Reverse extra-anatomic aortic arch debranching procedure allowing thoracic endovascular aortic repair of a chronic ascending aortic aneurysm

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ABSTRACT

A 79-year-old woman was admitted with a large chronic dissecting ascending aortic aneurysm starting 5 mm distal to the ostia of the left coronary artery and ending immediately proximal to the innominate artery. A reverse extra-anatomic aortic arch debranching procedure was performed. During the same operative time, through a transapical approach, a thoracic stent graft was deployed with the proximal landing zone just distal to the coronary ostia and the distal landing zone excluding the origin of the left common carotid artery. The postoperative course was uneventful. Computed tomography at 12 months documented patent extra-anatomic aortic arch debranching and no evidence of endoleak. (J Vasc Surg Cases and Innovative Techniques 2018;4:102-5.)

Keywords: Ascending aorta; Thoracic aorta; Aortic dissection; Stent graft

Type A aortic dissection is a cardiovascular catastrophe associated with high mortality. Medical therapy is associated with poor outcome, with a mortality rate of around 60%.[1] Open surgical repair is the first-line therapy for type A aortic dissection. However, a mortality rate of up to 60%[2] has been reported in high-risk patients. A less invasive approach would be highly beneficial in high-risk patients.

Currently, stent graft placement in the ascending aorta for the treatment of pseudoaneurysms, intramural hematoma, and even type A dissections has been described in anecdotal reports.[3,4] We report a "reverse" extra-anatomic debranching to provide a suitable landing zone for thoracic endovascular aortic repair (TEVAR). The patient has consented to the publication of this article.

CASE REPORT

The patient, a 79-year-old woman with a past medical history of nonischemic cardiomyopathy and severe chronic obstructive pulmonary disease, presented to the emergency department with chest pain and shortness of breath. Computed tomography (CT) showed a large chronic dissecting ascending aortic aneurysm 6.9 cm in anteroposterior diameter (Figs 1 and 2; Video).

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This patient was unlikely to survive open ascending arch repair because of her cardiac morbidity and severe chronic obstructive pulmonary disease. Emergent transthoracic echocardiography showed a dilated ascending aorta with an intimal flap, an ejection fraction of 40%, and diastolic dysfunction. Pulmonary evaluation performed 1 year ago found a postbronchodilator forced expiratory volume in 1 second of 75% of predicted value.

The aneurysm started 5 mm distal to the ostia of the left coronary artery and ended immediately proximal to the brachiocephalic trunk. The aorta above the aortic valve measured 31 mm, whereas the distal landing zone at the left subclavian was only 24 mm in diameter. A reverse arch debranching procedure was performed. This was composed of the following: left subclavian artery to right axillary bypass (retropharyngeal route); sequential reimplantation of the left and right common carotid arteries into the left subclavian artery to right axillary bypass; and right and left common carotid artery and right subclavian artery ligation. Ligation of the innominate artery was not accessible by a cervical approach. Bypass was performed using an 8-mm Dacron graft (Fig 3). During the same operative time, a transapical approach was performed. A left lateral thoracotomy in the fifth intercostal space (5-cm incision) was used to expose the apex of the heart. Two standard purse-string sutures were placed to close the hole at the end of the procedure, and an echocardiographically guided puncture was performed. A Valiant (Medtronic, Santa Rosa, Calif) stent graft (34 × 100 mm) was chosen. The graft was deployed under fluoroscopic control with the proximal landing zone just distal to the coronary ostia and the distal landing zone excluding the origin of the left common carotid artery. The proximal and distal end of the stent graft was precisely adjusted and deployed under rapid ventricular pacing. Completion angiography demonstrated patency of the coronary ostia and the left subclavian artery without endoleak. Balloon dilation was not performed.

