Direct cerebral perfusion and myocardial protection with moderate systemic hypothermic arrest for high descending aortic aneurysm

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Hypothermic circulatory arrest (CA) allows treatment of aneurysms of the descending thoracic aorta (DTA) that involve the distal aortic without a neck that may be clamped. 1,2 Deep hypothermia has several drawbacks, however, particularly coagulopathy. Selective cannulation and blood perfusion of supra-aortic vessels (SAVs) provides excellent cerebral protection at temperatures as high as 26°C. 3 At this temperature, however, myocardial protection is advisable. We describe a simple technique to replace the distal aortic arch and proximal DTA through a left thoracotomy with CA at 26°C, while the brain is perfused and the heart is protected with cardioplegia without isolation of the ascending aorta.

Clinical Summary
A 35-year-old white man had a history of hypertension. A chest radiograph suggested aortic enlargement, and computed tomographic scan showed a 7.3-cm calcified aneurysm of the DTA without intraluminal thrombus involving the distal aortic arch and ectasia of the proximal left subclavian artery (2.3 cm) and of the ascending aorta (5.2 cm). Magnetic resonance angiography provided better understanding of the anatomy (Figure 1, A). The ejection fraction was (40%), with normal coronary arteries and mild aortic and mitral insufficiency. Skeletal manifestations of the Marfan syndrome were not present. Histologic examination of the aortic wall, performed after surgery, confirmed the atherosclerotic nature of this aneurysm.

A left posterolateral thoracotomy in the fourth intercostal space was performed, and cardiopulmonary bypass (CPB) was initiated by femoral cannulation, with the venous cannula advanced into the right atrium. A left ventricular vent was inserted through the left atrial appendage. During cooling of the patient, the SAVs were encircled with vessel loops.

CPB was stopped at 26°C. The unclamped aorta was opened, no thrombus or atheromatous debris was observed, and two catheters with an inflatable balloon at the tip (Retrograde Coronary Sinus Perfusion Cannula DLP 15F; Medtronic, Inc, Minneapolis, Minn) were inserted into the left common carotid artery (and the innominate artery. They were flushed at low flow to ensure that the SAVs were completely filled with blood; only then were the balloons cautiously inflated and the loops tightened. Perfusion with oxygenated blood from the pump was carried out at 10 mL/(kg · min).

A large occlusion and infusion balloon catheter (Pruitt Aortic Occlusion Catheter 12F; Ideas for Medicine, St Petersburg, Fla) was then positioned in the proximal ascending aorta. The latex balloon was inflated until it was occlusive, and cardioplegia was easily administered through the central lumen in the aortic root. Electric activity of the heart disappeared after 20 seconds. This allowed us to avoid isolating the ascending aorta (Figure 2).

Before insertion of the catheters into the SAVs, they were passed through a 26-mm collagen-coated tube Dacron polyester fabric graft with a presutured 10-mm side branch (Haemabridge 26×10; Intervascular, LaCiotat, France), which allowed the proximal anastomosis to be comfortably accomplished distal to the common carotid artery. The catheters were then removed, the side branch of the graft was connected with the CPB arterial circuit, and, after accurate flushing and deairing, the graft and the DTA were clamped. CPB was resumed from both the femoral artery and the side branch, and the patient was rewarmed. The total CPB time was 97 minutes, and the CA time was 20 minutes. The total

Figure 1. Magnetic resonance angiography. A, Preoperative view of aneurysmal dilatation of ascending thoracic aorta and DTA. Origin of left subclavian artery and distal aortic arch are also ectasic. B, Postoperative view of satisfactory reconstruction of distal aortic arch and proximal descending thoracic aorta and revascularization of left subclavian artery.
Operation time was 3 hours and 15 minutes. Total blood loss was 2500 mL, with no homologous transfusions.

The postoperative course was uneventful. Postoperative MR angiography was satisfactory (Figure 1, A).

Discussion

An elephant trunk procedure, with the ascending and arch replacements done first through midsternotomy, was considered for this case. Because the DTA was much larger than the ascending aorta, however, we decided to operate on the DTA first, with CA.

Even if CA time is kept to a minimum, deep hypothermia is still needed. This brings several drawbacks and increased mortality and morbidity from coagulopathy, respiratory distress, and renal, cardiac, and endothelial dysfunctions, as well as microembolus production. Long cooling and rewarming times should also be considered.

By using selective antegrade cerebral perfusion during systemic CA, hypothermia may be limited to 24°C to 26°C. This allows shorter CPB times, as well as avoiding a number of problems related to deep hypothermia. Moreover, selective antegrade cerebral perfusion allows longer duration of CA if needed. During CA at moderate hypothermia, myocardial protection may be an issue; the heart usually fibrillates, and myocardial energetic demands are still high. Therefore cardioplegic protection is usually provided.

In conclusion, selective antegrade cerebral perfusion and cardioplegia administration allowed excellent cerebral and myocardial protection during CA with only moderate hypothermia. Time was saved, and the disadvantages of deep hypothermia, especially coagulopathy, were avoided. In the future this technique could be particularly useful for type I and II thoracoabdominal aortic aneurysms when a “clampable” neck is not available, because coagulopathy is particularly dangerous in such cases in which extensive thoracoabdominal access is required.

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References