Challenging endovascular treatment of a thoracic saccular aneurysm in extensive coral reef aorta

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ABSTRACT

Coral reef aorta (CRA) is a rare condition characterized by heavily calcified obstructive atherosclerotic lesions in the aorta leading to severe luminal stenosis.1 The majority of the patients with CRA have hypertension and intermittent claudication at the time of diagnosis. CRA can cause malperfusion of the lower limbs or visceral branches, thromboembolic events, and cardiogenic shock.2 Endovascular aortic repair is established as a minimally invasive procedure for aortic diseases; however, the aortic occlusive lesions of CRA are commonly treated by conventional open surgery, including aortic endarterectomy and extra-anatomic bypass.3 Endovascular treatment was demonstrated for occlusive lesions of CRA,4,5 but thoracic endovascular aortic repair (TEVAR) for an aneurysm in CRA has not been reported. We present a challenging TEVAR in a patient with a descending thoracic aneurysm in CRA. The patient provided informed consent for the publication of her case details and images.

CASE REPORT

A 72-year-old woman presented with intermittent claudication and a history of hypertension, stage IV chronic kidney disease, and Alzheimer’s dementia. She did not have a history of hyperlipidemia or smoking. A computed tomography (CT) scan demonstrated a severely calcified aorta and saccular aneurysm with a maximum diameter of 60 mm in the descending aorta (Fig 1; Video 1). The visceral branches were patent: the circumferential ostial calcification involved the celiac trunk and the superior mesenteric artery. She had not experienced abdominal angina. Her ankle-brachial index was 0.71 on the right and 0.69 on the left side; additionally, sequential interarterial pressure measurements in the thoracic aorta during diagnostic angiography showed a significant pressure deficiency in the thoracic lesion around the aneurysm. In contrast, no pressure gradient was observed below the celiac trunk. The result of the pressure measurements are shown in Fig 1, A. Considering her frailty and heavy calcification in the aorta, conventional open surgery was not suitable. Therefore, TEVAR with an axillobifemoral bypass grafting was planned. We did not perform a spinal drain at surgery because the intercostal artery from the treatment range was judged to be occluded on a preoperative CT scan, and both the hypogastric arteries and subclavian arteries were patent.

The procedure was performed in a hybrid operating room under general anesthesia. Left axillobifemoral bypass grafting was performed using an 8 mm PTFE graft (GORE PROPATEN, W. L. Gore & Associates, Flagstaff, AZ) to secure the perfusion of the lower limbs and visceral branches after TEVAR. Subsequently, transfemoral TEVAR was initiated. We planned to use the CTAG system (TGU282815J; W. L. Gore & Associates, Flagstaff, AZ) to secure the perfusion of the lower limbs and visceral branches after TEVAR. Subsequently, transfemoral TEVAR was initiated. We planned to use the CTAG system (TGU282815J; W. L. Gore & Associates) with an oversizing rate of 15% in the proximal and distal landing zones (Fig 1, B and D). However, it was impossible to advance the 20F DrySeal Flex Introducer Sheath (W. L. Gore & Associates), which was stuck at level D in Fig 1, E, despite balloon dilatation. Therefore, the stent graft itself was delivered and could be advanced to level B (Fig 1, C); subsequently, the stent graft also got stuck and could not be advanced beyond the proximal edge (level B). We tried to perform a balloon dilatation using another stiff wire and advance the stent graft, but advancement was difficult. So, we deployed the stent graft and performed balloon dilatation of the stenotic lesions inside the stent graft, enabling the advance of the introducer sheath to the distal aortic arch, and deployed an

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Author conflict of interest: none.

Additional material for this article may be found online at www.jvascsurg.org.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

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https://doi.org/10.1016/j.jvscit.2022.07.010

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The TEVAR procedure is summarized in Video 1. Intraoperative angiography showed well-preserved visceral artery perfusion and no endoleaks (Video 2). Extubation was performed in the hybrid operating room, and the postoperative course was uneventful. The ankle-brachial index improved to 1.15 on the right and 1.11 on the left side, and claudication disappeared. One week postoperatively, a CT scan demonstrated the complete exclusion of the aneurysm, secured lumen of stent grafts, and patent axillofemoral bypass (Fig 2; Video 2). The treatment range was 175 mm, and the patient’s course remained uneventful for 1 year after the procedure. A CT scan 1 year after surgery showed regression of the aneurysm from 60 mm to 55 mm.

