European Journal of Cardio-thoracic Surgery 39 (2011) 598—599

EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

www.elsevier.com/locate/ejcts

How-to-do-it

Mega-aorta with aberrant right subclavian artery: use of a novel hybrid technique

Dimitri Kalavrouziotis, Francois Dagenais *

Department of Cardiac Surgery, Institut Universitaire de Cardiologie et de Pneumologie de Quebec, Quebec City, QC, Canada

Received 6 February 2010; received in revised form 5 May 2010; accepted 11 May 2010; Available online 23 June 2010

Abstract

A novel approach to the management of aortic arch aneurysm with an aberrant right subclavian artery (ARSA) is described. Construction of a Dacron graft with side arms adapted to the patient's arch anatomy allows for antegrade cerebral perfusion during circulatory arrest and revascularisation of the arch vessels. A long elephant-trunk graft is lowered into the descending aorta using a snare introduced from the femoral artery. Descending aortic stenting can be performed concomitantly or later. Advantages include antegrade cerebral perfusion during arch repair, diminished extent of stenting due to the long elephant trunk, type II endoleak prevention by ARSA ligation and preservation of antegrade flow in the right vertebral artery.

Keywords: Aortic aneurysm; Cerebral protection; Endovascular procedures

1. Introduction

The right axillary artery facilitates cerebral protection during replacement of the aortic arch by allowing for continuous antegrade cerebral perfusion during hypothermic circulatory arrest [1—4]. However, the presence of an aberrant right subclavian artery (ARSA) [5] negates this benefit. We describe a novel approach to the management of arch aneurysm with ARSA using a multi-branched arch graft and a long elephant trunk with concomitant or delayed endovascular stenting of the descending thoracic aorta.

2. Technique

A 63-year-old male presented with an asymptomatic 6-cm aneurysm of the distal aortic arch with diffuse aneurysmal involvement of the remaining thoracic aorta as a fortuitous discovery. An ARSA was also identified. He was brought to the operating room for elective repair. Two 8-mm Dacron side grafts were anastomosed to a main 8-mm graft to create a trifurcated arch graft (Fig. 1). This graft is fashioned according to the patient's arch anatomy and may require an additional side-arm graft if the left subclavian artery is accessible through a median sternotomy and can be directly revascularised (i.e., if it is not severely displaced in the left chest).

After median sternotomy and systemic heparinisation, the ascending aorta is cannulated. Systemic cooling is then initiated. During the cooling period, the ARSA is ligated in the posterior mediastinum as it emerges from behind the oesophagus on its right lateral aspect. The right common carotid artery is then divided between clamps and an end-to-end anastomosis is performed using a side arm of the arch graft (side-arm labelled 'C' in Fig. 1). A second arterial perfusion cannula is 'Y'-d off of the arterial line and is inserted and secured to the right lateral side-arm of the multi-branched arch graft (Fig. 1). At 24 °C, circulatory arrest is begun with continuous selective antegrade perfusion of the right common carotid at 10 ml kg^{-1} min^{-1}. The proximal portion of the arch aneurysm is resected and a distal anastomotic neck is fashioned proximal to the take-off of the left subclavian artery, which is oversewn. End-to-end anastomosis to the left common carotid is performed using the side-arm labelled 'D' in Fig. 1.

A separate graft is inverted onto itself to create a long elephant trunk of approximately 30 cm, depending on the extent of the descending thoracic aneurysm. A radiopaque marker such as an umbilical tape can be sutured to the distal end of the elephant trunk to enhance fluoroscopic identification during subsequent endografting. The distal end of the invaginated graft is grasped using a tulip-shaped snare (ENSnare System, Angiotech Inc., Gainesville, FL, USA) inserted through the right femoral artery, ensuring that

* Corresponding author. Address: Laval Hospital, Department of Cardiac Surgery, 2725 chemin Sainte-Foy, Quebec City, QC, Canada, G1V 4G5. Tel.: +1 418 656 4717; fax: +1 418 656 4707.
E-mail address: Francois.Dagenais@chg.ulaval.ca (F. Dagenais).

1010-7940/$ — see front matter © 2010 Published by Elsevier B.V. on behalf of European Association for Cardio-Thoracic Surgery.
doi:10.1016/j.ejcts.2010.05.013

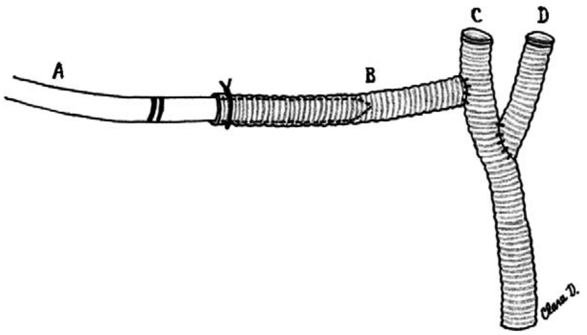

Fig. 1. Branched arch graft with side-arms for the arterial perfusion cannula (A) which allows for antegrade cerebral perfusion during arch reconstruction. The side-arm containing the cannula (B) will eventually be used to perform an extra-anatomic bypass to the right axillary artery. Additional branch grafts are used for revascularization of the right common carotid artery (C) and the left common carotid artery (D). An additional side-arm graft can be added to create a quatrifurcated graft in order to revascularise the left subclavian artery if directly accessible (not shown).

the long elephant trunk is adequately lowered into the descending aorta. The elephant trunk anastomosis is performed and the proximal part of the graft is everted back into the mediastinum and is cannulated and clamped to reperfuse the descending aorta and initiate rewarming. Next, the graft is appropriately trimmed and anastomosed to the sino-tubular junction.

