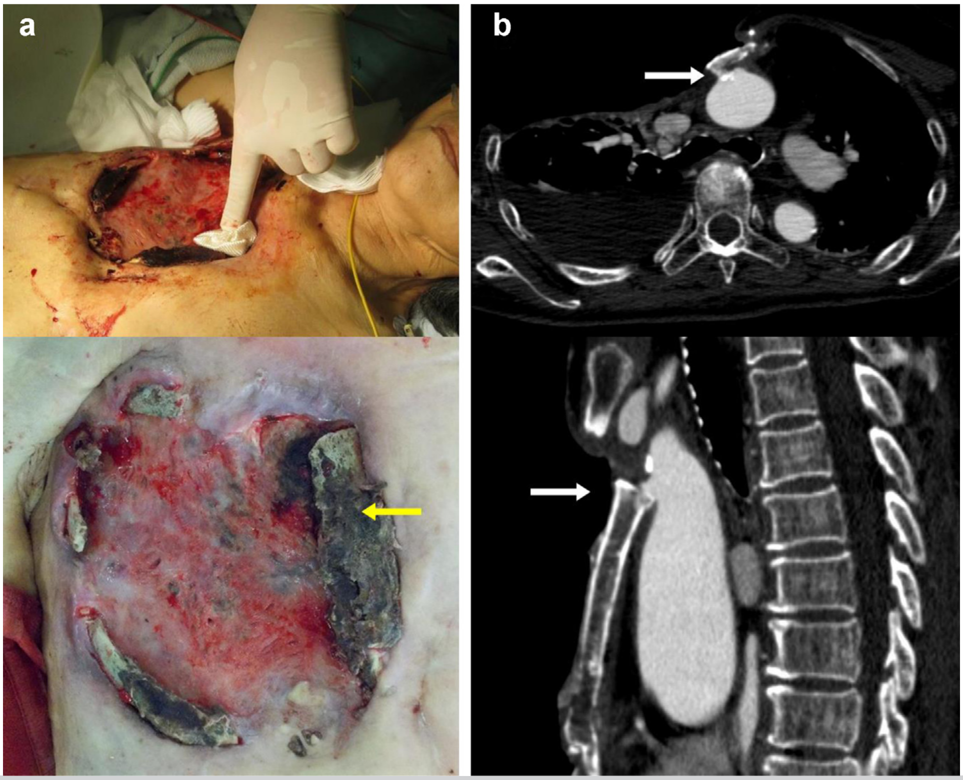

Fig 1. Preoperative findings. **a,** The right thoracic wall defect and bone exposure of the sternum (*yellow arrow*) and ribs with osteonecrosis were observed. **b,** Preoperative contrast-enhanced computed tomography (CT) scan showing that the ascending aorta (AAo) was directly compressed by the sternum at the level of the brachiocephalic artery (BCA) bifurcation (*white arrow*).

in the AAo, leading to a type Ia endoleak (Fig 2, *c*). A Zenith TX2 proximal extension (36 mm × 77 mm) was similarly trimmed and deployed inside the first one. However, the first device moved proximally when the second device passed through. The BCA was embolized using a 16-mm Amplatzer Vascular Plug (AGA Medical Corp, Plymouth, Minn). A completion aortogram revealed no type Ia endoleak (Fig 2, *d*). We decided to leave the left CCA open to prevent the devices from causing further stent-graft migration and because hemostasis had been adequately achieved.

After surgery, external compression was no longer required, and her anemia did not worsen. On postoperative day 10, the patient underwent resection of the exposed bone and a rectus abdominis skin flap transplant. The postoperative CT scan at 1 month showed no endoleak (Fig 3).

DISCUSSION

Cases of ascending aortic injury associated with surgery and radiotherapy for breast cancer are rare. Because of the high risk of open repair, we emergently performed hybrid zone 0 debranching TEVAR.