**DISCUSSION**

CRA is characterized by heavily calcified obstructive lesions in the aorta.\(^1\) Endovascular aortic repair is established as a minimally invasive procedure for aortic diseases; however, an occlusive lesion of CRA is commonly treated by conventional open repair with a reported operative mortality of up to 11.6%\(^2\). Although previous articles have described the endovascular repair of obstructive lesions in CRA\(^4,5\), this report is the first of TEVAR for thoracic pseudoaneurysms in CRA.

We had some concerns regarding TEVAR. First, stent graft deployment limited by a lack of self-expanding capacity might lead to the acute malperfusion of downstream vascular territories. Therefore, we performed an axillofemoral bypass concomitantly to secure downstream perfusion after TEVAR. In consideration of the better reported graft patency rate of axillofibemoral bypass, compared with axillounifemoral bypass, we decided to use the axillofibemoral method.\(^6\) Regarding severe calcification of the orifice of the right subclavian artery, we decided to put the inflow in the left subclavian artery.

The postoperative CT scan showed a secured stent graft lumen; thus, whether an axillofibemoral bypass was necessary was debatable; a pressure study performed after TEVAR might provide clarity. This factor seemed to be one of the important reflection points in our case. Second, a heavily calcified aorta can fracture the endograft. It was challenging to advance the introducer sheath and stent graft through the severely calcified aorta, increasing the risk of fracture and embolization. Considering the heavily calcified obstructed aorta, a different low-profile stent graft system might have been useful; however, we decided to use the CTAG system owing to its high flexibility in consideration of the risks of stent graft collapse and fracture, which resulted in a well-secured stent graft lumen, even in the stenotic lesions. Stent grafts with a lower profile and more flexibility may be helpful to advance the introducer sheath and stent graft through the severely calcified aorta. Furthermore, a through-and-through wire technique could be a useful option for stent graft delivery. Notably, no fracture or embolic events were observed in this case.

**CONCLUSIONS**

We reported a challenging TEVAR in a patient with a descending thoracic saccular aneurysm in CRA. Although we had difficulty in advancing stent graft
system through the severely calcified aorta in CRA, we ultimately succeeded in excluding the aneurysm.

REFERENCES

1. Qvarfordt PG, Reilly LM, Sedwitz MM, Ehrenfeld WK, Stoney RJ. "Coral reef" atherosclerosis of the suprarenal aorta: a unique clinical entity. J Vasc Surg 1984;1:903-9.
2. Verreault-Julien L, Beaudoin J, Thériault MM, Do DH. Case report of an unusual and catastrophic presentation of coral reef aorta. Eur Heart J Case Rep 2019;3:1-5.
3. Grotemeyer D, Pourhassan S, Rehbein H, Voiculescu A, Reinecke P, Sandmann W. The coral reef aorta: a single centre experience in 70 patients. Int J Angiol 2007;16:98-105.
4. Holfeld J, Gottardi R, Zimpfer D, Dorfmeister M, Dumfärth J, Funovics M, et al. Treatment of symptomatic coral reef aorta by endovascular stent-graft placement. Ann Thorac Surg 2008;85:1817-9.
5. Plimon M, Fälkensamme J, Taher F, Assadian A. Covered endovascular repair of the paravisceral aorta. J Vasc Surg Cases Innov Techn 2017;3:186-91.
6. Kalman PG, Hosang M, Cina C, Johnston KW, Ameli FM, Walker PM, et al. Current indications for axillounifemoral and axillobifemoral bypass grafts. J Vasc Surg 1987;5:823-32.

Submitted Dec 10, 2021; accepted Jul 18, 2022.