

DISEASES OF THE AORTA**SURGICAL TECHNIQUES**

Repair of Multiple Aneurysms of the Thoracic Aorta with a Hybrid Prosthesis

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ABSTRACT Complex aneurysmal disease of the thoracic aorta is commonly treated with the elephant trunk technique using two-stage surgery. However, this procedure is associated with high morbidity and mortality. We present the surgical technique used to correct diffuse aneurysmal aortic disease that involves the aortic arch and the descending aorta. The frozen elephant trunk technique using the E-vita Open prosthesis (hybrid procedure), that combines surgical and interventional technologies, was useful to simplify the conventional surgical procedure in a single-stage approach with optimal results. doi: 10.1111/j.1540-8191.2011.01211.x (*J Card Surg* 2011;26:197-200)

INTRODUCTION

Complex aneurysmal disease of the thoracic aorta is commonly treated with the elephant trunk technique using two-stage surgery.¹ Nevertheless this procedure is associated with high morbidity and mortality. For that reason, different one-stage techniques were developed to reduce the operative risk of these patients. The “frozen elephant trunk technique” is a one-stage procedure that combines the endovascular approach with the conventional open-surgery.²

The E-vita Open prosthesis (Jotec Inc., Hechingen, Germany) is a type I hybrid procedure³ specifically indicated to treat diffuse aneurysmal thoracic aortic disease. This technique restores normal aortic anatomy by combining an open technique to replace the aortic arch and a stent graft to treat the descending thoracic aorta.

The E-vita Open consists of a single polytetrafluoroethylene graft encapsulating circumferential Z-shaped nitinol rings along its length with a Dacron prosthesis at the proximal end (the length of this part is 70 mm). The length of the stent graft segment is variable, ranging between 150 mm in sizes 24–30 and 160 mm in larger sizes up to size 40.

SURGICAL TECHNIQUE

To illustrate the surgical technique of E-vita Open implantation, we present a 74-year-old male with

diffuse aneurysmal thoracic aortic disease. The patient was referred to our hospital with one-month history of epigastric pain and a diagnosis of multi-aneurysmal degeneration of the thoracic aorta demonstrated by computed tomographic scan (CT). Twenty years before, he suffered an acute abdominal aneurysm rupture treated successfully, but with residual ischemic failure of the left kidney. The CT showed significant dilatation of the aortic arch and two saccular aneurysms in the descending aorta with a diameter of 59 and 61 mm, respectively (Fig. 1).

We chose a single-stage surgical approach using the “frozen elephant trunk technique” with the E-vita Open prosthesis (Fig. 2). The surgical procedure was performed using a conventional median sternotomy. After systemic heparinization, cardiopulmonary bypass (CPB) was instituted with an arterial cannula introduced into the right axillary artery and with a single venous two-stage cannula through the right atrium. Myocardial protection and cardiac arrest was induced with cold blood cardioplegia (antegrade and retrograde fashion). After the temperature (nasopharyngeal) of 28°C was achieved, the heart was arrested and circulatory arrest was initiated. Cerebral protection was achieved using antegrade selective cerebral perfusion and moderate hypothermia, as previously reported.⁴ The axillary cannulation provided antegrade cerebral blood flow throughout the whole surgery, ensuring proper brain protection. When the CPB was stopped, the innominate artery was clamped and we then initiated the selective brain perfusion through the axillary artery using a blood flow of 10 mL/Kg/min. The left carotid and left subclavian arteries were clamped to avoid the steal

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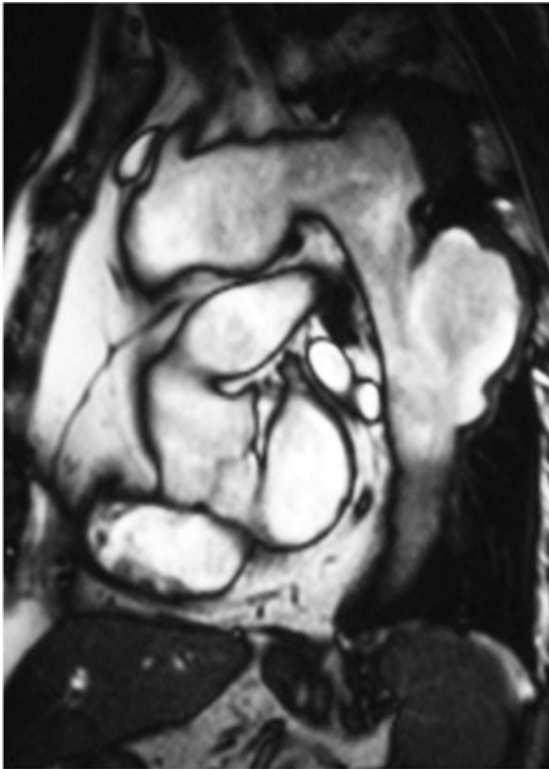


