Lack of blood supply, not atherosclerosis, kills the brain in aortic arch surgery

Ourania Preventza, MD, and Joseph S. Coselli, MD

From the Division of Cardiothoracic Surgery, Michael E. DeBakey Department of Surgery, Baylor College of Medicine; and the Department of Cardiovascular Surgery, Texas Heart Institute, Houston, Tex.

Disclosures: J.S.C. participates in clinical research trials conducted by Glaxo Smith Kline, Edwards Lifesciences, and Bolton Medical; consults for, receives royalties and a departmental educational grant from, and participates in clinical trials for Vascutek Terumo; and consults and participates in clinical trials for Medtronic, Inc, and W. L. Gore & Associates. O.P. consults for Medtronic, Inc, and W. L. Gore & Associates, and she has received travel expenses from Cook Medical, Inc.

Received for publication Jan 5, 2017; accepted for publication Jan 12, 2017; available ahead of print Feb 21, 2017. Address for reprints: Ourania Preventza, MD, BCM 390, One Baylor Plaza, Houston, TX 77030 (E-mail: opsmile01@aol.com).

J Thorac Cardiovasc Surg 2017;153:1054-5

0022-5223/\$36.00

Copyright © 2017 by The American Association for Thoracic Surgery

<http://dx.doi.org/10.1016/j.jtcvs.2017.01.008>

Ourania Preventza, MD

Central Message

In patients with or without carotid and intracranial atherosclerosis who are undergoing aortic arch surgery, the risk of atheroembolism may be increased, and an individualized approach is imperative.

See Article page 1045.

During aortic arch surgery, perfusion strategies that protect the brain are indisputably important for achieving excellent results. At the same time, these strategies are the Achilles' heel of the procedure, if they are not in place or are not performed properly during the operation. In this issue of the *Journal*, Imasaka and colleagues¹ report that obstructive carotid and intracranial disease is often associated with ischemic stroke during open aortic arch surgery and that embolism is the most common cause of permanent stroke in these patients. Imasaka and colleagues¹ also show that a previous cerebrovascular event and shaggy aorta are determinants of neurologic morbidity during open aortic arch surgery and that preoperative screening is a useful step for identifying patients who are at increased risk for ischemic stroke.

Aortic arch calcification has been associated with the presence of mobile or ulcerated aortic plaques,² and the risk of atheroembolism from aortic plaques in aortic surgery is well recognized. In addition, patients with previous stroke have been reported to be at risk for permanent stroke³; often they have ulcerated noncalcified plaques or mobile atheromas, which are associated with an increased frequency of atheroembolization regardless of the presence of carotid or vertebral disease. In the absence of carotid disease, large or complex aortic atheromas can be seen in the arch, signifying that the different sites of predilection can be uncertain, even though atherosclerosis is a systemic disease.⁴ During aortic arch surgery, the lack of blood supply as a result of emboli, rather than the atherosclerosis itself, kills the cerebral neurons. Although different adjuncts for brain protection have recently been improved, the real concern is how to prevent emboli from occurring during aortic arch surgery. Emboli can result from the presence of aneurysm, iatrogenic manipulation, inflammation, or sheer forces caused by perioperative hypertension.

Patients with carotid and intracranial artery disease, which can be a surrogate for atheromatous disease, are

deserving of more intensive screening before undergoing major aortic surgery. Such screening may include brain perfusion single-photon emission computed tomography, positron emission tomography, and magnetic resonance imaging.¹ In addition, for patients with previous stroke, preoperative brain imaging can be equally important. Once this information has been gathered, the next logical step is to decide how best to avoid neurologic morbidity after an aortic arch operation. We must consider important information that could affect how we conduct the operation, including the assessment of a complete or incomplete circle of Willis, evaluation for arch anomalies and for possible vertebral arteries coming off the aortic arch, determination of the size of bilateral vertebral arteries, and determination of the presence of aberrant subclavian arteries or a cervical arch. In patients with diffuse and heavy arch atherosclerosis or currently ulcerated plaque, the cannulation site is very important. Femoral artery cannulation should be avoided, and performing alternative cannulation strategies such as right axillary cannulation should be considered.⁵ In addition, if direct aortic cannulation is used, preoperative chest computed tomography, intraoperative epiaortic ultrasonography, or transesophageal echocardiography should be used for

guidance before aortic cannulation. Furthermore, the proper aortic cannulas must be selected to decrease the turbulence on the aortic arch. Clamping of the aorta during the cooling period to work on the proximal aortic part first should be avoided, and the aorta should not be clamped in the case of diffuse arch atherosclerosis. An open distal anastomosis or arch reconstruction should be performed after cooling, without any clamp application in the ascending aorta. Finally, in patients in whom occluded carotid intracranial disease is present, careful management of postoperative blood pressure can be crucial.

To minimize postoperative neurologic morbidities after aortic arch surgery, an individually tailored perioperative approach should be in the armamentarium of cardiac surgeons.

References

1. Imasaka K, Tayama E, Tomita Y. The impact of carotid and/or intracranial atherosclerosis on perioperative stroke in patients undergoing open aortic arch surgery. *J Thorac Cardiovasc Surg*. 2017;153:1045-53.
2. Shimada Y, Ueno Y, Tanaka Y, Okuzumi A, Miyamoto N, Yamashiro K, et al. Aging, aortic arch calcification, and multiple brain infarcts are associated with aorto-genic brain embolism. *Cerebrovasc Dis*. 2013;35:282-90.
3. Preventza O, Garcia A, Cooley DA, Haywood-Watson RJ, Simpson K, Bakaeen FG, et al. Total aortic arch replacement: A comparative study of zone 0 hybrid arch exclusion versus traditional open repair. *J Thorac Cardiovasc Surg*. 2015;150:1591-8; discussion 1598-600.
4. Kernan WN, Ovbiagele B, Black HR, Bravata DM, Chimowitz MI, Ezekowitz MD, et al. American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Peripheral Vascular Disease. Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2014; 45:2160-236.
5. Ayyash B, Tranquilli M, Eleftheriades JA. Femoral artery cannulation for thoracic aortic surgery: safe under transesophageal echocardiographic control. *J Thorac Cardiovasc Surg*. 2011;142:1478-81.