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Successful Repair of Type I Endoleak Using the Frozen Elephant Trunk Technique

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Thoracic endovascular aortic repair (TEVAR) has emerged as an effective therapy for a variety of thoracic aortic pathologies. However, various types of endoleak remain a major concern, and its treatment is often challenging. We report a case of type I endoleak occurring 19 months after zone II hybrid TEVAR. The endoleak was successfully repaired by the frozen elephant trunk technique, without removal of a previous stent graft, combined with ascending aorta and total arch replacement.

Key words: 1. Endovascular stent
2. Aneurysm
3. Aorta, surgery

Case report

A 73-year-old man was admitted to the emergency department for hemoptysis. The patient had undergone a zone II hybrid thoracic endovascular aortic repair (TEVAR) 19 months prior, which consisted of a left common carotid artery (LCCA) to left subclavian artery (LSA) bypass with an 8 mm Gore-Tex graft (W. L. Gore and Associates Inc., Flagstaff, AZ, USA) and descending thoracic aneurysm repair with a Seal thoracic stent graft (40×150 mm; S&G Biotech Inc., Seongnam, Korea). The aneurysm was 70 mm in size and extended from the LSA to the mid-thoracic level. A computed tomography (CT) scan at admission showed a newly onset contrast leakage on the proximal portion of the stent graft and that the aneurysm had enlarged (86 mm) (Fig. 1). No definite aorto-bronchial fistula was present on the CT scan. As there was no safe landing on zone 0 and I due to atherosclerotic aneurysmal change (40 mm) with severe calcification, an additional TEVAR with debranching procedure was insufficient to solve the problem. Conventional repair from the ascending aorta to descending thoracic aorta was a high-risk option considering the patient's age and co-morbidity. Thoracic stent graft retrieval is a most troublesome procedure, but it was not essential in this case because there was no evidence of graft infection. Therefore, a less invasive hybrid procedure was conducted using the frozen elephant trunk technique.

Ascending aorta and bi-caval cannulation was done under median sternotomy. Deep hypothermic circulatory arrest (23°C) was initiated with selective antegrade cerebral perfusion through the innominate artery and LCCA. The intima of the aorta at the leakage site had thinned and ulcerated due to exposure to bare springs of the previous stent graft. Retrograde dissection was not observed. The new Valiant

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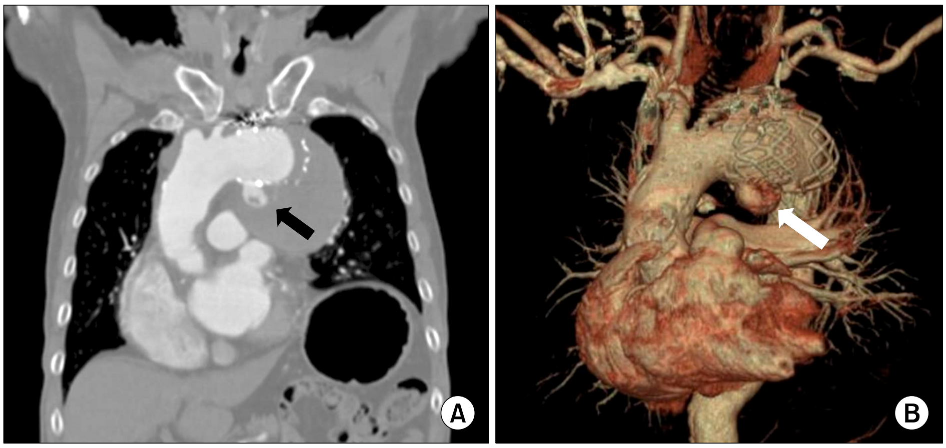

Fig. 1. Preoperative images. (A) The coronal section of CT shows type I endoleak at the proximal portion of the previous stent graft (black arrow). The maximal diameter of the aneurysm is 86 mm. (B) 3-Dimensional CT angiography shows type I endoleak at the proximal portion of the previous stent graft (white arrow). CT, computed tomography.

