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Discussion

Dr Banshi Koul (Lund, Sweden). An excellent study and preliminary results. However, I wonder, when you have a 14F cannula in the innominate, how did you control the blood pressure in these patients before you went on to antegrade cerebral perfusion? Did you cross-check the blood pressure from the left radial and compare that with the right? How did your flows affect the pressures?

Dr Garg. Thank you for your question. We monitored the blood pressure in the contralateral limb, the brachial pressure that way. Also, we did not want to be overperfusing the brain, so we tried to keep our pressures <70 mm Hg.

EDITORIAL COMMENTARY

Innominate artery cannulation: The Toronto technique for antegrade cerebral perfusion in aortic arch reconstruction—a clinical trial opportunity for the International Aortic Arch Surgery Study Group

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Antegrade cerebral perfusion (ACP) with hypothermic circulatory arrest (HCA) has recently become a mainstream technique in aortic arch surgery, obviating the requirement for profound hypothermia.¹⁻³ Furthermore, extensive recent data demonstrate that unilateral ACP with adequate pressure and monitoring during HCA has achieved excellent outcomes, suggesting that bilateral ACP may

FIGURE 1. Penn technique for direct cannulation of the innominate artery for antegrade cerebral perfusion during hypothermic circulatory arrest for aortic arch reconstruction.

not be required in this setting.^{4,5} Although axillary arterial cannulation remains a popular strategy choice for unilateral ACP, cannulation of the innominate artery with or without a side graft has recently emerged as a reasonable choice.⁶⁻⁸

The report by Garg and colleagues⁹ from the University of Toronto in this issue of the journal explores this concept in more detail. In their report (N = 50 adults; 2010-2012), they demonstrate that direct cannulation of the innominate artery with a 12F pediatric venous cannula for ACP during HCA for aortic arch reconstruction is feasible and safe.⁹ The average nadir temperature for and duration of ACP in this series were $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 19 ± 5 minutes, respectively. The studied patients all underwent elective surgical intervention for aneurysm of the proximal thoracic aorta. The following clinical categories were excluded: emergency surgery, acute aortic dissection, and total aortic arch reconstruction.

The first consideration is why the aortic surgeon should strongly consider innominate artery cannulation in the conduct of aortic arch repair. As Garg and colleagues⁹ point out, axillary artery cannulation adds extra surgical time and carries such risks as upper extremity ischemia, local nerve injury, and seroma. In addition to avoiding these risks of axillary artery cannulation, ACP through the innominate artery also allows the entire aortic arch repair to be conducted in the chest after median sternotomy. This preference for a centralized arterial cannulation strategy to streamline the surgical process and minimize complications also explains the clinical drift away from peripheral arterial cannulation to echocardiographically guided central aortic cannulation in acute type A dissection here at the University of Pennsylvania (Penn) and elsewhere.^{10,11} Innominate artery cannulation with the Toronto technique for

unilateral ACP is a natural extension of this search for simple centralized arterial cannulation management for aortic arch reconstruction with HCA.

Innominate artery cannulation for ACP during HCA has also been adopted here at Penn (Figure 1). The Penn technique involves direct cannulation of the innominate artery with a 9F aortic root cannula, which is then secured with a Rumel tourniquet. During HCA, the proximal innominate artery is clamped, and the unilateral ACP is delivered through the innominate artery, as in the Toronto technique. Since 2008, more than 60 cases have been performed in this fashion at Penn, with excellent results. To date, there have been no clinical strokes, and in-hospital mortality is 1%.¹² This series is currently being further analyzed for publication in the near future (personal communication with the senior author [W.Y.S.], September 26, 2014).

Given that this technique is viable and advantageous, the second consideration concerns the contraindications to cannulation of the innominate artery for ACP. As Garg and colleagues⁹ mention, the Toronto technique may be best used in an elective setting, where there is minimal tortuosity, dissection, or atheroma of the innominate artery. Cerebral atheroembolism remains a major risk whenever a major arch vessel is manipulated and is a reason that bilateral ACP carries an ongoing stroke risk.⁴ The Toronto technique involves the Seldinger approach with cannulation over a wire. Upstream carotid atherosclerosis would be a source of significant stroke risk from atheroembolism caused by the wire in the carotid artery. Garg and colleagues⁹ do not report the incidence of carotid atheroma in their patient series. It would seem prudent to avoid this complication by ensuring tight control of the wire in the innominate artery, as illustrated in their graphics.

The third consideration is whether this quest for centralized arterial cannulation for ACP matters at all, given that the HCA times are so short and that significant clinical equipoise exists regarding ACP in this setting.¹³⁻¹⁶ Recent data from leading centers around the world have demonstrated that for short aortic arch reconstructive times (less than 45 minutes of HCA), straight HCA and retrograde cerebral perfusion are also associated with excellent outcomes, although at deeper levels of hypothermia than used by Garg and colleagues.^{9,13-16} Regardless of arterial cannulation site, the advantage of unilateral ACP in aortic arch repair with short HCA times appears to be that the level of hypothermia for HCA can be in the range of 25°C , because deeper levels of hypothermia are not required for neuroprotection in the setting of ACP.¹⁻⁴ This difference shortens cooling and rewarming times on cardiopulmonary bypass. This significant reduction in total operative time may translate into important outcome advantages, such as reduced mortality, reduced coagulopathy, and lower transfusion burden, although further trials are required to answer this question.

In conclusion, Garg and colleagues⁹ are to be congratulated for focusing attention on the Toronto technique for innominate artery cannulation to deliver unilateral ACP during HCA. Further trials with more power are required to define the clinical niche of this technique the conduct of aortic arch repair. This represents a major research opportunity for the newly formed International Aortic Arch Surgery Study Group.¹⁷

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