Cerebrovascular Autoregulation in Moyamoya Disease

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Abstract

Introduction: Blood pressure limits that support cerebrovascular autoregulation are unknown in pediatric Moyamoya Disease. The aim of this study was to determine if autoregulation indices derived from cerebral near-infrared spectroscopy (NIRS) could identify these blood pressure ranges.

Methods: Pediatric patients with Moyamoya having surgical revascularization had autoregulation measured perioperatively with the NIRS-derived cerebral oximetry (COx) and hemoglobin volume index (HVx), which measures cerebral blood volume (CBV; measured by relative tissue perfusion) and the 5-mmHg ranges of optimal mean arterial blood pressure (MAP) with best autoregulation and the lower limit of autoregulation (LLA) were identified.

Results: Of 7 enrolled patients, the indices identified optimal MAP in 67 patients intraoperatively (86%) and 68% patients postoperatively (100%). An intraoperative LLA was identified on at least one side by COx in 3/7 (43%) patients and by HVx in 2/7 (29%) patients. Patients with unilateral disease exhibited a trend toward higher intraoperative HVx (p=0.012) and COx (p=0.172) on the side with vasculopathy.

Conclusions: The NIRS-derived indices may assist clinicians in identifying and targeting blood pressures that support autoregulation.

Introduction

• Moyamoya involves steno-occlusive changes in the internal carotid arteries and main branches. 1
• Patients with Moyamoya have an increased risk of perioperative ischemia from cerebral blood flow dysregulation. 2 The blood pressure limits of autoregulation in pediatric Moyamoya are unknown.
• Continuous autoregulation monitoring could enable clinicians to target a blood pressure range that maximizes autoregulatory function.

Autoregulation indices derived from NIRS, the cerebral oximetry index (COx) and hemoglobin volume index (HVx), can identify the optimal mean arterial pressure range (MAP) with the most robust autoregulation and the lower limit of autoregulation (LLA).

• COx represents the relationship between cerebral autoregulation and MAP. 3
• When autoregulation is impaired, there is a positive correlation between cerebral autoregulation and blood pressure, yielding a positive COx. When autoregulation is functional, cerebral autoregulation and blood pressure are negatively correlated, yielding a negative COx. (Figure 1)

• HVx represents the relationship between cerebral blood volume (CBV; measured by relative tissue hemoglobin content by NIRS) and MAP. 4
• When vascular reactivity is impaired, there is a positive correlation between CBV and MAP, yielding a positive HVx. When vascular reactivity is functional, CBV and MAP are negatively correlated, yielding a negative or near-zero HVx. (Figure 1)

Objective

To determine the feasibility using the NIRS-derived indices to identify MAP, optimal MAP (MAP OPT), and LLA.

Methods

• Pilot study of pediatric patients undergoing indirect surgical revascularization for Moyamoya at JHU.
• Intraoperative LLA was identified on at least one side by COx and in 6/7 (86%) patients by HVx.
• Postoperative LLA was identified on at least one side in 6/8 (100%) patients by both COx and HVx.

Results

• Of 4 patients with unilateral disease, the indices identified optimal MAP in 6/6 (100%) patients by both COx and HVx, and in 5/6 (86%) patients by COx alone (p=0.012) and HVx (p=0.172) on the side with vasculopathy. (Figure 3)

• Intraoperative LLA was identified on at least one side by COx (86%) and HVx (100%) and in 2/7 (29%) patients by HVx.
• Intraoperative LLA was identified on at least one side by COx in 3/7 (43%) patients and by HVx in 2/7 (29%) patients. Patients with unilateral disease exhibited a trend toward higher intraoperative HVx (p=0.012) and COx (p=0.172) on the side with vasculopathy. (Figure 3)

Conclusions

• NIRS-derived autoregulation indices may guide clinicians in identifying and targeting blood pressures that support autoregulation.

References

1. RM Scott, et al. NEJM 2008
5. JK Lee, et al. OCM 2011