After surgery, the patient was extubated within 24 hours. A CT scan confirmed satisfactory exclusion of the ascending aortic

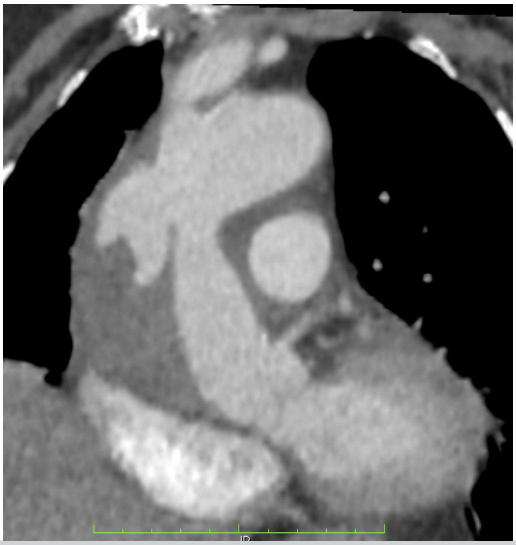

Fig 1. Computed tomography (CT) showed a large dissecting ascending aortic aneurysm (6.9 cm). The aneurysm started 5 mm distal to the ostia of the left coronary artery and ended immediately proximal to the brachiocephalic trunk.

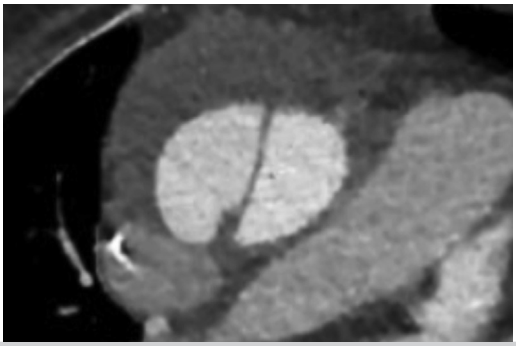

Fig 2. Contrast-enhanced axial computed tomography (CT) image demonstrates an intimal flap that separates the two channels in the ascending aorta.

aneurysm with no endoleak. The patient made a successful recovery and was discharged home on the fifth postoperative day. CT at 12 months documented a patent stent graft and extra-anatomic aortic arch debranching and no evidence of endoleak, stent graft expansion, and aneurysm shrinkage (Fig 4).

DISCUSSION

This report demonstrates a case of chronic type A aortic dissection successfully treated by TEVAR. It illustrates the utility of reverse extra-anatomic aortic arch debranching and the transapical approach for precise deployment of stent grafts in the ascending aorta.

Emergency surgical intervention remains the "gold standard" treatment of type A aortic dissection and intramural hematoma, yet up to 30% of patients with this disease are unable to undergo an open repair.[5] In those patients unfit for open repair, endovascular therapy has emerged as a possible alternative.

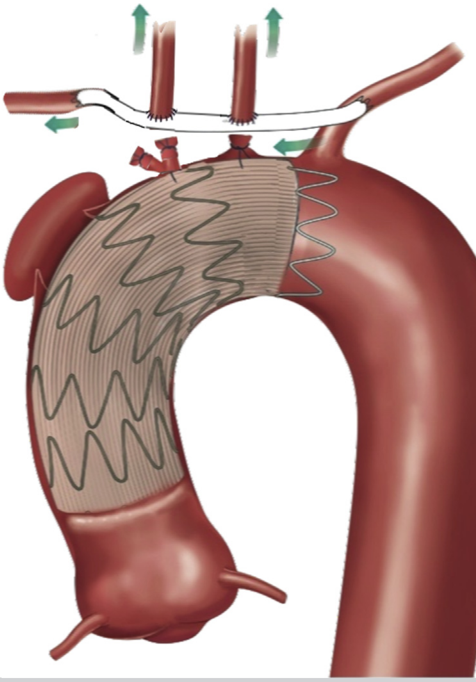

Fig 3. Drawing of the reverse extra-anatomic aortic arch debranching and thoracic endovascular aortic repair (TEVAR) of a chronic ascending aortic aneurysm.

The anatomic and physiologic challenges to endovascular therapy of the ascending aorta remain formidable. They include proximal graft fixation close to the aortic valve and coronary ostia and a distal landing zone that may impinge on the innominate artery.

