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SHORT REPORT

Use of an Extracorporeal Femoral-carotid Shunt in the Management of Complex Supra-aortic Disease

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Abstract Management of symptomatic multifocal supra-aortic atherosclerotic disease presents a complex surgical challenge. We describe a novel approach where a temporary extra-corporeal femoro-carotid shunt was used to maintain cerebral perfusion during hybrid surgical and endovascular treatment for tandem supra-aortic lesions.

Management of symptomatic multifocal supra-aortic atherosclerotic disease presents a complex surgical challenge. Notably, the hazards of intra-operative cerebral hypoperfusion, incompetent homeostatic mechanisms, cerebral reperfusion injury and brittle blood pressure must be anticipated. We describe a novel approach where a temporary extra-corporeal femoro-carotid shunt was used to maintain cerebral perfusion during hybrid surgical and endovascular treatment for tandem supra-aortic lesions.

Report

A 69-year-old female patient with a history of NYHA (New York Heart Association) class II ischaemic heart disease and right femoro-popliteal bypass presented with crescendo transient ischaemic attacks with left arm weakness and a background of subclavian steal syndrome. Duplex ultrasonography and catheter angiography showed bilateral 80–90% internal carotid stenoses, a tight stenosis at the origin of the innominate artery and left subclavian artery occlusion (Fig. 1). Retrograde flow was detected within the left vertebral artery and orthograde flow in the right. A right carotid endarterectomy with concomitant retrograde innominate artery stenting was planned for her symptomatic cerebrovascular disease, although concern existed about the risk of cerebral hypoperfusion.

Conventional shunting or bypass from other supra-aortic arteries was unattainable due to the multifocal disease. A femoral-to-carotid temporary shunt was thus planned to maintain cerebral perfusion. After induction of general anaesthesia, a transcranial Doppler (TCD) was positioned to monitor flow velocity in the middle cerebral artery (MCA). In view of the previous right femoro-popliteal bypass, the left common femoral artery was accessed percutaneously to allow introduction of a 7-French sheath. The right

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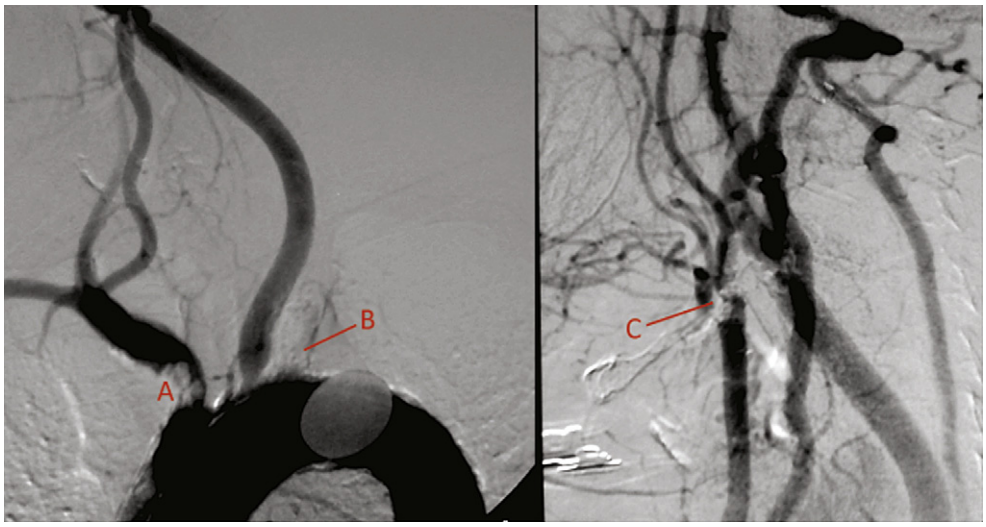

Figure 1 Catheter angiography demonstrating a tight stenosis at the origin of the innominate artery (A) and left subclavian artery occlusion (B) and right internal carotid stenosis (C).

carotid bifurcation was then exposed by a standard lateral approach. After control of the internal carotid artery and anticoagulation with 5000 U heparin, a longitudinal arteriotomy was made to allow introduction of a Pruitt-Inahara shunt, which communicated with the femoral sheath through extension tubing and a Luer lock adapter (Fig. 2). Pre-clamp mean MCA velocity was 59 cm s^{-1}, becoming immeasurable after clamp application and rising to 71 cm s^{-1} after opening of the femoro-carotid shunt. Retrograde innominate stenting was first performed using a 20-mm Saxx stent dilated to 9 mm (C.R. Bard Inc., Murray Hill, NJ, USA). Carotid endarterectomy (CEA) with Dacron patch closure was then performed. Total cross-clamp time was 78 min. Emboli were only detected by TCD during innominate angioplasty, although these were halted by clamping the shunt and venting blood through the Pruitt-Inahara side 'T'-port achieved. Following surgery, the patient was commenced on aspirin 75 mg o.d./clopidogrel 75 mg o.d. dual antiplatelet therapy.

