DATA SUPPORT CONTINUED ROLE FOR STRAIGHT DEEP HYPOTHERMIC CIRCULATORY ARREST

Video clip is available online.

Reply to the Editor:

We thank Drs Formica, D'Allesandro, and Messina for their kind comments.

All cardiac surgeons love blood flow, especially to the brain. Our team loves it too. There are differences, however, between naturally delivered flow to the brain in the native state and surgically delivered antegrade cerebral perfusion (ACP). Specifically, for ACP, we tend to flow too much (usually approximately 800 mL/min) and in an unbalanced fashion (to the innominate artery alone, or to the innominate and carotid arteries—rarely perfusing the left subclavian and the left vertebral arteries). This nonphysiologic application of blood flow can have consequences—especially focal hypometabolism and localized brain edema, which can be visualized on brain imaging and may persist for weeks.¹

We enjoy the simplicity of deep hypothermic circulatory arrest (DHCA), with which the operation can be done without any clutter, delay, or blood in the field.

FIGURE 1. Technique for aortic arch replacement with elephant trunk procedure. L, Left. (Reprinted with permission.⁵)

We agree entirely with Formica and colleagues that the paucity of randomized clinical trials makes it hard to compare accurately among different cerebral protection methodologies in aortic arch surgery. We have previously catalogued the available studies (Table 2 in reference 2). The available data are based largely on retrospective analysis of heterogeneous populations and variable outcome definitions, which are not directly comparable.

Although our article on which Formica and colleagues comment³ is focused specifically on the *late* outcomes after surgery with DHCA—a topic on which there is a dearth of information—the Formica commentary⁴ focuses more on acute outcomes, on which we have previously written extensively.^{2,5} In the article on which the commentary is based, we show that late outcomes are excellent after application of DHCA. In fact, long-term survival after elective, nondissection, first-time operations is not statistically different from that of an age- and sex-matched control population. That is to say, survival is restored to “normal.”

That said, we have no quarrel with use of ACP for aortic arch operations. We consider ACP to be a perfectly

VIDEO 1. A 78-year-old woman, on the morning after total aortic arch replacement, spells her surgeon's difficult surname, “Eleftheriades,” first forward and then backward. This is a vivid demonstration of the complete preservation of cognitive ability by deep hypothermic circulatory arrest. (Reproduced with permission.¹¹)

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reasonable approach. It is important, to recognize, however, that, despite its growing popularity, ACP has not led to better results than seen in our extensive series with straight DHCA: operative mortality of 2.9% and stroke rate of 2%.²

Very recently, abundant and rigorously defined and analyzed data from multiple centers has been published as part of the International ARCH project.⁶ Propensity analysis has been possible with these data. The recent article compared moderate hypothermia plus ACP with DHCA plus ACP for total arch procedures. Mortality and stroke rates were 11.6% and 13.8%, respectively, and stroke rates were 7.8% and 8.0%, respectively.⁷ Comparing this with our overall mortality of 2.9% and stroke rate of 2% with straight DHCA, it is hard to argue for the superiority of ACP at any temperature.

Formica and colleagues are concerned about performance of extensive arch procedures under DHCA—specifically about whether one might run out of DHCA time during extensive arch surgery. We routinely perform arch replacement under DHCA, with elephant trunk, under straight DHCA. We find it takes about 20 minutes to perform the distal anastomosis with elephant trunk and about 20 minutes to reattach the Carrel patch carrying the head vessels, bringing us home well within the safe interval of 40 to 50 minutes.⁵

We often move the level of the distal aortic anastomosis and seating of the elephant trunk to the site between the left common carotid and the left subclavian arteries. See [Figure 1](#). This allows easy access for the distal anastomosis and full exposure of all anastomotic sites for any hemostatic suturing that may later be required. During a stage II elephant trunk procedure, through a left thoracotomy, the dangling Dacron polyester fabric graft is retrieved and anastomosed as far down the thoracoabdominal aorta as necessary. The left subclavian artery is revascularized at that time through a side arm from the main aortic graft.

It is vitally important to recognize as well that most strokes after aortic and aortic arch surgery represent embolization of arteriosclerotic material,⁸ which is not dependent on or determined by brain preservation technique.

In our experience, we have not noted any significant increase in postoperative complications from DHCA (including stroke, postoperative bleeding, kidney injury, or spinal cord injury).^{5,8}

In addition to the extensive clinical experience with DHCA that we have analyzed, both short and long term, we have also scrutinized neurocognitive function clinically and by advanced quantitative metrics—including looking at a group of “highly cognitive” individuals who need every

bit of their brain function for their work. DHCA was found to preserve function quite remarkably.^{9,10}

We therefore consider ACP to be a perfectly acceptable method of brain protection for aortic arch surgery. We believe that DHCA is also an excellent—and clinically unsurpassed—option for these cases, with substantial supporting experience and analysis.

Sometimes a picture really is worth a thousand words. In [Video 1](#), we link again¹¹ to a brief interview done by our nurse coordinator at 7 AM on the morning of postoperative day 1 after total aortic arch replacement in a 78-year-old woman with arch aneurysm. Please note how highly preserved her cognitive function is shown to be—as she spells her surgeon’s very difficult name correctly and then goes one very challenging step further ([Video 1](#)). This case demonstrates what we see on a daily basis at our institution: superb brain protection by DHCA, with a “dry” (nonedematous) brain able to function immediately at a very high level.

Anneke Damberg, MD

Bulat A. Ziganshin, MD, PhD

John A. Eleftheriades, MD

Aortic Institute at Yale-New Haven Hospital

Yale University School of Medicine

New Haven, Conn

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