How-to-do-it

Double-arterial cannulation for aortic valve replacement with porcelain aorta

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Abstract

We describe a new technique of aortic valve replacement (AVR) in patients with porcelain aorta. Three patients (mean age 75 years) were treated. The cardiopulmonary bypass (CPB) was established after side-graft right axillary artery and direct femoral artery cannulation. Venous drainage was obtained by atrio-caval cannulation. The procedures were performed in mild hypothermia (30°C). Cerebral perfusion was carried out by clamping the innominate artery and all epiaortic vessels. The aorta was endoclamped by a Foley balloon inserted into the isthmus. The aorta was then opened longitudinally for 10 cm to expose and replace the aortic valve. Near-infra-red spectroscopy (NIRS) and bilateral radial artery pressure were used to monitor effective cerebral perfusion. Operative mortality was absent. The mean time of CPB was 73 min. NIRS-derived tissue oxygenation was maintained above 55%. Postoperative course was uneventful. This technique has several advantages: first, the cannulation of right axillary and the common femoral artery allows simultaneous cerebral and systemic perfusion. Second, any form of cross-clamp is avoided and the aorta is occluded away from the epiaortic vessels. Third, there is an increased freedom to choose the best place for aortotomy.

Keywords: Aortic valve replacement; Porcelain aorta; Cardiopulmonary bypass

1. Introduction

Manipulation of the ascending aorta in patients with porcelain aorta can be the cause of major morbidity, including aortic dissection or cerebral infarction secondary to embolism of atherosclerotic or calcific debris. Because of the diffuse, circumferential, plate-like calcification of the proximal aorta, conventional techniques for cannulation and cross-clamping need to be modified to reduce the risk of aortic injury and atheroembolism. We describe a surgical strategy for aortic valve replacement (AVR) in patients with severe calcified ascending aorta.

2. Materials and methods

After full median sternotomy the preoperative diagnosis of severe ascending aortic calcification is confirmed by direct palpation. Cardiopulmonary bypass (CPB) is then established: atrio-caval cannulation is used for venous drainage while right axillary via a side-graft and direct femoral cannulation in a Y configuration (Fig. 1) are both used for arterial return. The aorta is then endoclamped by a Foley occluding balloon inserted with a purse-string suture into the distal part of the arch in a spot free of calcium. When mild hypothermia (30°C) is reached, unilateral antegrade cerebral perfusion is obtained by sequentially clamping the arch vessels. At this time, the whole ascending aorta and arch are excluded from the systemic circulation. Left ventricular venting will progressively collapse the aorta showing a longitudinal rim of non-calcified wall that can be followed to perform the aortotomy. Although the spectrum of porcelain aorta might vary, it is our experience that once the aorta is completely de-pressurised it is always possible to locate cracks in the calcium where the aorta could be opened. Although these spots cannot be where needed by the surgeon, the possibility of excluding the whole aorta from circulation gives the surgeon a high degree of freedom for aorta incision. A longitudinal aortotomy (10 cm) is usually performed to obtain a satisfactory access to the aortic valve. AVR is then performed in the usual fashion. Cerebral perfusion is continuously monitored with near-infra-red spectroscopy (NIRS) and presence of bilateral radial artery pressure. In fact, after clamping all cerebral vessels (including the left subclavian), a left radial pressure equal to the right radial pressure is a sign of good communication between the two hemispheres. In case of unsatisfactory perfusion of the left side of the brain (low NIRS and low left radial pressure), bilateral perfusion is obtained by inserting an intraluminal shunt between the innominate and the left carotid artery as previously described [1].

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3. Results

This technique was successfully performed in three consecutive male patients (mean age 75 years) undergoing AVR with a porcelain aorta detected by echo-cardiography, angiography and computed tomography (CT) studies before the operation. The mean CPB time was 73 min and all patients were weaned from CPB without difficulty. The tissue oxygenation index value derived from NIRS was maintained above 55% during the procedure. Postoperative course was satisfactory without minor or major neurological dysfunction.

4. Discussion

A simple aortic valve replacement becomes a high-risk procedure when the ascending aorta is severely calcified or grossly atherosclerotic. Standard aortic cannulation and clamping can easily mobilise aortic soft plaque or calcific debris markedly increasing the risk of cerebral emboli [2]. To avoid such complications, various techniques have been used: (a) isolation and temporary occlusion of the innominate and carotid arteries and subsequent aortic clamping; (b) endovascular clamping of the ascending aorta; and (c) total aortic valve replacement under deep hypothermic circulatory arrest [3,4]. However, any form of aortic clamping carries a risk of mobilising aortic debris, and hypothermic circulatory arrest increases the risk of neurological dysfunction as well as that of coagulopathy. To avoid manipulation of the aorta, other forms of ‘no-touch’ techniques using peripheral arterial cannulation have been proposed. In particular, it is possible to use apico-aortic conduits especially indicated for those patients who have previously undergone coronary bypass surgery [5]. Currently, there is also the possibility of implanting a percutaneous aortic valve either with a trans-apical or trans-femoral approach. However, the use of this innovative technology in this peculiar setting is still debatable [6].

The above-mentioned technique to manage a porcelain aorta has several advantages. First, the double-arterial cannulation of the right axillary and the common femoral artery allows cerebral and systemic perfusion while the whole ascending aorta and arch is excluded from the circulation and can be used as a large and unobstructed operative field. Second, any form of clamping inside the ascending aorta is avoided; a Foley catheter is inserted into any site of the distal part of the arch and inflated below the isthmus. Profound hypothermia and circulatory arrest are completely avoided.

Third, the large longitudinal incision of the aorta gives a good view of the aortic valve and simultaneously allows a simple washing and debridement of the internal wall of the aorta. Finally, at the end of the procedure, simple deflation of the Foley catheter will re-establish heart perfusion while the brain vessels are still occluded, further reducing the risk of stroke.

The proposed surgical approach is safe and reliable in patients with porcelain aorta and has the potential to reduce the prevalence of cerebral and systemic embolisation.

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References