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Commentary: Keep the head cool. Keep the spine cooler

Mehrdad Ghoreishi, MD,^a and Joseph Coselli, MD^{b,c,d}

Spinal cord deficit is an extremely rare event after total transverse aortic arch replacement with hypothermic circulatory arrest.¹⁻⁴ Notably, there have been a handful of reports describing paraplegia or paraparesis after “extended” total aortic arch repair that also includes a portion of the descending thoracic aorta, such as during “long” elephant trunk or frozen elephant trunk repairs.^{5,6} Because of the recent general shift toward warmer temperatures during aortic arch repair, there is some concern regarding inadvertent harm to the spinal cord. The question is whether antegrade cerebral perfusion (ACP) itself is protective against paraplegia in long-interval moderate hypothermic circulatory arrest or if the surgeon should rely more on protection provided by hypothermia.

Kinoshita and colleagues⁷ investigated brain and spinal cord oxygen saturation levels using near-infrared spectroscopy (NIRS) at the forehead and along the mid-line of the back at the T3 and T10 level in 18 patients undergoing total transverse aortic arch replacement. The oxygen saturation levels declined immediately in all levels after initiation of circulatory arrest at a tympanic membrane temperature of less than 25°C. The oxygen saturation levels increased in the forehead right after the initiation of ACP and remained partially elevated at upper thoracic level (T3), but continued to decline without recovery at the lower thoracic level (T10). Kinoshita and colleagues⁷ concluded that ACP partially perfuses the upper thoracic spinal cord via

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Until we obtain an accurate modality to monitor spinal cord perfusion, extra caution should be taken in aortic arch replacement when warmer temperatures are used during hypothermic circulatory arrest.

collateral circulation from vertebral arteries through an anterior spinal artery, with no or minimal effect on lower thoracic cord perfusion during circulatory arrest. The authors state that cooling is more protective against spinal cord neurologic deficit than is ACP.

Perhaps the authors could have also highlighted the importance of restoring perfusion to the downstream aorta immediately after the distal anastomosis is completed to minimize the potential for distal ischemia—they did indicate oxygen saturation improved upon resuming lower body cardiopulmonary bypass, which may be readily provided by using a side perfusing branch of the main replacement graft. Most surgeons understand that both the circle of Willis and the feeding arteries of the spinal cord are highly variable and inherently complex, but few perform detailed preoperative imaging to identify anomalies; instead, blanket protections are undertaken to cover most scenarios, although the risk of postoperative spinal cord deficit remains a threat after complex aortic repair.⁸

Unfortunately, there is currently no direct way to measure spinal cord blood flow at the time of lower body circulatory arrest. Kinoshita and colleagues⁷ believe that oxygen saturation levels detected by NIRS along the paraspinal muscles are an indirect indicator of spinal cord blood flow—a phenomenon not yet clearly accepted. Moreover, the position of NIRS optodes is a debated question. Some prefer to place optodes directly above the vertebrae,⁹ and others position the optodes above the paravertebral muscles,

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called “indirect paraspinal collateral network monitoring.”¹⁰ Regardless of the positioning of the optodes, available animal studies^{11,12} have shown promising correlations between NIRS data on regional oxygenation and spinal cord perfusion. Further clinical trials are deemed necessary to investigate if NIRS detected spinal oxygen saturation is an accurate modality for spinal cord blood flow.

In most studies, including the current one, the perfusion pressure with ACP is maintained at (or below) 50 mm Hg to prevent any cerebral edema. However, one wonders whether a slightly higher ACP perfusion pressure and flow (closer to 60 mm Hg) or a lower degree of hypothermia (<22°C) would have any impact on the NIRS-detected oxygen saturation of the spinal cord. Until we obtain an accurate modality to monitor spinal cord perfusion in real time (both intraoperatively and postoperatively), extra caution should be taken in total transverse aortic arch replacement when warmer temperatures during hypothermic circulatory arrest are used for long intervals.

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Commentary: No cord left behind

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Until recently, protection from end-organ injury during aortic arch surgery has focused on the brain. The primary means for organ protection was hypothermia, and because the organ most susceptible to ischemia is the brain, there

John Bozinovski, MD, MSc (left), and Asvin M. Ganapathi, MD (right)

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The move to warmer temperatures during aortic arch surgery should not abandon consideration of the risk to the spinal cord.

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