Hybrid thoracic endovascular aortic repair of ascending aortic pseudoaneurysm

Toshihito Gomibuchi, MD,[a] **Tetsuya Kono, MD,**[a] **Kouhei Takahashi, MD,**[a] **Yuko Wada, MD,**[b] **Daisuke Fukui, MD,**[b] and **Jun Amano, MD,**[b] *Suwa and Matsumoto, Japan*

We report the successful thoracic endovascular aortic repair of an ascending aortic pseudoaneurysm. Because the risk of resternotomy after conventional surgery was very high, endovascular repair with extra-anatomic reconstruction of the supra-aortic vessels was performed using the femoral artery as the donor artery. Complete exclusion of the pseudoaneurysm was achieved, with no postoperative complications or neurologic sequelae. (J Vasc Surg 2014;59:1695-7.)

Thoracic endovascular aortic repair (TEVAR) has recently been recognized as an alternative to open surgery for the treatment of thoracic aortic aneurysms.[1] Combined with supra-aortic bypass, this minimally invasive technique has also been used in the treatment of aortic arch aneurysms. We describe the successful repair of an ascending aortic pseudoaneurysm with supra-aortic bypass (hybrid TEVAR) using the femoral artery as the donor artery.

CASE REPORT

Emergency pulmonary embolectomy with cardiopulmonary bypass for acute pulmonary thromboembolism was performed in a 74-year-old woman with a history of multiple surgeries. Mediastinitis developed postoperatively, necessitating rectus abdominis muscle flap reconstruction. The patient presented in the emergency department 2 years later with a painful, pulsatile sternal swelling. Examination revealed a temperature of 36.8°C, and laboratory testing revealed a white blood cell count of 7.54×10^9/L and a slightly elevated C-reactive protein level of 1.09 mg/dL. Computed tomography (CT) angiography revealed a large pseudoaneurysm (51 mm) of the ascending aorta, without aortoiliac occlusive disease or arteriosclerotic arterial occlusive disease. The pseudoaneurysm arose in and was eroding the sternum and also had an extrathoracic component (Fig 1). A ruptured pseudoaneurysm of the ascending aorta was diagnosed. Conventional open surgery through median resternotomy was ruled out because of the high risk of massive hemorrhage and the amount of time required for cardiopulmonary bypass. Therefore, an emergency hybrid TEVAR was planned.

Under general anesthesia, both femoral arteries, both common carotid arteries, and the right axillary artery were exposed. Heparin (3000 units) was administered. A subcutaneous right femoral-right axillary-left carotid bypass was performed using an expanded 8-mm × 70-cm × 40-cm polytetrafluoroethylene graft (Vascular Graft; W. L. Gore & Associates, Flagstaff, Ariz). The proximal end of the graft was anastomosed to the right femoral artery in an end-to-side fashion. The distal end of the graft was also anastomosed to the axillary artery in an end-to-side fashion, and the other end of the graft was anastomosed to the left carotid artery in an end-to-end fashion. The proximal stump was ligated. Intraoperative angiography showed good visualization of the circle of Willis and no narrowing of the carotid artery, and so no revascularization of the left subclavian artery was performed.

The left femoral artery was used as the access route for endoprosthetic insertion. A 40- × 20-mm GORE TAG Thoracic Endoprosthesis (W. L. Gore & Associates) was inserted and advanced to the ascending aorta. The endoprosthesis extended from the sinotubular junction to the descending aorta and was deployed without rapid ventricular pacing or adenosine triphosphate infusion. All supra-aortic vessel origins were covered. Coils were used to occlude the origin of the brachiocephalic artery, which was accessed from the distal side of the right axillary artery anastomosis. Pulsation remained despite completion angiography demonstrating no endoleak, and so the possibility of a minor endoleak was considered. A second graft was thus deployed several millimeters proximal from the first graft. Subsequent completion angiography demonstrated perfusion of the supra-arch vessels, with no endoleak.

No postoperative complications or neurologic sequelae were observed. A follow-up CT angiogram at 1 week revealed complete exclusion of the pseudoaneurysm, with no evidence of an endoleak (Fig 2). The patient's postoperative course was uneventful at the 6-month follow-up, and the pseudoaneurysm was significantly reduced on CT (Fig 3).

From the Department of Cardiovascular Surgery, Suwa Red Cross Hospital, Suwa[a]; and the Department of Cardiovascular Surgery, Shinshu University School of Medicine, Matsumoto.[b]

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Reprint requests: Tetsuya Kono, MD, Department of Cardiovascular Surgery, Suwa Red Cross Hospital, Kogandori 5-11-50, Suwa, Nagano 392-8510, Japan (e-mail: tkonocvsurg@suwa.jrc.or.jp).

