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EDITORIAL COMMENTARY

Brain protection in aortic arch surgery: Antegrade cerebral perfusion and retrograde cerebral perfusion need a tougher row to hoe

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See related article on pages 2896-902.

The article in this issue of the *Journal of Thoracic and Cardiovascular Surgery* by Ganapathi and colleagues¹ compares outcomes of aortic hemiarch replacement with antegrade cerebral perfusion (ACP) versus retrograde cerebral perfusion (RCP) in a large number of patients. Ganapathi and colleagues¹ are to be congratulated for their superb clinical results and well-written study. They have contributed significantly to our body of knowledge with this work.

Important design characteristics of this study include the following:

- The 2 patient groups were very dissimilar initially, so propensity matching was applied to overcome this limitation.

- The operations were all hemiarch procedures, so the circulatory arrest times were all very short (generally less than 20 minutes).
- The study included both elective and emergency cases.
- The patients were quite young (mean age, 51 years).
- The ACP and RCP groups were cooled to an unusually low level (<15°C).

This study provides useful data, solidifying the conventional wisdom that operations requiring less than 30 minutes of deep hypothermic circulatory arrest (DHCA) are safe regardless of modality of cerebral protection. In view of this point, this study is unlikely to change practice but rather affirms current principles.

The restriction to hemiarch operations is both a benefit and a liability. This restriction makes for an important element of uniformity among patients but at the same time limits the degree to which the findings can be generalized.

It is important to note that Ganapathi and colleagues¹ delivered ACP only to one side of the brain through a right axillary cannula only. This is highly controversial because of the concern that ACP blood may not adequately reach regions remote from the right carotid artery, especially in case of an incomplete circle of Willis. Many experts advocate perfusion of both carotids, or even of both carotids and the left subclavian artery (to recruit the left vertebral artery as well).²

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FIGURE 1. Pie chart illustrating the responses of the editorial board members of *AORTA Journal* to a poll regarding cerebral protection method of choice for aortic arch surgery. DHCA, Deep hypothermic circulatory arrest. (Reprinted with permission.³)

It is interesting that Ganapathi and colleagues¹ performed their study in the present era, because RCP (despite use by such authorities as Safi and Coselli) seems to be losing steam generally, out of concerns that little oxygen is actually delivered to brain tissue.¹ In addition, a recent poll of experts indicates that only 7% currently use RCP (Figure 1).³

Certain limitations of this study bear review. The inherent dissimilarity between groups, necessitating propensity matching, will raise some eyebrows among readers. This is especially true considering that there were significant differences between the 2 groups in number of patients, age, sex, hypertension, tobacco abuse, chronic obstructive pulmonary disease, congestive heart failure, New York Heart Association functional class, and previous aortic surgery.

The relative “simplicity” of the procedures (hemiarach only) makes this study unrevealing regarding more complex arch operations—missing the arena of more complicated arch work, where clarification is more sorely needed to guide clinical practice.

Most important are 2 factors limiting the relevance of the information provided in this study. First, the arrest times are so short that almost any technique of brain protection would suffice. Two reports from our group demonstrate that DHCA suffices as a sole method of brain protection—unequivocally so for short arrest times.^{4,5} Second, the temperatures used are so low that exceptionally complete cerebral protection would be provided by the hypothermia alone. As shown in the classic studies by Bigelow, the brain metabolic rate falls exponentially with decreasing temperature, so that oxygen demand in this study, on the

FIGURE 2. Drop in cerebral metabolic rate (to 12% of normothermic levels at 18°C) with hypothermia. (Reprinted with permission.⁶)

basis of systemic hypothermia alone, would be about 5% of that at normothermia (Figure 2).⁶

So, although Ganapathi and colleagues¹ set out to determine which brain protection technique was more effective, ACP or RCP, it appears that their therapies were insufficiently challenged for detection, because any method of brain protection, including no perfusion at all from either direction, would likely have sufficed for these patients. One might postulate that the exceptionally deep hypothermia was the active modality, and the ACP and RCP were just along for the ride. This perspective is also supported by a recent study by Kaneko and associates⁷ that compared all 3 of these techniques of cerebral protection (straight DHCA, ACP, and RCP) for noncomplex hemiarach surgery. Kaneko and associates⁷ showed that DHCA alone is as safe as other adjunct cerebral protection techniques, with no difference in postoperative morbidity and mortality. They concluded that there is no need to complicate the procedure overly with perfusion adjuncts when DHCA is simple, effective, and incurs no additional risks.

Ganapathi and colleagues¹ set out to correct the “equipoise” between ACP and RCP. *Equipoise* is defined as a state of genuine uncertainty regarding the benefits or disadvantages of either therapeutic arm of a clinical trial. This study, by virtue of the short arrest intervals and the very deep levels of hypothermia, did not challenge either modality—ACP or RCP—sufficiently to resolve the equipoise. ACP and RCP need a “tougher row to hoe” to provide evidence of their fullest neuroprotective abilities.

We are indebted to Ganapathi and colleagues¹ for demonstrating the adequacy and the equivalence of ACP and RCP for hemiarach operations.

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