Regarding the treatment options for proximal aortic disease, debranching TEVAR has been reported with acceptable results.[3,4] In addition, advanced endovascular techniques, including chimney graft, periscope graft, in situ fenestration, fenestrated graft, and branched graft, have potential.[5-8] Of these, the debranching procedure was performed because we had limited experience with more advanced techniques; thus, we chose a more reliable method.

A meta-analysis on TEVAR in the AAo without a debranching procedure showed favorable outcomes.[9] The challenges of zone 0 TEVAR are related to the specific anatomy and morphology of the AAo, including the proximity of the coronary arteries, aortic valve, left ventricle, and arch vessels. The mean length of the AAo is 74 ± 20 mm, and the mean diameter is reported to be 33.4 mm and 30.5 mm in men and women, respectively.[10,11] These anatomic features can lead to difficulties in obtaining adequate stent-grafts. Regarding the device length, it was assumed that the other devices were ≥100 mm long and, thus, had a risk of covering the LSCA. Therefore, the 77-mm-long device was used. Although abdominal cuffs could be a treatment option, their shaft length is shorter, and a carotid, a subclavian, or an axillary artery approach would be required.[9] If a device is inserted via an inflow vessel, the possibility of vessel injury should be considered. The Zenith TX2 (Cook Medical) poses a risk of LV injury owing to its long NC. The NC was approximately 5 cm long and was trimmed to

