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Case Report

Aortic Arch and Root Reconstruction in Chronic Type a Aortic Dissection with Impaired Cerebral Blood Flow due to Malperfusion of the Bilateral Vertebral Arteries and Occlusion of the Posterior Communicating Arteries

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Abstract

Cerebral malperfusion is a life-threatening complication of type A acute aortic dissection. Even in the chronic phase, special care is required in some patients with complicated brain blood flow patterns to avoid intraoperative cerebral malperfusion. The present report describes the case of a patient with chronic type A aortic dissection and complex impaired cerebral blood flow, in which selective antegrade cerebral perfusion using a branch graft attached to left subclavian artery anastomosed via a double-barrel technique and reconstruction of arch vessels resulted in a successful outcome without any new neurological deficits. The case presentation is followed by a discussion of the relevant published literature.

Keyword: Aortic Dissection; Perfusion; Brain

Introduction

Cerebral malperfusion is a life-threatening complication of type A acute aortic dissection and has an impact on the indications for surgical intervention [1,2]. However, even in the chronic phase, special care is required to avoid ischemic cerebral damage in some patients with complicated brain blood flow patterns caused by preoperative cerebral malperfusion.

Case Report

A 67-year-old man experienced sudden onset of chest pain and was transferred to our hospital. Although Computer Tomography (CT) showed A type an aortic dissection, emergent surgery was postponed, because he was very drowsy and had left hemiplegia at the time of admission. CT imaging showed early signs of brain infarction [3] in the territory of the right middle cerebral artery as well as cerebral malperfusion secondary to obliteration of right carotid artery. The patient needed mechanical ventilation in his early clinical course but was weaned from the ventilator on hospital day 10 and eventually recovered from severe consciousness disorder. The left incomplete paralysis remained, but he could walk with a stick at the time of the first discharge. Two months later, elective aortic root and total arch replacement was planned to address progressive dilation of the aortic root and severe aortic valvular regurgitation. CT and preoperative Magnetic Resonance (MRI) showed a unique cerebral perfusion pattern. The right cerebral hemisphere had become atrophic because of the preceding infarction. Dissection was present in the bilateral subclavian arteries and in the right common carotid arteries, and the bilateral vertebral arteries were branched from the false lumen of the subclavian arteries (left side dominant). Further, the posterior communicating arteries were totally occluded (Figure 1). Therefore, a specific intraoperative perfusion technique was planned for brain protection. After a median sternotomy, Cardio Pulmonary Bypass (CPB) was established by extracting blood from the right atrium and rerouting it to the right axillary and femoral arteries with left ventricular venting. The patient was cooled to 20°C, and the ascending aorta was cross-clamped and transected. After injection cold cardioplegia solution, Bentall operation was performed with a composite valved graft during systemic cooling. After aortic root replacement, circulatory arrest and Selective Antegrade Cerebral Perfusion (SCP) was begun through the right axillary artery perfusion

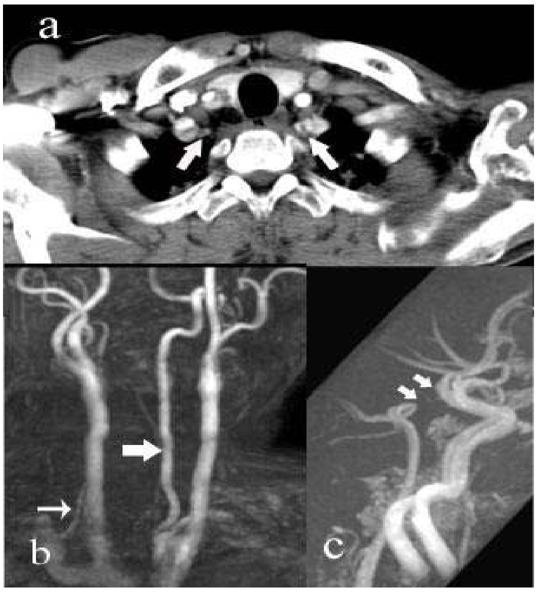

Figure 1: a: Bilateral vertebral arteries branch from the false lumen of the subclavian arteries (arrows). **b:** The right vertebral artery (narrow arrow) is very atrophic when compared with the left vertebral artery (thick arrow). **c:** The posterior communicating arteries are completely occluded (arrows).