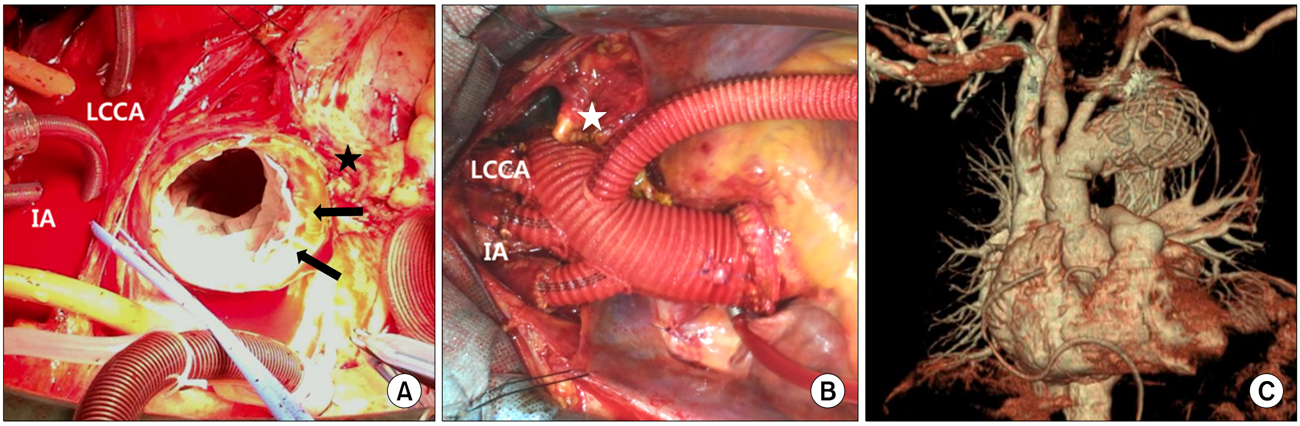

Fig. 2. Intraoperative images. (A) Operative findings after arch resection with selective antegrade cerebral perfusion to the LCCA and IA. The new stent graft was overlaid on the inside of the previous stent (black arrow). The aortic wall was thin, ulcerated, and enlarged at the site of the bare springs of the old stent (black star). (B) Ascending aorta and total arch replacement was performed with a 24×10×8×8×10 mm InterGard Woven aortic arch graft (Maquet Holding BV & Co. KG, Rastatt, Germany). Weakened aortic wall on leakage site was oversewn and anastomosed to the graft with reinforcement (white star). (C) 3-Dimensional computed tomography angiography showing the double stent graft by overlay on the inside and complete resolution of type I endoleak, postoperatively. LCCA, left common carotid artery; IA, innominate artery.

thoracic stent graft (34×150 mm; Medtronic Inc., Minneapolis, MN, USA) was overlaid on the inside of the previous stent graft (Fig. 2A). The stent graft size was determined by the diameter and length of the thoracic aorta on the distal landing zone. The proximal portion of the new stent graft was anastomosed with the aortic arch between the left carotid artery and subclavian artery and reinforced with a bovine pericardial patch. The ascending aorta and aortic arch was replaced using a 24×10×8×8×10 mm InterGard Woven aortic arch graft (Maquet Holding BV & Co. KG, Rastatt, Germany) (Fig. 2B). The patient was weaned from cardiopulmonary bypass uneventfully. The selective antegrade cerebral perfusion time was 125 minutes by the completion of arch vessel anastomosis and the aortic cross clamp time was 195 minutes. The patient was extubated on postoperative day 4 with an intact neurological outcome, and discharged on postoperative day 22 without complication. Postoperative CT angiography revealed no endoleak (Fig. 2C). The aneurysm was successfully excluded on the 6 months follow-up CT.

Discussion

Since its introduction in the 1990s, TEVAR has emerged as an attractive therapy for a variety of thoracic aortic pathologies, especially for patients with extreme high risk in conventional open surgery. However, endograft failure has remained a significant clinical concern and its treatment is often challenging. Although the incidence of endograft failure is known to be low, the true rate of reintervention might be higher because published data on the long-term results of TEVAR are limited [1,2].

