Successful Endovascular Aortic Repair (EVAR) for an Abdominal Aortic Aneurysm with a Shaggy Aorta Using a Temporary Filtered Aorto-Venous Shunt for Protection against Shower Embolism

Abstract

Endovascular aortic repair (EVAR) is generally considered to be contraindicated in the presence of a shaggy aorta, because of the high risk of shower embolization. However, many patients who have abdominal aortic aneurysms (AAAs) with diffuse aortic atherosclerosis need EVAR because of high surgical risk. We report a case of AAA with massive aortic plaques that was treated with EVAR, using an extracorporeal shunt with a blood filter constructed from the femoral artery and vein during the procedure. The patient had an uneventful postoperative course. This method of sieving emboli in a filter in an external shunt is highly effective for EVAR of a shaggy aorta.

Key words: EVAR, abdominal aortic aneurysm, shaggy aorta, thromboembolism

Introduction

Endovascular aortic repair (EVAR) is a minimally invasive treatment that has been widely performed for the treatment of abdominal aortic aneurysms (AAAs). Having lower perioperative mortality and morbidity than conventional surgical repair, EVAR has recently become the first-line treatment of AAA [1]. However, EVAR entails various risks, including vascular injury, endoleaks, device malfunction, and embolic complications. In particular, there has been considerable discussion about EVAR for a shaggy aorta. This term is derived literally from the “shaggy” look of the plaques, which consist mainly of cholesterol crystals accumulating on the aortic wall as a result of advanced arteriosclerotic changes. These cholesterol crystals frequently disperse and in some cases cause embolism, a condition that is described as shaggy aorta syndrome [2]. While endovascular procedures are considered to be contraindicated for an atheromatous aorta, given the possibility of severe embolic complications caused by the catheter and other endovascular devices, many AAA patients with a shaggy aorta who are not considered good candidates for open surgery because of their high operative risk.

Here we report a case of successful EVAR for an AAA with massive aortic plaques, in which a special aorto-venous (A-V) filter was attached to the femoral artery and vein. This method is very effective for preventing lower extremity distal embolization.
Fig. 1. Preoperative CT scan shows a severe shaggy aorta and an abdominal aortic aneurysm. The white arrows demonstrate abundant irregular atherosclerotic plaque in the abdominal aorta. CT: computed tomography.

Fig. 2. Curved planar reformatted CT angiography shows multiple atherosclerotic plaques in the abdominal aorta, especially around the renal arteries (yellow circle). CT: computed tomography.

Case Report

An 82-year-old man was referred for a 52-mm AAA. He had emphysema with asthma, chronic kidney disease (creatinine 3.77 mg/dL), peripheral artery disease, hypertension, and hyperlipidemia. He also had a history of myocardial infarction. Contrast-enhanced computed tomography (CT) showed abundant irregular atherosclerotic plaque in the abdominal aorta and iliac arteries (Fig. 1, 2).

Considering the operative risk factors, EVAR was scheduled. However, there was a high possibility that distal embolic complications would occur after the endovascular repair. Therefore, an A-V shunt device with a filter was used during the EVAR procedure to prevent distal embolism to the lower extremities or other abdominal tributaries. First, an 8-mm artificial vessel (Gelsoft® ERS; Vascutek Ltd., London, UK) was formed into a Y-shape and anastomosed to the right common femoral artery. One of the distal sides of the artificial vessel was used as an access route for inserting the contralateral leg, and the other side was connected to the entrance to the A-V shunt circuit. An efferent conduit was anastomosed to the right common femoral vein, and a filter (AL-6NSJ, 100 mL; Pall Corporation, Tokyo, Japan) was interposed between the afferent and efferent conduits. A Doppler flow meter (HD-800; Hadeco Inc., Tokyo, Japan) was attached just distal to the filter to monitor A-V shunt flow during the procedures (Fig. 3A, B, C). As there was a large amount of plaque around the orifices of the renal arteries, a Gore® EXCLUDER C3® (RMT231412J; W. L. Gore & Associates, Inc., Flagstaff, AZ, USA) was inserted from the left common femoral artery through an 18-F sheath (Gore® DrySeal; W. L. Gore & Associates, Inc., Flagstaff, AZ, USA) and gently deployed just below the left renal artery, preventing plaque migration to the renal arteries (Fig. 2). The leg of the Gore® EXCLUDER® (PXC181000J) was then inserted as an ipsilateral extension through the sheath in the left common femoral artery and deployed at a site proximal to the stenosis of the left common iliac artery. Fi-
Fig. 3. (A) A-V filter (AL-6NSJ, 100 mL, Pall Corporation, Tokyo, Japan) with a sensor for blood flow. (B) Actual appearance of the temporary extracorporeal filtered A-V shunt system. (C) Operation schema of the temporary extracorporeal filtered A-V shunt system. (D), (E) Trapped large plaques (arrows) in the A-V filter. (F) On microscopic examination, the debris consists of cholesterol crystals, thrombus, and fibrin (hematoxylin and eosin staining, ×40). A-V: aorto-venous.