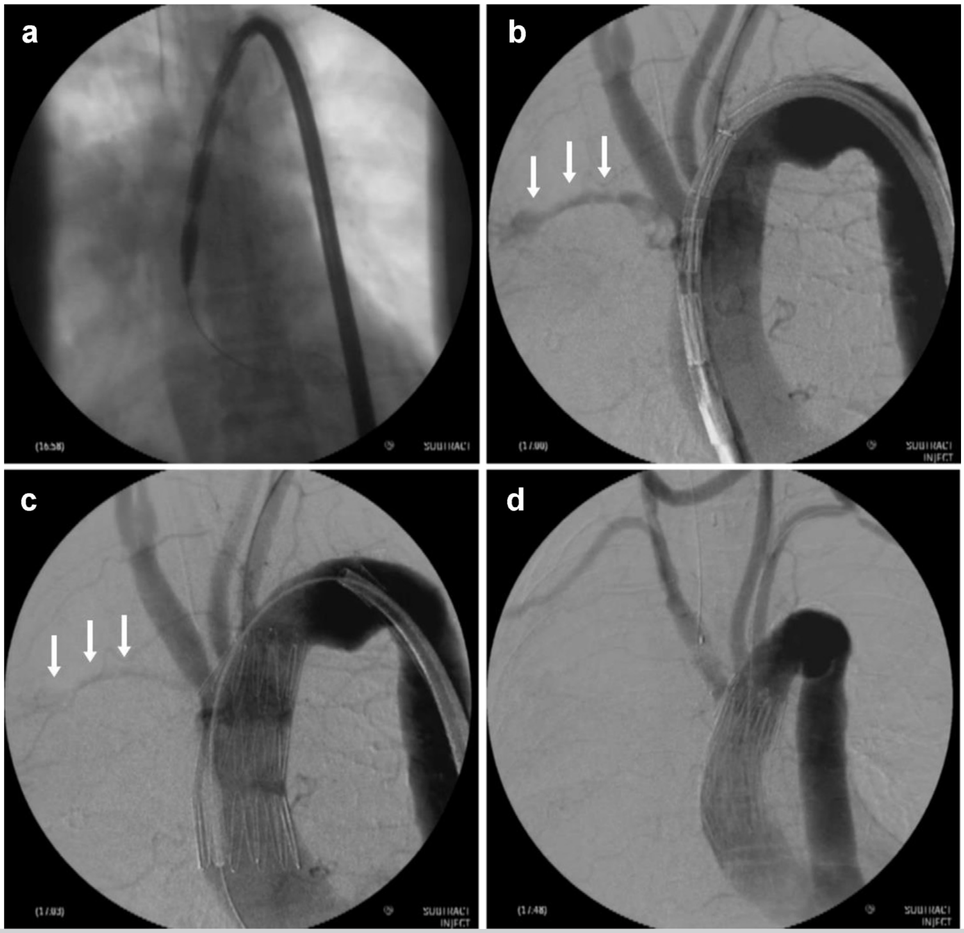

Fig 2. Intraoperative angiograms. **a,** A stent-graft was inserted after trimming the nose cone (NC). **b,** An extravascular leak was observed at the level of the brachiocephalic artery (BCA) bifurcation (*white arrows*). **c,** A residual extravascular leak was observed (*white arrows*). **d,** A completion aortogram showed no extravascular leak.

about one half with a scalpel, with a file used to smooth the surface. This maneuver avoided LV injury and deployed the stent-graft more proximally. Concerns exists that trimming the NC could affect tracking of the device and that such use is off label. In our patient, severe angulation of the aorta was not seen, and the devices were inserted smoothly.

One of the life-threatening complications after TEVAR is retrograde type A acute aortic dissection. The proximal landing zone, proximal stent-graft configuration, oversizing, and an ascending aortic diameter have been associated with the development of retrograde type A acute aortic dissection.[12-14] In our patient, the 34-mm device was used; it was oversized by 10% at the proximal AAo and 17% at the BCA bifurcation. However, the addition of a larger device was required as a result. We did not use any adjuncts such as gated CT, transesophageal echocardiography, or intravascular ultrasonography, although they might have helped to determine the precise size, especially that of the AAo.

The selection of the inflow vessel is critical in debranching procedures. In cases of zone 0 debranching TEVAR, the LSCA, descending aorta, and femoral artery have been reported as inflow vessels.[15-18] In our patient, given that the target lesion, BCA, and left CCA were in close proximity, both arteries had required coverage. Therefore, we selected the LSCA and revascularized the bilateral CCAs. Considering that hemostasis was achieved without covering the left CCA, we might have been able to perform an operation inflow from the left CCA. The long-term graft patency using the LSCA as an inflow vessel is unclear. The LSCA is more likely to be affected by atherosclerosis than the right, and thoracic radiotherapy might induce large-vessel vasculopathy.[19] Based on the blood pressure differences between the arms and the CT findings, the LSCA was determined to supply enough flow.

CONCLUSION

Zone 0 debranching TEVAR could be an effective treatment option in ascending aortic injury even during emergency surgery. Furthermore, advanced endovascular techniques would lead to more options for treatment in these cases.

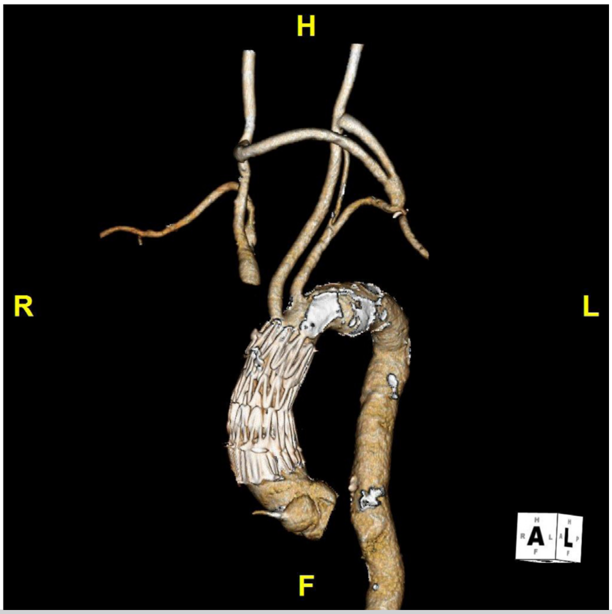

Fig 3. Postoperative findings. Postoperative contrast-enhanced computed tomography (CT) showing no leak and a patent graft.

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