Figure 1. The CT shows dilatation of the aortic arch and two consecutive saccular aneurysms of the descending aorta.

phenomenon. The aneurysmal aorta was excised to the left of the proximal descending thoracic aorta in close proximity to the takeoff of the left subclavian artery. This narrow and partially healthy area was the anchor place of the E-vita Open. We next ligated the left subclavian artery and prepared the arch vessels for inclusion into the graft.

In a first step, the stent-graft portion of the E-vita system was introduced in the descending aorta, progressing through the arterial lumen in an antegrade manner (Fig. 3A). When the prosthesis was positioned correctly it was carefully released with a pull back system (Fig. 3B and C), avoiding the excessive progression of the stent into the aorta during the delivery maneuvers. It is useful to have an assistant surgeon to keep fixed the device using a side table during the release phase. In our experience, the positioning of the stent graft is suitable under direct view. Therefore, we have simplified the procedure by not using a guidewire. In this case it was even more appropriate due to the previous abdominal aortic disease with residual narrowing of the artery. Once the E-vita was released, the initial segment of the Dacron portion, closed to the proximal portion of the stent graft, was sutured and fixed to the aortic wall (at the level of the aortic neck, adjacent to the left subclavian artery) and reinforced with a Teflon felt (Fig. 4A).

In a second step, the Dacron portion was deployed and the supra-aortic vessels were anastomosed altogether in an island graft manner (Fig. 4B and C). Then the Dacron portion was clamped proximally, the innominate artery and the left carotid were opened, and the systemic perfusion was restored. The selective brain perfusion time was 46 minutes.

Finally, the proximal segment of the Dacron portion was anastomosed to the aorta as a supra-coronary graft. CPB time was 121 minutes.

The optimal location of the E-vita Open and the adequate opening of the stent portion were confirmed by transesophageal echocardiography.

The patient made an uneventful recovery and was discharged on the seventh postoperative day. There were no neurologic complications related to cord ischemia or brain injury.



Figure 2. The E-vita open hybrid prosthesis. The stent graft portion is folded in the delivery system.

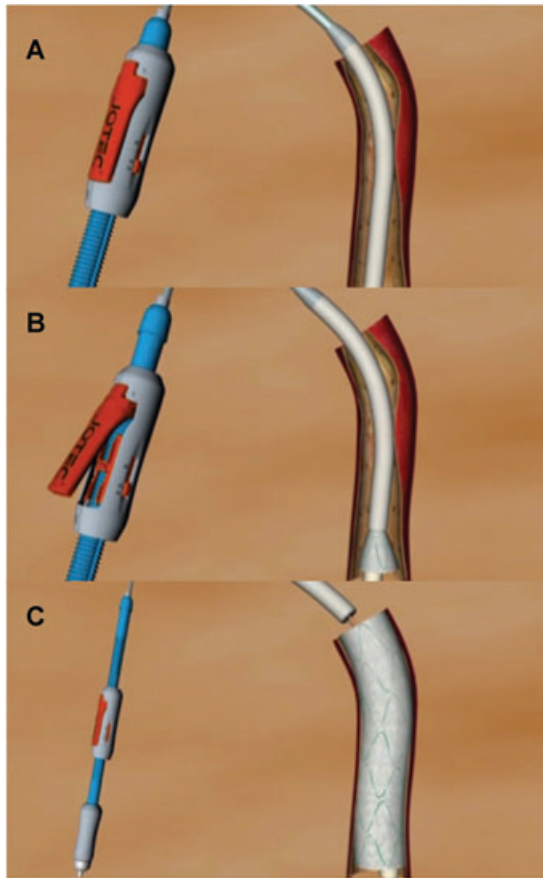


Figure 3. Illustration of the releasing process of the E-vita (JO TEC). Introduction of the stent graft into the aortic lumen, excluding the aneurysmal segments (A). When the prosthesis was positioned correctly it was carefully released with a pull-back system (B and C).