Full expansion of the elephant trunk graft is obtained by inflating a Reliant balloon catheter (Medtronic Inc., Minneapolis, MN, USA) within the elephant trunk. The multi-branch arch graft is then anastomosed in an end-to-side fashion to the main graft. The remaining right lateral side arm that previously contained the arterial cannula used for antegrade cerebral perfusion is used as an extra-anatomic bypass to the right axillary artery (side-arm labelled 'B' in Fig. 1). The graft is introduced into the right pleural cavity and tunnelled above the second rib to reach the axillary artery and an end-to-side anastomosis is performed via a subclavicular incision. Descending thoracic endovascular stenting either as a concomitant procedure or delayed as part of a two-stage procedure completes the repair (Fig. 2).

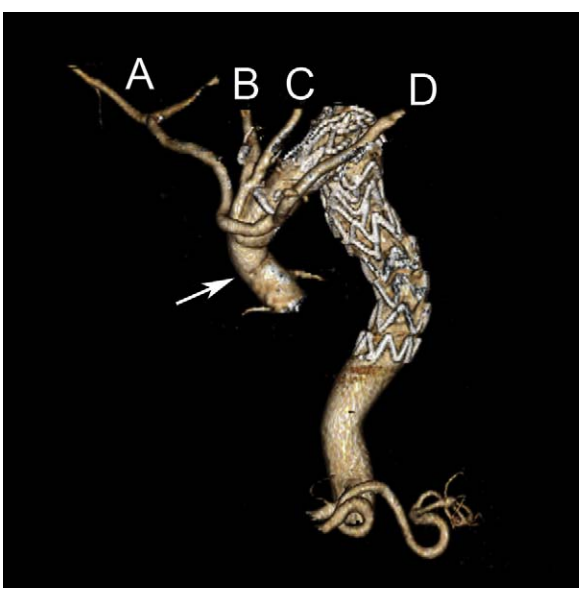

Fig. 2. Computed tomographic reconstruction of the thoracic aorta at 1 week following surgery. The trifurcated arch graft perfusing the right axillary (A), the right common carotid (B), and the left common carotid (C) arteries is shown. An extra-anatomic bypass to the left subclavian artery was also performed using an additional 8 mm graft (D). The extent of endografting is from the mid-arch to the distal descending aorta. The arrow denotes the proximal anastomosis of the evaginated portion of the elephant trunk graft to the sino-tubular junction.

3. Comment

There are multiple advantages associated with this technique for patients with arch aneurysm and an ARSA. Direct revascularisation of the right common carotid artery during cooling and subsequent continuous antegrade cerebral perfusion during hypothermic circulatory arrest through a side arm of a multi-branch graft increase brain protection. An elephant-trunk anastomosis proximal to the origin of the left subclavian artery facilitates exposure and reduces the risk of recurrent laryngeal nerve injury. A long elephant trunk decreases the length of subsequent stent-grafting required. The likelihood of inappropriate infolding and elephant-trunk malposition in the descending aorta is minimised by using a lasso-type snare catheter and a Reliant balloon catheter. The long elephant-trunk technique should be avoided in the presence of a significant clot burden in the descending aorta. Furthermore, ARSA ligation in the posterior mediastinum avoids a subsequent type II endoleak, and extra-anatomic revascularisation of the right axillary artery preserves antegrade flow in the right vertebral artery.

In the setting of a severely displaced left subclavian artery in the left hemithorax, as in the case described here, the artery may be ligated at its origin from within the arch aneurysm, and an extra-anatomic bypass to the left axillary artery may be performed as described above for revascularisation of the right axillary artery. Alternatively, if the left subclavian artery is directly accessible via median sternotomy, a third side-arm graft may be added to create a quatrifurcated arch graft at the beginning of the procedure and this side branch can be used in an end-to-end anastomosis to the left subclavian artery.

Two patients underwent this procedure including the one described here. No perioperative complications occurred.

References

[1] Sabik JF, Nemeh H, Lytle BW, Blackstone EH, Gillinov AM, Rajeswaran J, Cosgrove DM. Cannulation of the axillary artery with a side graft reduces morbidity. Ann Thorac Surg 2004;77:1315—20.

[2] Strauch JT, Spielvogel D, Lauten A, Lansman SL, McMurtry K, Bodian CA, Griepp RB. Axillary artery cannulation: routine use in ascending aorta and aortic arch replacement. Ann Thorac Surg 2004;78:103—8.

[3] Svensson LG, Blackstone EH, Rajeswaran J, Sabik JF, Lytle BW, Gonzalez-Stawinski G, Varvitsiotis P, Banbury MK, McCarthy PM, Pettersson GB, Cosgrove DM. Does the arterial cannulation site for circulatory arrest influence stroke risk? Ann Thorac Surg 2004;78:1274—84.

[4] Dagenais F, Dumont E, Mathieu P, Voisine P. Advances in thoracic aortic surgery: arch replacement with axillary cannulation and thoracic stent grafts. Can J Cardiol 2007;23(Suppl. B):76B—9B.

[5] Freed K, Low VHS. The aberrant right subclavian artery. AJR Am J Roentgenol 1997;168:481—4.