Concomitant frozen elephant trunk procedure and pulmonary embolectomy

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INTRODUCTION

The antegrade stented (frozen) elephant trunk is an excellent one-stage option for patients with extensive aortic disease [1]. Under hypothermic circulatory arrest, antegrade delivery of a combined stent-prosthetic graft enables stenting of descending aortic pathology, and subsequent removal of the prosthetic graft portion allows ascending aortic and arch replacement. Pulmonary embolectomy is a lifesaving intervention for patients with pulmonary embolus, but exposure may be difficult in patients with concomitant aortic pathology. The objective of this report is to describe a case of simultaneous frozen elephant trunk and pulmonary embolectomy and highlight the management of this uncommon disease combination.

CASE PRESENTATION

A 70-year-old man with dyspnoea and severe left-sided chest pain was diagnosed with a saddle pulmonary embolus and a partially thrombosed 5.7 cm aortic arch aneurysm (Fig. 1a). He was anticoagulated and transferred to our centre. Past history included infrarenal aortic replacement for aneurysm 8 years prior, hypertension and obesity (BMI 36). Family history included a brother and sister with Factor V Leiden mutation and activated protein C resistance, but he had not been tested.

Lab parameters, EKG and Duplex sonogram of the neck vessels were unremarkable. Echocardiography revealed an ejection fraction of 71%, pulmonary hypertension [pulmonary artery pressure 42 mmHg + central venous pressure (est. 5–10 mmHg)], normal sized right ventricle (RV) (3.9 cm) with good contractility, no evidence of acute RV overload or hepatic venous stasis. Aortic protocol CT thorax (Fig. 1b) revealed a 44 mm ascending aorta, 38 mm arch and a 52 mm proximal descending aortic aneurysm. A simultaneous pulmonary embolectomy and a one-stage procedure for his extensive aortic pathology were planned.

Once on cardiopulmonary bypass (CPB) via the right axillary artery and right atrium, and during cooling, the aorta was cross-clamped just proximal to the innominate artery takeoff. Next, a cardioplegia needle vent was inserted into the aortic root, with subsequent intermittent cardioplegia administration. A left ventricular vent was placed. Following induction cardioplegia, a second cross-clamp was applied just above the sinotubular junction (STJ), and the portion of the aorta between the two clamps was excised. A longitudinal incision was made in the right pulmonary artery (PA) extending into the left PA. Copious thrombus was extracted bilaterally, and the PA was closed.

At 26°, the innominate artery was clamped, permitting antegrade ‘unilateral’ (right) brain perfusion. The clamp proximal to the innominate artery was removed, and distal circulatory arrest was initiated. The aortic aneurysm was opened into the aortic arch longitudinally just anterior to the takeoff of the supraaortic vessels. Due to extreme head vessel ostial calcification, separate reimplantation was planned using the Spielvogel trifurcated graft technique [2]. An antegrade 14 F perfusion catheter was advanced into the left carotid, achieving selective antegrade ‘bilateral’ brain perfusion (ABP) using the technique popularized by Kazui et al. [3]. The left subclavian artery (LSA) was then isolated, and an 8-mm prosthesis was sewn end-to-end to it. The resulting defect in the aortic arch was closed, thereby achieving an arch aortoplasty. A 33 mm diameter (160 mm long) E-vita prosthesis (Jotec GmbH, Hechingen, Germany) was delivered into the descending aorta, ensuring that the graft-stent graft interface would be just proximal to the site of the LSA takeoff. After stent graft deployment, the graft-stent graft interface was sewn to the aorta, and the graft portion was withdrawn, deaired and clamped. Distal body perfusion was re-initiated via graft cannulation. One limb of a bifurcated prosthesis was then sewn...
to the L CCA and the other to the innominate artery under maintenance of antegrade cerebral perfusion. Once both anastomoses were completed, the innominate artery clamp was released, and ABP was achieved via the right axillary artery. Next, the cannula for distal body perfusion was removed from the E-vita prosthesis and the proximal portion of the bifurcated prosthesis was sewn to the E-vita graft. After anastomosis completion, all graft limbs were deaired, and the graft portion of the E-vita prosthesis was clamped proximal to this anastomosis. Axillary arterial perfusion was resumed and provided perfusion to the brain and body. Systemic rewarming was initiated. A 32-mm graft with sidearm was then sewn to the STJ proximally, and to the E-vita graft distally. The cross-clamp was removed after deairing, and the sidearm of the 32-mm graft was then anastomosed to the 8-mm LSA graft.

Postoperatively, he was extubated within 12 h, and discharged on Day 8 after an uncomplicated hospital stay. The postoperative CT is shown (Fig. 2). The central PAs were clear of thrombus, with only mild residual thrombus in the subsegmental right lower lobe arteries. Three-month follow-up CT revealed proximal descending aortic aneurysm sac shrinkage.

**COMMENT**

Both antegrade (stented) frozen elephant trunk and pulmonary embolectomy operations can be challenging, high-risk procedures requiring hypothermia and complex circulatory management.

Several technical details were critical to the success of this case:

(i) Double-clamp technique: resection of the ascending aorta using the double-clamp technique affords excellent exposure to the PA trunk and branches, allowing successful extraction of the emboli.

(ii) Paraplegia: coverage of less descending aorta reduces paraplegia risk. The arch aortoplasty facilitated more proximal implantation of the E-vita prosthesis. The 33-mm E-vita prosthesis is 16 cm long, but implantation of the stent graft several centimetres further proximally resulted in coverage of only 12 cm of the descending thoracic aorta.

(iii) ABF: If the head vessel ostiae are heavily calcified or contain mobile plaques, the plaques must be resected to ensure safe insertion of the brain perfusion cannulae. An arch first technique is possible, but the arch graft makes later suturing of the stented elephant trunk difficult, whereas the brain perfusion cannulae can be secured out of the way while the distal anastomosis is performed.

(iv) LSA revascularization: sewing a separate prosthesis to the LSA during circulatory arrest initially allowed a more comfortable anastomosis with the side-arm graft of the ascending prosthesis.

**Conflict of interest:** M.M. is a speaker for, and receives honoraria from, St. Jude Medical, and is on the advisory board for Bayer AG.
REFERENCES