Fig. 4. Intraprocedural aortograms obtained just before (A) and after (B) stent-graft deployment.
tive time was 246 minutes, and the estimated blood loss was 240 mL. During the procedures, heparin (2 mg/kg) was administered systemically, and the activated clotting time was kept over 300 s. The average shunt flow was approximately 1300 mL/min when the external shunt was used. After the operation, the filter was detached from the A-V shunt circuit, and multiple large plaques were seen to be trapped in the filter (Fig. 3D, E, F). The patient’s course was uneventful and he was discharged on the eighth postoperative day, without any substantial elevation of serum enzymes, including creatinine, creatine phosphokinase, or amylase. A postoperative contrast-enhanced CT scan acquired about 6 months after the operation demonstrated the patency of the endografts, without any evidence of either endoleaks or visceral infarction (Fig. 5).

Discussion

EVAR has been widely performed for the treatment of AAs, gaining acceptance by the public and the medical community, since it is a minimally invasive procedure with lower perioperative mortality and morbidity than conventional surgical repair. However, it is evident from a study comparing EVAR and open surgical repair in patients with a massive aortic atheromatous thrombus that EVAR was associated with a significantly higher rate of late-phase embolic complications[3]. The repair of AAA has a higher risk of embolization than other vascular procedures, because of the thrombus and debris in the aneurysmal sac or atherosclerotic aorta that can be released into the circulation during the manipulation of various guidewires, sheaths, and stents. The incidence of lower extremity embolism has decreased dramatically with the improvement of techniques and progress in the design of stent grafts; it is now reported to occur in just 0.9% of patients [4]. EVAR is generally considered to be contraindicated for shaggy aorta because of the high risk of shower embolization [3, 5]. Nevertheless, there is no doubt that many surgically high-risk patients who have AAA with diffuse aortic atherosclerotic diseases require endovascular treatment. We recently described the use of a temporary filtered A-V shunt during the endovascular treatment of an AAA patient with a shaggy aorta who had a high surgical risk. In the present case, the patient had pulmonary dysfunction with emphysema, renal dysfunction, peripheral artery disease, hypertension, hyperlipidemia, and a history of myocardial infarction. Considering these risks, EVAR with an A-V shunt system for the prevention of distal embolism could reasonably be used in this patient. There are several reports of methods for the prevention of distal embolism [6-8]. Intra-arterial distal filter systems or balloon protection systems are often used in carotid, coronary, or peripheral interventions. However, application of these devices for EVAR in a shaggy aorta inherently demands additional manipulation of the devices within the shaggy aorta or target vessels, which further increases the chance of embolic complications. In addition, multiple protection devices are necessary to prevent distal embolism from the abdominal aorta to tributaries, which increases the cost and invasiveness of the operation and potentially impedes the EVAR procedure itself. Therefore, these options seem to be impractical in EVAR. On the other hand, successful prevention of distal embolism during thoracic EVAR with temporary introduction of an intra-aortic filter around the abdominal branch has been reported [9]. However, this device is not currently available, and it is difficult to apply to EVAR for anatomical reasons.

In comparison with these protection methods, the present temporary filtered extracorporeal shunt system can be coaxial with the stent-graft delivery system, and it can trap debris more efficiently, lowering the risk of distal embolism in several ways. First, this external shunt and the stent-graft systems work simultaneously at the same access route with a two-way artificial graft. Second, the shunt system collects embolic particles directly into the circuit with clamping of the common femoral arteries distal to the access region, to prevent distal embolism. The classical clamp of the distal femoral arteries during EVAR may also prevent embolic complications to the lower limbs, though stagnation of the blood flow containing scattered debris within the aorta may paradoxically increase the chance of migration of debris to the internal iliac arteries, lumbar arteries, or other visceral arteries. The present extracorporeal shunt system does not
cause stagnation of the blood flow and is able to capture embolic debris efficiently throughout the procedure. Finally, since this shunt system has an extra-aortic filter, distal embolism is less likely to occur than it would with intra-aortic filter systems.

Nevertheless, the temporary filtered A-V shunt system has some limitations. One is that it is impossible to prevent distal shower embolism completely, especially into the internal iliac arteries. However, because of the extensive collateral arterial network, pelvic ischemia rarely occurs when the internal iliac arteries are occluded; thus, it is rarely a major problem [10]. Another limitation is the hemodynamics when this external shunt system is introduced. Systolic blood pressure drops by 15-20 mmHg during this procedure. These alterations are predictable, and one must carefully avoid heart failure if patients have low cardiac function and the shunt flow volume is too great. Adjustment of the size of the A-V shunt route is indispensable during the process, and more attention should be paid to ensure that operative time is not overly prolonged. Finally, in comparison with simple EVAR, EVAR with a temporary filtered A-V shunt involves additional costs of the graft or filters, and the prolonged procedure time. A further study on improving the cost-effectiveness of the temporary A-V filtered shunt during EVAR is required.

In conclusion, in cases of EVAR with a shaggy aorta in particular, the present method of capturing emboli in a filter in an external shunt is highly effective.

**Conflict of interest:** The authors declare that they have no conflicts of interest to report.

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