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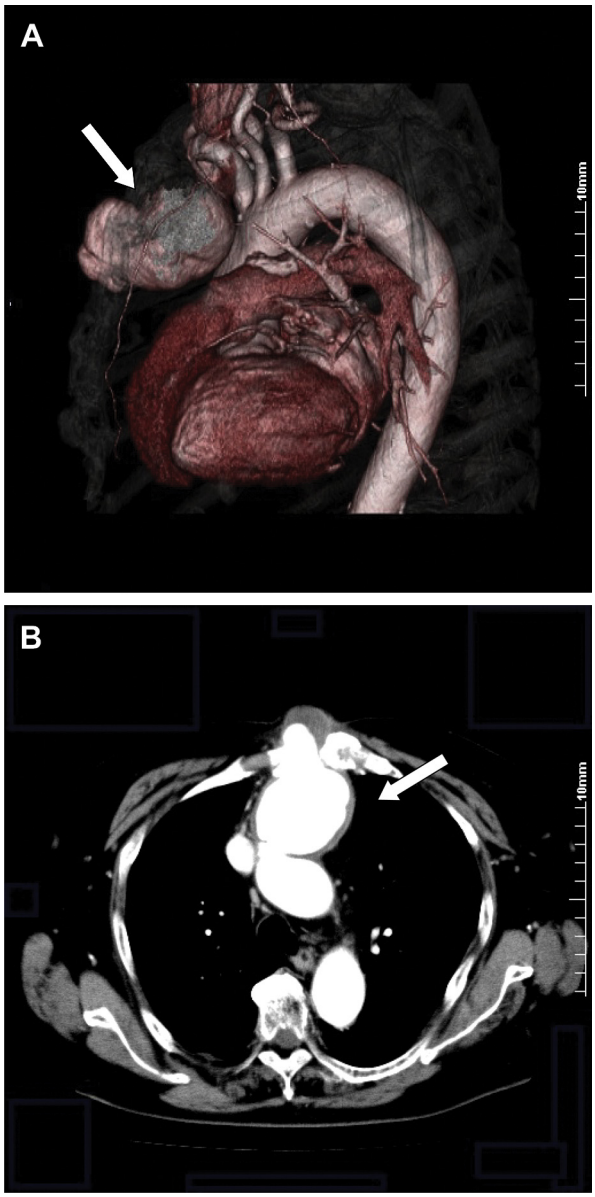

Fig 1. An ascending aortic pseudoaneurysm with an extrathoracic component eroding the sternum (*arrows*) is shown in a preoperative **(A)** volume-rendered computed tomography (CT) angiogram and in an **(B)** axial CT image.

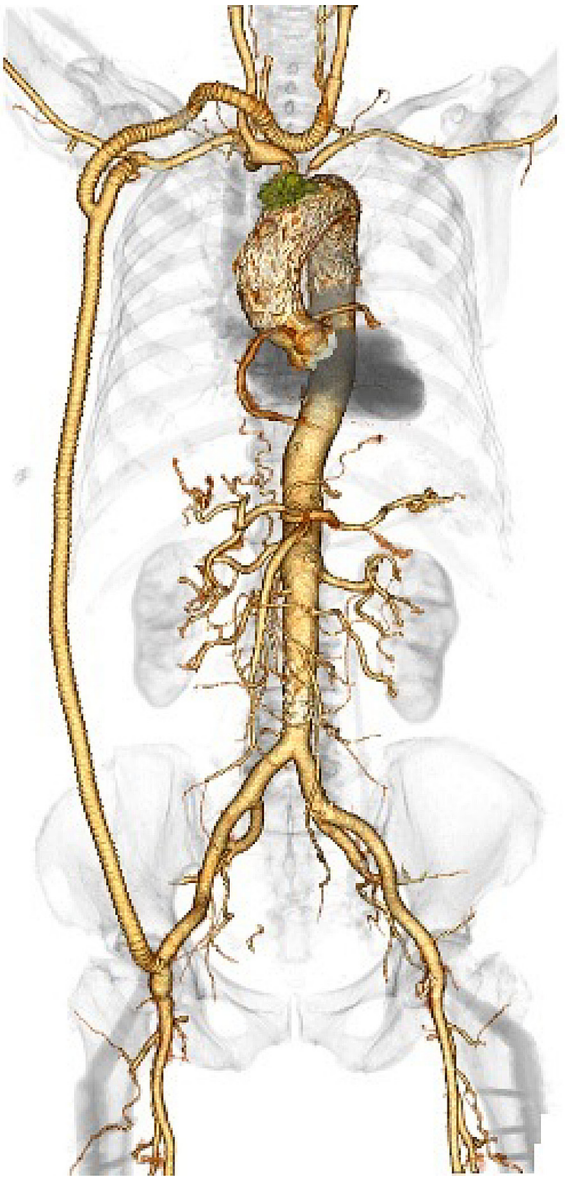

Fig 2. A volume-rendered postoperative computed tomography (CT) angiogram shows the branched prosthetic graft connecting the supra-arch vessels. Blood flow from the femoral artery provides the inflow for all supra-arch vessels.