The magnetic resonance made postoperatively showed a complete repair of the aorta with total exclusion and thrombosis of the thoracic aneurysms (Fig. 5). Our group has performed successfully three complete surgical reconstructions of complex thoracic aortic disease (involving aortic arch) using the E-vita Open implantation with the simplified technique. In the follow-up, 18 months later, one patient needed to complete the procedure in the descending and abdominal aorta using two conventional endovascular stent grafts anchored to the stent portion of the E-vita. The other two patients are asymptomatic one year after the surgery, with total exclusion of the aneurysmal aortic segments.

DISCUSSION

Multiple aneurysmal disease of the thoracic aorta is associated with a high risk of mortality and morbidity during the surgical treatment based on the classic elephant trunk technique. Recently, the development of interventional technologies using hybrid procedures has decreased the morbidity and mortality for surgery involving concomitant aneurysms of the aortic arch and descending aorta. At this point, we can distinguish two

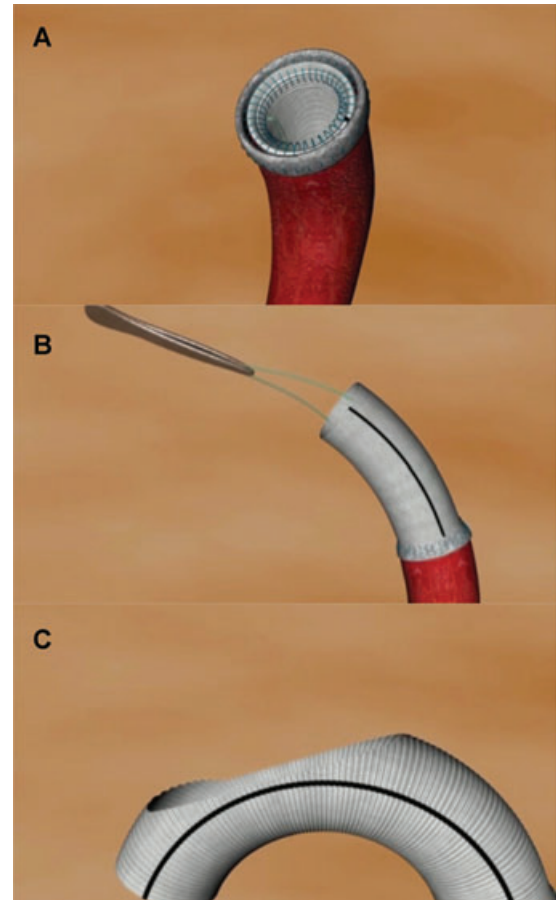


Figure 4. Illustration of the surgical anchoring of the E-vita (A). Unfolding of the Dacron portion (B). Preparing the Dacron to perform the supra-aortic vessels anastomosis (C).

different types of hybrid procedures³ depending on the aortic arch approach. Type I procedures are founded in the opinion that the aortic arch should be surgically replaced. Therefore it is necessary to use CPB, cardiocirculatory arrest, and brain protection. In this sense, the data previously reported support the optimal long-term results of conventional open surgical repair of the aortic arch.⁵ One of these type I procedures, is the "frozen elephant trunk" technique that combines surgical and endovascular techniques. In this field the E-vita Open simplifies the thoracic aortic approach avoiding the second-step surgery to treat the distal descending aorta.⁶ Thus, it reduces the mortality and morbidity of the waiting time between the two classical surgical steps and eliminates the potential risk of the second one (left thoracotomy).

On the contrary, type II procedures use the endovascular repair concept as the main technique, excluding the aortic arch with a stent graft instead of replacing it. In addition, the open surgical step of this hybrid approach is limited to revascularize the supra-aortic branches.