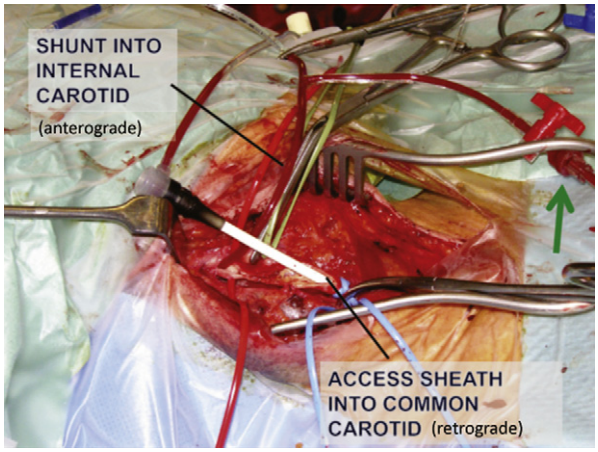

Figure 2 Pruitt-Inahara shunt placed into internal carotid artery and access sheath into common carotid artery. The afferent limb of the Pruitt-Inahara shunt is connected to the femoral sheath via extension tubing and a Luer lock adapter (arrow).

Discussion

Historically, innominate artery re-vascularisation has been through intrathoracic exposure or extra-anatomic reconstruction. Anterograde angioplasty of combined innominate and internal carotid disease is made hazardous by the difficulty in negotiating cerebral protection devices across the tandem disease. Retrograde innominate stenting combined with CEA, as performed in the presented case, provides minimally invasive alternative.[1]

Conventional carotid shunting in this case was not achievable due to co-existing innominate artery stenosis. This case demonstrated the feasibility of extra-corporeal femoro-carotid shunting during the treatment of complex tandem supra-aortic lesions.

A similar, but wholly percutaneous, approach has been described in the setting of Type A aortic dissection with acute innominate artery occlusion.[2] Percutaneous carotid access in the present case was inadvisable due to the symptomatic internal carotid disease, which necessitated open exposure and control to avoid embolisation. Temporary extracorporeal bypass to maintain cerebral perfusion using an 8-mm axillary-to-common carotid Dacron graft prior to retrograde thoracic aorta stenting through the carotid approach has been previously described.[3] This approach was avoided because of the co-existing subclavian and innominate disease. Furthermore, a shunt avoids the additional operative time and morbidity associated with a graft anastomosis and its subsequent reversal.

Intra-operative TCD monitoring confirmed that flow rate through the extra-corporeal circuit was sufficient to maintain cerebral circulation. However, presence of iliac disease or intra-operative hypotension must be viewed with caution as these may cause significant flow reduction. During conventional

usage, the Pruitt-Inahara transmits a fluid flow at approximately 180 ml min^{-1} at a blood pressure of 120/80 mmHg (Data from LeMaitre Vascular, Inc.), which may also be manipulated by blood pressure control as guided by TCD measurements.

Management of complex supra-aortic disease in this manner is associated with a number of controversies. First, though not performed, pre-emptive angioplasty of the asymptomatic left carotid prior to CEA could enhance intracerebral perfusion, although the potential requirement for shunting cannot be dismissed. Second, particulate matter from innominate angioplasty may enter the brain via the carotid artery, vertebral artery or by retrograde entry of emboli into the aorta and transit into the internal carotid through the extracorporeal shunt. Thus, the risk of cerebral embolisation is reduced but not obviated by femoro-carotid shunting. It is of interest that, in this case, embolisation ceased by control of the shunt and venting blood through the Pruitt-Inahara side 'T'-port. Third, minimally diseased ilio-femoral segments are prerequisite.

In conclusion, this case highlights the validity of femoro-carotid shunting to maintain intra-operative cerebral perfusion in the surgical management of complex cerebrovascular disease.

Conflict of Interest

None.

Funding

None.

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