The proximal entry tear was located at the distal part of the ascending aorta at least 6 cm distal to the left coronary ostia but was associated with a retrograde extension of the dissection ending 5 mm distal to the left coronary ostia. We thought than even landing in a proximal dissected neck, the closure of the entry tear could seal the chronic dissecting aneurysm.

CT imaging studies have reported that TEVAR is anatomically feasible in about 30% of patients with type A dissection with a proximal entry tear in the ascending aorta.[6]

Extra-anatomic bypass has previously been described through left lateral thoracotomy from the descending thoracic aorta.[7] This approach has the advantage of providing a long landing zone for the stent graft but at the cost of invasive thoracotomy and thoracic aorta clamping. This case report illustrates the feasibility of a reverse aortic arch debranching procedure to provide a distal suitable landing zone. The main advantages are to provide debranching from a cervical approach without aortic clamping.

Another challenge is that the hemodynamic forces in the ascending aorta resist accurate graft deployment. Rapid pacing helps improve stent positioning during graft deployment. In case of a partial occlusion of one

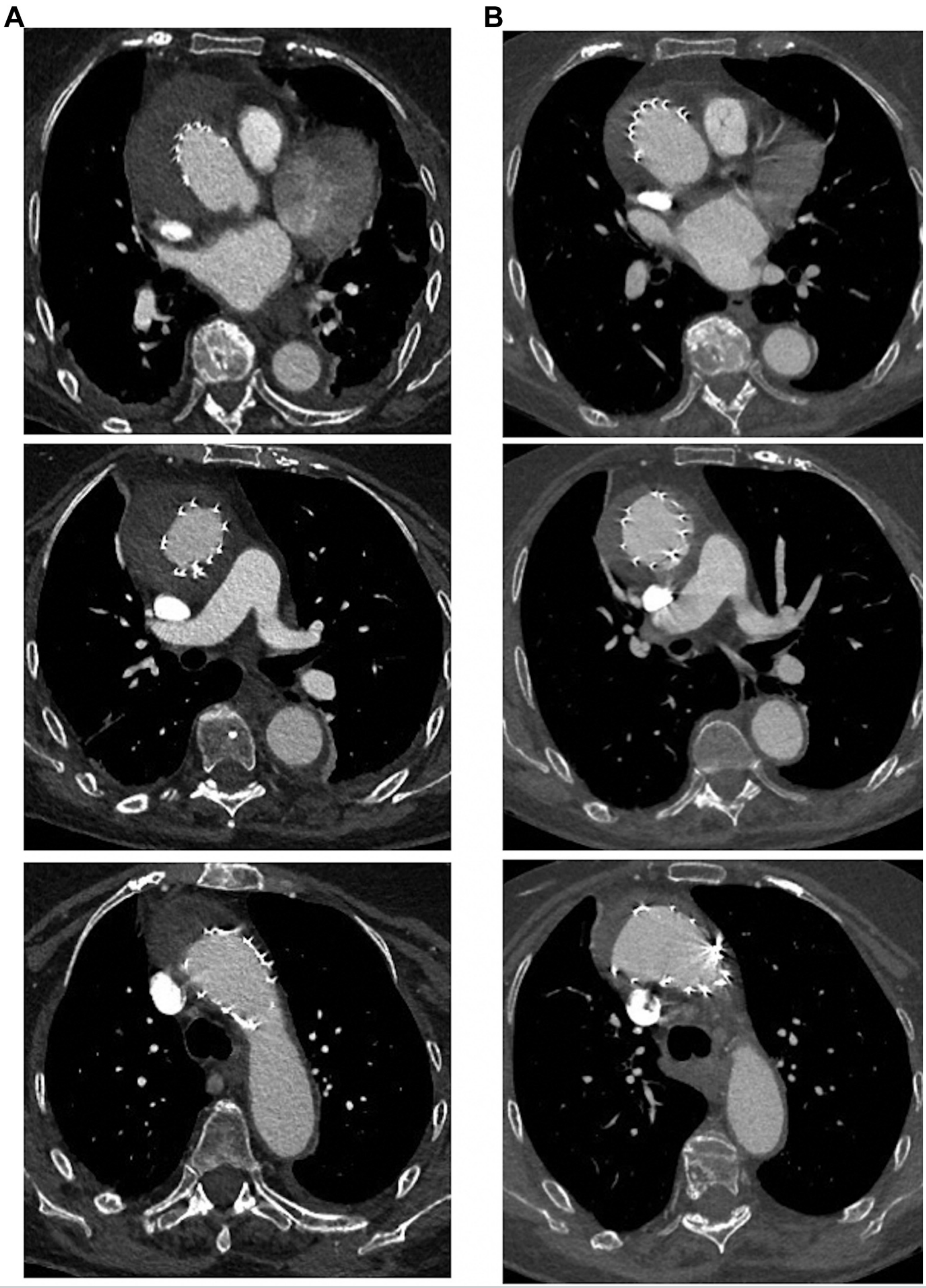

Fig 4. Postoperative computed tomography (CT) scan (axial slices) at 1 week **(A)** and 6 months **(B)** showing patent stent graft, no evidence of endoleak, stent graft expansion, and aneurysm shrinkage.

of the coronary arteries by the stent graft, balloon-facilitated repositioning would have been attempted. In case of failure, the patient would have been immediately placed on cardiopulmonary bypass support through cannulation of the femoral vessels, and during hypothermic circulatory arrest, the stent graft would have been removed and the ascending aorta replaced.

