Competing perfusion strategies: Effect on microvascular oxygen tension

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Increasing knowledge and experience in the surgical treatment of congenital heart disease has translated into improvements in operative mortality. However, to obtain these results we subject very young patients to physiologic extremes (ie, profound hypothermia, low flow, and deep hypothermic circulatory arrest [DHCA]) unheard of elsewhere in medicine. As a consequence, more attention is now being directed at the long-term cognitive and neuropsychiatric outcomes of these children. Perfusion management and organ protection is an important factor that undoubtedly contributes to long-term outcomes. The article by DeCampi and associates¹ examines the impact of low-flow perfusion (20 and 40 mL/[kg · min]) on the brain (as well as muscle, liver, small bowel) and compares it with DHCA.

The authors measure the microvascular Po_2 ($<20 \mu\text{m}$) in the brain using a technique of oxygen-dependent quenching of phosphorescence. This technique calculates the oxygen concentration as a function of a phosphorescent probe. When excited by light energy, this probe can either release this energy as light (phosphorescence) or transfer the adsorbed energy to oxygen. This principle has been used in a variety of other models with in vitro and in vivo validation.

Their data show significantly higher cortical Po_2 in the brain of animals receiving regional perfusion as compared with those undergoing DHCA. During the rewarming period, both perfusion groups demonstrated higher cortical Po_2 than did the DHCA group. Although I believe this is a significant result, the strength of this article is in the examination of what is occurring in the brain after cardiopulmonary bypass (CPB). During the recovery period, cortical Po_2 in the DHCA group remained below baseline values. Notably, animals perfused with 40 mL/(kg · min) showed a significant deterioration in cortical Po_2 during recovery, with significant hemodynamic instability. In fact, the only group in which recovery Po_2 approximated baseline was in animals perfused with 20 mL/(kg · min).

These data suggest that the conditions under which we support the circulation during cardiac surgery may have important but not obvious implications. The effects of hypothermic CPB on the brain may extend outside the operating room, when even minor hemodynamic fluctuations may risk secondary injury to the recovering brain. In this scenario, meticulous hemodynamic management and temperature control in the early postoperative period assume new importance.

The best method to protect the brain during hypothermic CPB still remains unknown. Heretofore the status of the brain *after* CPB has received little attention. This information would suggest that, in the evaluation of competing strategies, the status of the brain during the recovery period should also receive attention.

References

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