How-to-do-it

Aortic arch replacement using a four-branched aortic arch graft

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Abstract

Surgical repair for aortic arch aneurysms is associated with considerable mortality and morbidity. Adequate brain protection is essential. Experience of aortic arch repair in six patients using a four-branched arch graft is described. There were two emergency and three reoperations. One patient had ruptured aneurysm. Hypothermic cardiopulmonary bypass (18–22°C) was employed. A four-branched polymer albumin-coated arch graft was used. The fourth branch of the graft was used for secondary arterial cannulation to ensure continuous brain circulation. One hospital death occurred. No permanent neurological event occurred. The four-branched arch graft facilitates fashioning arch branch anastomoses and provides better brain protection. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Current surgical management of a dissection/aneurysm involving the transverse aortic arch is graft replacement using total circulatory arrest with deep hypothermia [1,2]. Its principal drawback consists in the limited safe ischemic period. If cardiac arrest occurs for more than 45 min selective cerebral perfusion should be employed [3,4]. Antegrade cerebral perfusion through either the right axillary artery, innominate artery [1,5–7] or through uni- or bilateral carotid artery cannulation have been advocated [8]. Surgical approaches for total arch replacement include the en bloc technique, in which the arch vessels are reconstructed en bloc to a tube graft, or the separated graft technique, which utilizes prefabricated branched aortic arch prosthesis. The present report reviews our experience using a four-branched arch prosthesis for replacement of the transverse aortic arch.

2. Operative techniques

Following cannulation of right subclavian and right femoral artery cooling is started. We use retrograde cold blood cardioplegia, which is repeated every 20 min. The brachio-cephalic, left carotid and left subclavian arteries are exposed through median sternotomy. If a Bentall procedure is required the ascending aorta is prepared during the cooling time. The cooling is stopped at 20°C, the patient is placed in Trendelenburg position, the femoral cannula is clamped and cerebral perfusion is started via the subclavian cannula (800 ml/min, 60 mmHg). If cannulation of the subclavian artery is not possible, cerebral perfusion is started just after the anastomosis of the left carotid artery. The transverse aortic arch is replaced by a four-branched polyester, albumin-coated aortic arch prosthesis (Intervascular, Tampa, FL) and sutured by running 4-0 Prolene suture (Ethicon, Somerville, NJ). The distal anastomosis is performed and rewarming is started. First the left carotid artery is anastomosed. Cerebral perfusion is thereafter administered through the fourth branch of the prosthesis and the right subclavian artery. When the anastomosis of the left subclavian artery seems to be difficult it is better to fashion the anastomosis prior to other branches. At the end of the procedure cerebral perfusion is administered only through the fourth branch (Fig. 1). Additional procedures can then be performed. The proximal anastomosis is fashioned last. After cardiopulmonary bypass is terminated, the fourth branch is resected.

3. Material

A four-branched aortic arch prosthesis was used for replacement of the transverse aortic arch in six patients. Mean age was 70 ± 8 years and 67% were women. There were three primary operations (one arch aneurysm, two Type III aortic dissections with retrograde involvement of the arch)
and three reoperations (two arch aneurysms and one dissection, all operated for Type I aortic dissection, with either supracoronary tube graft replacement of the ascending aorta or Bentall operation). Emergency operations were performed for two patients. Preoperative risk factors were: arterial hypertension 83% (5/6), hyperlipidemia 33% (2/6), current smokers 17% (1/6), and ruptured aneurysm was present in one patient. In addition to the arch replacement one patient had a valve-sparing Tirone David procedure, an ascending aortic tube graft in supracoronary position 1

elephant trunk and stent graft (Talent stent graft system, 38–36 mm, Medtronic AVE Inc., Minneapolis, MN) for the descending thoracic aorta. Another patient had a Bentall operation 1

a tube graft for the descending aorta, and the third patient had a simultaneous replacement of the ascending aorta in a supra coronary position.

4. Results

Cardiac arrest time was 26 ± 8 min. Average aortic cross-clamping time was 155 ± 72 min (ranging from 20 to 240 min) and cardiopulmonary bypass lasted on average 241 ± 55 min (ranging from 130 to 320 min). There was one in-hospital death, an emergency procedure due to an extensive ruptured thoracic aneurysm, involving the transverse aortic arch. None of the six patients had any neurological events. Bleeding requiring a repeat thoracotomy occurred in one patient, and pulmonary failure requiring ventilatory support for more than 48 h after surgery occurred in one patient. Mean intensive care unit stay was 4.5 ± 1.8 days.

5. Discussion

Mortality and morbidity associated with aortic arch replacement has decreased. Suspension of the cerebral circulation may lead to neurological injuries. Improved brain protection modalities have been tried. Selective antegrade cerebral perfusion through cannulation of the axillary or carotid artery has been reported as successful [5,6].

The advantage of complete arch replacement is that the risk for embolization as cause of neurological deficits may diminish [4]. Separated graft technique also results in shorter total pump and cerebral perfusion times [7]. Bleeding at anastomosis can more readily be controlled and atherosclerotic lesions near the origin of arch vessels can be carefully resected. In addition, antegrade cerebral perfusion through a fourth branch after completion of left carotid artery and innominate artery can prevent embolization as an effect of retrograde perfusion through the femoral artery or a poor cerebral perfusion due to perfusion of a false lumen, which may occur in cases with dissection.

A technical difficulty using the separated graft technique for replacement of the aortic arch could be fashioning the distal aortic anastomosis. This can be overcome by using either an interposition graft sutured to the thoracic aorta or to utilize a stent graft system as was used in one case with descending aortic dissection.

References


