Options for arterial cannulation to provide antegrade cerebral perfusion: Everything old is new again

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Some clinical problems have multiple, nearly equally effective solutions, with no clear winner among them. Craig Miller frequently points out that there is more than one way to skin a cat. Cat lovers will be relieved to know that “cat” does not refer to the mammal but rather the catfish. The somewhat easy skinning process can begin at the head, near the tail fin, or laterally. In moderately skilled hands, all 3 options are equally effective.

Over the decades, several cerebral protection strategies have been used during aortic arch reconstruction. These include simple deep hypothermia as initially described by Griep and colleagues,¹ providing a quiet, dry, unencumbered surgical field. Hypothermia alone continues to produce excellent results, including extremely low morbidity and mortality. Retrograde cerebral perfusion (RCP), initially popularized by Ueda and colleagues,^{2,3} has been used frequently in conjunction with deep hypothermia. The popularity of RCP has declined in recent years; today, it is used primarily in select patients with significant atherosclerotic load or for whom alternative techniques are considered less appropriate.

Antegrade cerebral perfusion (ACP) was initially used successfully by De Bakey and colleagues⁴ by directly cannulating the innominate and left common carotid arteries; decades later, ACP was popularized by Kazui and colleagues.⁵ In the hands of dedicated teams, deep hypothermia alone, RCP, and ACP produce similarly excellent results.

Most frequently, ACP is established via the right axillary artery by direct cannulation or a small side graft. An increasingly popular alternative inflow site is the innominate artery. In this issue of the *Journal*, Jassar and colleagues⁶ at the University of Pennsylvania report their experience with 100 elective hemiarch reconstructions with ACP established by direct innominate artery cannulation. Their technique involved direct ascending aortic cannulation for initial perfusion, cooling to 24°C to 28°C (moderate hypothermia), and directly cannulating the innominate artery by inserting a short-tip 9F cardioplegia cannula through a horizontal mattress suture. The left

Innominate artery perfusion delivered via a graft sutured to anterior aspect of artery. Used with permission of Baylor College of Medicine.

Central Message

ACP via the innominate artery—using direct cannulation or a side branch—protects the brain during arch repair.

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carotid and left subclavian arteries are neither perfused nor occluded, and after the distal anastomosis is completed, cardiopulmonary bypass is reestablished directly through the aortic graft. The results were excellent—only 1 death (1%) and 2 postoperative neurologic events (2%), neither of which resulted in permanent neurologic deficit. The patients were a select group: All underwent hemiarch replacement of a distal ascending/proximal aortic arch, and it appears that none had aortic dissection or an emergency procedure. In addition, none had anatomic injuries or dissection of the innominate artery. The authors concluded that their technique is safe and yields excellent results.

The case against axillary artery access is that it requires an additional incision and, consequently, extra operative time. Also, although axillary inflow provides excellent initial flow and is clearly a useful adjuvant to ACP, there is risk to the brachial plexus. We have previously described a series⁷ of 68 patients who underwent a wider variety of arch operations, including aortic dissection repair and total aortic arch replacement in which an 8-mm end-to-side graft was anastomosed to the distal innominate artery for both cardiopulmonary bypass inflow and ACP support (Figure 1). Thirty-day mortality was low at 1.5%, and the permanent stroke rate was 2.2%. We then reported using a similar technical approach in a larger series⁸ of 263 patients, with excellent results. Mortality and stroke were 4.9% and 1.9%, respectively, in a series that included emergency cases, aortic dissection, acute and chronic aortic

FIGURE 1. Innominate artery cannulation. After 1 mg/kg of heparin is given, a partial occluding clamp is applied to the distal aspect of the artery, a longitudinal arteriotomy is created, and an 8-mm graft is sewn onto the anterior aspect of the artery in an end-to-side fashion. The graft is carefully flushed and de-aired and is then attached to the inflow line from the cardiopulmonary bypass circuit to provide systemic hypothermic circulatory arrest and antegrade cerebral perfusion. Used with permission of Baylor College of Medicine.

dissection, and total aortic replacement. Our experience with this technique now exceeds 470 cases.

Jassar and colleagues⁶ have provided additional clinical support for the safety and effectiveness of ACP, most notably at moderate temperatures, and for the use of the innominate artery as an alternative access site for ACP in the treatment of patients with selected aortic pathology. Clearly, this adjunct should represent just one weapon in the armamentarium of cardiothoracic surgeons for managing such problems. One would hope that additional clinical evidence is forthcoming to support the use of this valuable tool in more complex aortic arch procedures, including emergency surgery, acute aortic dissection repair, and total arch replacement.

Scott A. Weldon, MA, CMI, created the illustration. Susan Y. Green, MPH, Sally P. Timko, BA, and Stephen N. Palmer, PhD, ELS, contributed to the editing of the manuscript.

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