In our opinion, the diffuse thoracic aortic disease benefits from a comprehensive and anatomic repair of the aortic structures. Therefore, we consider that the

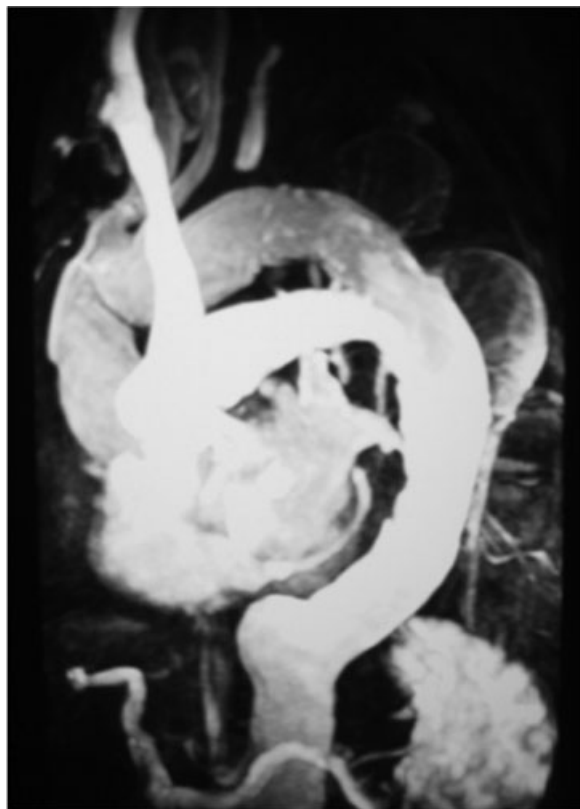


Figure 5. *The magnetic resonance made postoperatively showed the complete repair of the aorta with total exclusion of the thoracic aneurysms.*

hybrid procedure type I (E-vita Open) is the best option to treat extensive aortic disease that involves the ascending aorta, arch, and descending aorta.

On the other hand, the type II hybrid procedures are useful to treat lesions limited to the aortic arch. In this localized disease, the stent graft may exclude the arch successfully, while its end-sides (proximal in ascending aorta and distal in descending aorta) can be located in healthy aortic wall.^{3,7}

The experience with the E-vita Open in this field is limited but the recent results seem to be very satisfactory,⁶ with a short-term outcome equal to the type II procedures.³ However, the aortic arch replacement performed with this hybrid prosthesis provides a safer surgical anchor for the stent graft portion. Likewise, the stent graft is placed in the descending aorta with less angulation and less curvature than in type II procedures. These two characteristics could be decisive elements to ensure optimal long-term results with the E-vita aortic reconstruction.

Despite these encouraging results, mid- and long-term follow-up are required to demonstrate effectively the efficacy of the E-vita Open in the treatment of complex thoracic aortic disease compared with other alternative techniques.

REFERENCES

1. Estrera AL, Miller CC, Porat EF, et al: Staged repair of extensive aortic aneurysm. *Ann Thorac Surg* 2002;74:S1803-1805.
2. Kato M, Ohnishi K, Kaneko M, et al: New graft-implanting method for thoracic aortic aneurysm or dissection with a stented graft. *Circulation* 1996;94(9 Suppl):II188-II193.
3. Koullias GJ, Wheatly GH: State-of-the-art of hybrid procedures for the aortic arch: A meta-analysis. *Ann Thorac Surg* 2010;90:689-697.
4. Pacini D, Leone A, Di Marco L, et al: Antegrade selective cerebral perfusion in thoracic aorta surgery: Safety of moderate hypothermia. *Eur J Cardiothorac Surg* 2007;31:618-622.
5. Toda K, Taniguchi K, Masai T, et al: Arch aneurysm with long elephant trunk: A 10-year experience in 111 patients. *Ann Thorac Surg* 2009;88:16-22.
6. Di Bartolomeo R, Di Marco L, Armaro A, et al: Treatment of complex disease of the thoracic aorta: The frozen elephant trunk technique with the E-vita open prosthesis. *Eur J Cardiothorac Surg* 2009;35:671-676.
7. Melissano G, Bertoglio L, Civilini E, et al: Results of thoracic endovascular grafting in different aortic segments. *J Endovasc Ther* 2007;14:150-157.