The mechanism of endograft failure is multifactorial including insufficient landing zone, marginal aortic anatomy, proximal and distal aortic events, and infection. Advanced endovascular or surgical intervention related to endograft failure carries risk and increases morbidity and mortality [1,3]. To reduce the endoleak, therefore, precise review of the anatomical shape is very important when the decision on the type of treatment is initially made. Previous studies have shown that the length of the landing zone is directly correlated with early and long-term success of TEVAR, which should have at least 3 cm of normal aorta both proximally and distally, and have at least 5 cm in overlapping zones [4]. Aortic angulation of the landing zone is also a crucial factor to consider. An unsuitable landing zone due to angulation has resulted in aneurysmal formation even in a mostly normal aortic segment [1]. In this case, a short proximal landing zone of the initial TEVAR procedure was presumably insufficient to ensure a safe landing of the stent-graft. Because the landing zone had already had atherosclerosis and had increased to about 4 cm in diameter, it was inappropriate.

In addition, another important failure mechanism is retrograde type A dissection. Several factors have been identified leading to this fatal complication [5]. Proximal bare cell graft, which is often used for preventing graft migration in aortic arch TEVAR, is more likely to cause this event than non-bare spring stent-graft. Steep arch angulation, graft oversizing, compliance mismatch between the native aortic wall and endograft, and intrinsic disease of the native aorta all account for the retrograde dissection. Incomplete endograft apposition to the aortic arch (bird-beak configuration) has been known to induce endoleak and adverse clinical events [6]. An imperfectly apposed lip of the endograft may act as an obstacle to direct pulsatile flow between the device and the native aortic wall, so that there is an increased risk of type I and II endoleak as well as stent-graft collapse or infolding [7]. Bird-beak configuration mainly occurred due to the anatomic complexity of the aortic arch, but may be influenced by each device or the design of each graft. Therefore, it could be prevented by more strict patient selection, taking into account the adequate stability of landing zones, angulation and curvature at the aortic arch, and optimum device for use in the curved aortic arch.

In the present case, the growth of the aneurysm over time can be considered the cause of the stent's displacement and leakage. We assume that an insufficient landing zone and marginal aortic anatomy could lead to aneurysm enlargement despite an initial TEVAR procedure. When considering this case retrospectively, graft failure could have been avoided by performing ascending and total arch replacement combined with a debranching procedure and TEVAR at the initial stage of intervention. It seems that the interventional cardiologist recommended a hybrid TEVAR due to the surgical risk associated with the advanced age of the patient. However, we believe that the aortic lesion at the initial CT scan was not suitable for a Zone II TEVAR procedure. To reduce the need for a secondary surgical intervention following TEVAR, therefore, not only is optimal patient selection important, but it is also crucial to approach the case with a multidisciplinary team from the beginning of treatment. Furthermore, life-long aortic surveillance should be considered for all TEVAR patients, especially patients with marginal anatomy undergoing procedures at close intervals, because endograft failure could lead to a fatal event.

The frozen elephant trunk (FET) technique is a hybrid, single-staged alternative to conventional surgery for repairing complex pathologic conditions of the thoracic aorta, which extends to the descending thoracic aorta. Advantages of the FET approach are comparatively lower mortality by avoiding thoracotomy, shorter hospital stays, and less pain. Moreover, experience with performing the FET technique is expanding, and early and midterm results have been encouraging [8-11].

In our case, the FET technique was a good option for several reasons. There was no sufficient landing site in zone 0 and I, and due to severe atherosclerosis with calcification in the ascending aorta the case was difficult to treat by endovascular repair with a debranching procedure. However, conventional surgery with removal of the previous graft was expected to be a difficult and risky option due to the patient's age and physical condition. As there had been no evidence of graft infection, a less invasive hybrid procedure was performed for the patient.

In summary, secondary surgical intervention related to endograft failure carries risk and increases morbidity and mortality. The most important method for preventing reintervention is a multidisciplinary approach with further critical evaluation of the patient from the first treatment. An awareness and recognition of endograft failure is needed. The FET technique is a useful method to repair type I endoleak, leaving the previous stent graft in place in selected cases.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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