Commentary: Functional assessment of circle of Willis—interesting observation or critical consideration?

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Cerebral protection is paramount for the performance of safe aortic arch repair surgery. A recent survey initiated by the European Association for Cardio-Thoracic Surgery Vascular Domain of more than 100 European centers revealed that bilateral antegrade selective cerebral perfusion (biASCP) is performed in most centers, usually with 22°C to 26°C perfusate temperature and perfusate flow and pressure in the range of 10- to 15-mL/kg and 60 mm Hg, respectively.¹ In the United States, however, biASCP use is much less common, with markedly higher proportions of unilateral antegrade selective cerebral perfusion (uASCP), retrograde cerebral perfusion, and hypothermic circulatory arrest techniques.²

The evidence in support of either uASCP or biASCP is inconclusive. Although some surgeons use biASCP—presumably to deliver a more physiologically appropriate blood supply—others prefer uASCP because of its technical simplicity and the reduced manipulation of supra-aortic vessels, which may result in a lower risk of iatrogenic embolism or injury to the left common carotid artery.³ In their study reported in this issue of the *Journal*, Smith and colleagues⁴ focus on the functionality of the circle of Willis (CoW), which may present a new and promising technique during aortic arch surgery. Smith and colleagues⁴ describe identification of the patient's individual intracranial arterial collateralization with transcranial Doppler ultrasound (TCD) and present a decision-making algorithm for optimal cannulation and perfusion strategy in aortic arch repair.

Collateral arterial pathways and their clinical evaluation are highly complex issues. Before we conclude that cerebral protection strategies should be based on TCD characterization of the CoW, there are several issues to be addressed. First, TCD is not applicable in approximately 20% of patients because of poor acoustic transcranial windows,⁴ and an additional 15% of patients in the study of Smith and colleagues⁴ did not tolerate carotid compression for assessment of CoW function. Carotid compression should also be avoided in patients with severe carotid atherosclerosis, found in approximately 3% of patients undergoing aortic

Aortic arch repair requiring adequate cerebral protection.

Central Message

Functional assessment of the circle of Willis with transcranial Doppler may supply important information for cerebral protection strategy during aortic arch surgery.

See Article page 1298.

arch repair. The protocol and proposed risk-stratification strategy of Smith and colleagues⁴ is not applicable in 4 out of 10 patients undergoing aortic arch surgery. Second, the clinical relevance of the functional CoW anatomy is debatable, given that excellent clinical outcomes have been reported by centers solely applying uASCP during arch surgery.⁵⁻⁷ Local cerebral malperfusion may be attenuated by the use of hypothermia in such series. Indeed, the neurologic complication rates reported in these studies are much lower than would be expected, given the 28% rate of inadequate unilateral supply identified by the TCD classification system of Smith and colleagues.⁴ Third, hemodynamics at the time of initial TCD evaluation are very different than those observed during the operative repair of the arch. That is, the effects of anesthesia, nonpulsatile blood flow, hypothermia, and lower mean pressures are not taken into account during initial assessment of CoW functionality. Finally, TCD is highly operator dependent and has not found its way into routine use in the cardiac surgery operating room.

Consequently, the proposed TCD assessment of CoW functionality is not applicable in a significant number of patients, and its clinical relevance for the majority of patients remains unclear. In our opinion, however, TCD testing has the potential to become a powerful tool in identifying patients at high risk during arch surgery. More clinical data

will be required to validate preoperative TCD assessment with intraoperative findings during antegrade selective cerebral perfusion, and such information may lead to adjustments in cerebral perfusion strategy in individual patients (eg, switching from uASCP to biASCP). Whether intraoperative TCD assessment of the CoW is enough to prove or disprove the safety and efficacy of uASCP, an area of controversy for many years, remains to be seen.

In summary, Smith and colleagues⁴ present stimulating data on an innovative approach that may serve as an additional adjunct to improve the safety of arch surgery. Proper interpretation of the data from a technology that has been used sparingly in cardiac surgery will be required, however, and further refinement of the proposed algorithm will almost certainly occur. If TCD functional assessment of the CoW leads to a reduction of cerebral complications (eg, cerebral malperfusion in patients with insufficient intracerebral collateralization, or iatrogenic embolism from unnecessary carotid artery manipulation in patients with robust intracerebral collateralization), then the added effort will be well justified.

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