DISCUSSION

Pseudoaneurysm of the ascending aorta is a rare and potentially fatal complication. It can occur as a result of cannulation, aortotomy, or puncture and is common at the proximal site of a graft anastomosis. Thoracic re-entry through a median sternotomy carries the risk of aneurysm and potentially fatal hemorrhage. Common techniques include femoro-femoral cardiopulmonary bypass, profound hypothermia, and total circulatory arrest of the main circuit before resternotomy. However, postoperative mortality rates are very high when these techniques are used.[2]

Endovascular options, such as the use of an Amplatzer (AGA Medical Corp, Plymouth, Minn) device,[3] are also possible. However, complete occlusion of the pseudoaneurysm was required in this case, and so we chose to use TEVAR. TEVAR has been used for thoracic aneurysm repair with satisfactory results, but it has the limitation that landing zones must be considered to ensure proper circumferential seals and complete aneurysmal exclusion.[1] Landing zones are often inadequate in cases of ascending aortic aneurysm, and the risk of obstructing the flow of the coronary and brachiocephalic arteries is substantial. Therefore, TEVAR is not usually considered in patients

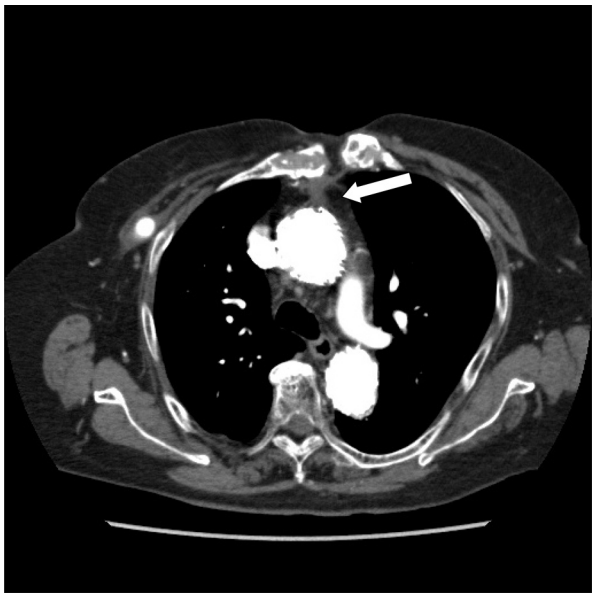

Fig 3. A postoperative axial computed tomography (CT) image shows the reduction of the ascending aortic pseudoaneurysm (*arrow*).

with an ascending aortic aneurysm. To compensate for the inadequate landing zones, hybrid TEVAR has been used successfully. Other studies have reported restored perfusion of supra-aortic vessels from the left subclavian artery and descending aorta using TEVAR.[4-6]

In the patient reported here, the distance from the sinus of Valsalva to the left subclavian artery was <10 cm. An endoprosthesis was used cover all supra-aortic vessels from the sinus of Valsalva to ensure complete aneurysmal exclusion; therefore, the supra-aortic vessels could not be used as donor arteries. In addition, a thoracotomy would be required if the descending aorta were used as an inflow, and because this was an emergency surgery, we chose to use the femoral artery as a donor because this was less invasive. The suitability of the femoral artery as a donor was confirmed by preoperative CT, which revealed no aortoiliac occlusive disease or arteriosclerotic arterial occlusive disease.

To bypass both sides of the common carotid artery creates a higher risk of stroke than bypassing one side, and so we performed a right axillary artery bypass and did not involve the right common carotid artery. In an emergency, if a migration of several millimeters is acceptable, we do not use rapid pacing or adenosine as an adjunct to facilitate graft deployment to simplify the procedure. To our knowledge, this is the first report of hybrid TEVAR using the femoral artery as the donor artery.

The concern regarding hybrid TEVAR with the femoral artery as the donor is the patency of the graft. Studies of axillofemoral bypass have reported acceptable patency outcomes.[7] Blood flow from the femoral artery to the head does not compete with other blood flow. Therefore, a high degree of patency may be expected. One study of hybrid TEVAR with flow dominant on the right side in the common and internal carotid arteries reported that regional cerebral blood flow and vasoreactivity were preserved postoperatively.[8] The authors did not comment on whether the flow from the femoral artery preserved cerebral blood flow. Careful observation is necessary in the future. If an anastomotic stenosis occurs, a bypass from the descending aorta may be considered.

There were no obvious signs of infection. However, because the patient had a history of mediastinitis, there was a possibility that the pseudoaneurysm was caused by an infection. In this context, replacement with a homograft or an antibiotic-soaked prosthetic graft would be considered. However, TEVAR was used because mortality rates are very high for open surgery. Antibiotics were administered postoperatively: meropenem, which had been used to treat the patient's mediastinitis, for 2 weeks, followed by oral levofloxacin thereafter.

CONCLUSIONS

We report successful repair of a ruptured pseudoaneurysm in the ascending aorta after repeated sternotomy using hybrid TEVAR. Hybrid TEVAR using the femoral artery as the donor artery should be considered as a possible alternative treatment of pseudoaneurysm of the ascending aorta.

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