INTRODUCTION

A hybrid approach, combining surgical and endovascular procedures, may be a less invasive substitute to correct aortic arch pathologies in high-risk patients. Our experience demonstrates that this approach can achieve excellent clinical outcomes. However, this technique does have some risks of fatalistic strokes, at least a small incidence of which may be cerebral ischemia during carotid artery clamping. We describe a hybrid procedure for atherosclerotic aortic arch aneurysm to maintain the tissue oxygen saturation level of the left hemisphere, which we installed a bailout external shunt from the right common femoral artery (RCFA) during reconstruction of the left common carotid artery (LCCA). The patient tolerated the procedure without any signs of postoperative stroke.

CASE REPORT

An 82-year-old male patient with a large atherosclerotic aortic arch aneurysm was referred to Shizuoka Red Cross Hospital. He had a long history of severe, chronic obstructive pulmonary disease. Because of the high surgical risks for conventional surgery (logistic Euroscore 29.21%), a hybrid method, consisting of proximal transposition of all arch branches and endovascular aortic arch repair, was indicated. Throughout the procedure, the brain oxygenation was monitored by a transcranial near-infrared spectroscopy (INVOS, Somanetics Corporation, Troy, MI).

A woven Dacron bifurcated graft (10 × 8 × 8 mm, Gelsoft ERS, Terumo, Tokyo, Japan) was selected, and another 8 mm of Dacron graft (Gelsoft ERS, Terumo, Tokyo, Japan) was anastomosed to an 8 mm limb. We administered 5000 units of heparin, applied a partially occluding clamp to the lateral curve of the ascending aorta, and anastomosed the 10-mm limb of the prepared graft. The LCCA was clamped, transected at the arch, and sutured proximally. The lateral limb of the graft was anastomosed in an end-to-end configuration. Two minutes after we had clamped the LCCA, the oxygen saturation level of the left cerebral hemisphere decreased lower than the safety limit. To re-establish brain perfusion, we installed an external shunt from the right common femoral artery to the left common carotid artery. The oxygen saturation was restored to an acceptably safe level, and the patient tolerated the procedure without any signs of postoperative ischemic stroke.

Key words: aortic arch aneurysm, hybrid repair, ischemic stroke

Usage of External Shunt in Hybrid Approach for Aortic Arch Aneurysm to Restore Cerebral Oxygenation

Hiroshi Mitsuoka, MD, PhD, Hidekazu Furuya, MD, Yoshinaga Nakao, MD, PhD, Tsunehiro Shintani, MD, PhD, and Shigeki Higashi, MD, PhD

A hybrid approach, combining open and endovascular procedures, may be a less invasive substitute to correct aortic arch pathologies in high-risk patients. We describe an 82-year-old male patient with an atherosclerotic aortic arch aneurysm, which was treated with proximal transposition of all arch branches and endovascular aortic arch repair. During the left common carotid artery reconstruction, oxygen saturation level of the left cerebral hemisphere decreased lower than the safety limit. To re-establish brain perfusion, we installed an external shunt from the right common femoral artery to the left common carotid artery. The oxygen saturation was restored to an acceptably safe level, and the patient tolerated the procedure without any signs of postoperative ischemic stroke.

Key words: aortic arch aneurysm, hybrid repair, ischemic stroke
perfusion, we installed an external shunt from the RCFA to the LCCA. For a source of oxygenated blood, the side port of a 7 Fr introducer sheath, which had been inserted to the RCFA for the endovascular access, was selected. Another 7 Fr sheath was inserted to the LCCA (Fig. 1). The shunt restored the oxygen saturation to an acceptably safe level (Fig. 2). After the completion of anastomosis, the LCCA sheath was removed. The puncture site was corrected by closing a small size of purse string suture. The innominate artery (INA) was similarly addressed, using the other 8 mm lateral limb. Another 8 mm limb was anastomosed to the left axillar artery (LAA) in an end-to-side fashion. During INA and LAA reconstruction, the brain oxygen saturation levels remained in a safe range. The TAG endoprosthesis (W.L. Gore & Associates, Flagstaff, AZ) was introduced from the RCFA and positioned distally to the suture line of the bifurcated graft. The left subclavian artery was coil-embolized, using platinum-tungsten alloy coils (Interlock fibered IDC occlusion system, Boston Scientific Corporation, Natick, MA). A final angiogram found no signs of endoleak (Fig. 3A). The patient tolerated the entire procedure and showed no signs of ischemic stroke postoperatively. Three-dimensional computed tomography (CT) at the third postoperative month found no signs of endoleak (Fig. 3B).

**DISCUSSION**

The mortality rate of conventional surgery for aortic arch aneurysm in high-risk patients is not negligible. One possible alternative may be the above-mentioned hybrid procedure. Although it has an acceptably low rate of procedure-associated death, the main drawback of the method may be its causing cerebrovascular accidents. The etiology of intraoperative stroke may be ischemic or embolic. Atherosclerotic debris can be released by surgical or endovascular procedures. Ischemic stroke results from inadequate cerebral perfusion related to flow cessation of carotid artery.

Empirically, a short period of arterial clamp during one side of carotid artery reconstruction does not decrease the brain oxygenation level severely. However, in the presence of extra- and intra-cranial arterial abnormality, even a few minutes of the flow cessation may cause a fatalistic degree of brain ischemia. A shunt tube for carotid endarterectomy (CEA) could have been used, if the remaining length of proximal carotid artery were long enough. Conversely, the length of remaining proximal LCCA was too short to use the shunt tube, especially in terms of sealing of arterial blood by inflating the proximal balloon. Therefore, the external arterial shunt, as described by Schönholz was employed as a bailout method.

The usage of temporal shunts has been a long-standing issue, especially related to CEA. Shunting is inherently...
risky, because it may cause embolic stroke, as well as unpredicted adverse events related to the technical problem. Controversies may exist in a decision-making about usage of external shunt under several methods of cerebral monitoring, including stump pressure (e.g. less than 50 mmHg), electroencephalogram (EEG) (e.g. at least 50% decrease in fast background activity), and INVOS (e.g. at least a 20% decrease from the background). Important thing is that none of these has complete accuracy in detecting intra-operative ischemia. On the other hand, these methods have acceptably high levels of sensitivity in detecting the brain ischemia. Furthermore, there is no method to detect the ischemic tolerance. Consequently, usage of any fashion of shunting should be justified under the above-mentioned circumstances. However, one study indicated that shunting might not be able to maintain local physiologic microcirculation. Thus, it is also necessary to reduce the duration of the surgical procedure, as well.

**CONCLUSION**

Establishing a temporary femoral-carotid shunt is technically feasible. The shunt can refurbish the circulation of blood to the brain during carotid artery reconstruction in the hybrid procedure for aortic arch aneurysms.

**REFERENCES**