There were several reasons that we adopted transapical access. First, the short length of the delivery sheath prevented a transfemoral delivery. Second, through a femoral access, accurate device control and deployment are hindered by loss of torque control through tortuous iliac vessels into the 270-degree aortic arch. Third, the distal cone of current grafts prohibits deployment close to the aortic valve. Finally, because transapical access is the most widely used alternative route for transcatheter aortic valve implantation, we became accustomed to this approach.

CONCLUSIONS

This report demonstrates a case of chronic type A aortic dissection successfully treated by TEVAR. It illustrates the utility of reverse extra-anatomic aortic arch debranching and transapical approach for precise deployment of stent grafts in the ascending aorta.

REFERENCES

1. Hagan PG, Nienaber CA, Isselbacher EM, Bruckman D, Karavite DJ, Russman PL, et al. The International Registry of Acute Aortic Dissection (IRAD): new insights into an old disease. JAMA 2000;283:897-903.
2. Trimarchi S, Eagle KA, Nienaber CA, Rampoldi V, Jonker FH, De Vincentiis C, et al. Role of age in acute type A aortic dissection outcome: report from the International Registry of Acute Aortic Dissection (IRAD). J Thorac Cardiovasc Surg 2010;140:784-9.
3. Ronchey S, Serrao E, Alberti V, Fazzini S, Trimarchi S, Tolenaar JL, et al. Endovascular stenting of the ascending aorta for type A aortic dissections in patients at high risk for open surgery. Eur J Vasc Endovasc Surg 2013;45:475-80.
4. Nienaber CA, Sakalihasan N, Clough RE, Aboukoura M, Mancuso E, Yeh JS, et al. Thoracic endovascular aortic repair (TEVAR) in proximal (type A) aortic dissection: ready for a broader application? J Thorac Cardiovasc Surg 2017;153:S3-11.
5. Swee W, Dake MD. Endovascular management of thoracic dissections. Circulation 2008;117:1460-73.
6. Moon MC, Greenberg RK, Morales JP, Martin Z, Lu Q, Dowdall JF, et al. Computed tomography-based anatomic characterization of proximal aortic dissection with consideration for endovascular candidacy. J Vasc Surg 2011;53:942-9.
7. Gerosa G, Bianco R, Bortolami A, Dal Lin C, Frigatti P, Tarantini G, et al. Transcatheter repair of combined ascending aortic pseudoaneurysm and aortic arch aneurysm through a cardiac transapical approach. Ann Thorac Surg 2011;92:2259-62.

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