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by clamping the innominate artery. The aortic arch was opened, and a 12-Fr SCP balloon cannula was inserted into the true lumen of the left common carotid artery and the left subclavian artery. To preserve enough blood flow to the left vertebral artery through the false lumen, the left subclavian artery was immediately attached to a free 8-mm branch graft using a double-barrel anastomosis technique, and the SCP balloon cannula was then re-inserted into this graft and perfused. The multi-branched arch graft was anastomosed with the distal arch for arch reconstruction, antegrade aortic perfusion was re-started using a branch graft, and rewarming was initiated. After the anastomosis between the arch graft and Bentall's graft, the cross-clamp of the arch graft was removed under SCP perfusion, and the heart was restarted (Figure 2). Finally, the left common carotid artery, innominate artery and the branch graft attached to the left subclavian artery were reconstructed with branch grafts. Regional brain oxygen saturation (rSO2) was measured with an optical spectrophotometer attached to the bilateral forehead of the patient throughout the operation to monitor cerebral circulation, and no abnormal change in this value was observed. Postoperative recovery of the patient was good, and there was no neurological complication. No remarkable changes were detected when comparing preoperative and postoperative brain CT images.

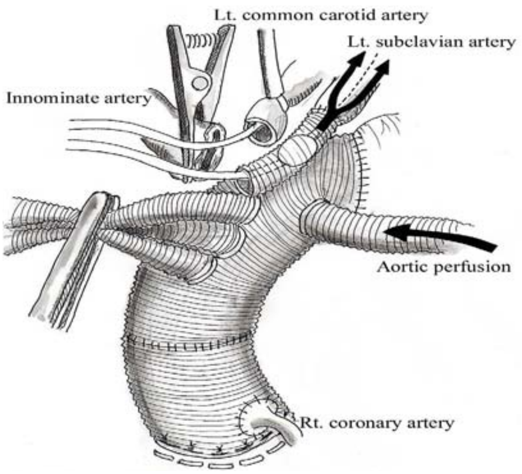

Figure 2: The arch is reconstructed with a multi-branched arch graft. SCP balloon cannula is inserted into the true lumen of the left common carotid artery and the branch graft attached to the dissected left subclavian artery. Antegrade aortic perfusion is re-started through a branch graft, and after main arch reconstruction, the cross-clamp of the arch graft is removed under SCP perfusion to allow resumption of cardiac function.

Discussion

Although severe cerebral infarction resulting from malperfusion is considered as a sign of poor prognosis in the acute phase of aortic dissection, it can also adversely affect outcomes if present during the chronic phase. The present case was uniquely difficult in that the bilateral vertebral arteries branched from the false lumen of the subclavian arteries, the posterior communicating arteries were occluded, and the patient had sustained previous brain damage. To maintain reliable cerebral perfusion, we first attached a free branch graft to the dissected left subclavian artery using a double-barrel anastomosis technique. It was unclear whether cerebral blood flow to the occipital area through the true lumen was sufficient, especially because there was no collateral blood flow from the carotid arteries due to the obstruction of bilateral posterior communicating arteries. Further, the left vertebral artery was large and dominant. Therefore, preservation of the false lumen of left subclavian artery was necessary for brain protection. Regional SO2 monitoring is usually helpful in aortic arch replacement, but this type of monitoring could not detect abnormities of cerebral perfusion in the isolated occipital area of brain in the present case. Therefore, it may be difficult to characterize whether focal cerebral perfusion is normal when relying solely on the change of rSO2, even when rSO2 does not decrease. We recognized a risk of aneurysmal change in the left subclavian artery after this dissected artery was reconstructed using a double-barrel anastomosis. However, this risk was likely equivalent to that associated with normal reconstruction, when the true lumen maintains adequate blood flow to the left vertebral artery through its punched-out hole or re-entry. Although the patient needed to be cooled to 20°C for brain protection because of the anastomosis of a free graft to the left subclavian artery [4], we used the period of the cooling phase to perform the Bentall procedure and reconstruct the arch branches after the removal of the cross-clamp of the arch graft. This time efficiency resulted in a reduction of the cardiac ischemia time and facilitated earlier rewarming; this might lead to shorter CPB time. Hypothermic circulatory arrest or retrograde cerebral perfusion cannot be relied on to protect the brain completely during prolonged procedures. However, use of the SCP technique allows a much longer interval of safe circulatory arrest [5]. In particular, SCP using the right axillary artery has the benefits of preventing retrograde emboli through femoral perfusion, facilitation of switching from systemic perfusion to SCP without discontinuity [4], and reduction of cannulation-induced emboli from the innominate artery and from the left carotid and subclavian arteries via a "flushing-out effect" upon initiation of perfusion. Therefore, the SCP technique enables completion of an otherwise time-consuming procedure possible while simultaneously preventing brain ischemia. In conclusion, the present report described a case of a patient with chronic type A aortic dissection and complex impaired cerebral blood flow, in which SCP using a branch graft attached to left subclavian artery anastomosed via a double-barrel technique and reconstruction of arch vessels resulted in favorable outcomes.

Disclosure Statement

The authors have no conflicts of interest to declare. No external funding was obtained for the work presented here.

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