Cerebral Autoregulation with Optical Monitoring during Cardiopulmonary Bypass

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Mean arterial pressure (MAP) targets are used to maintain adequate cerebral blood flow (CBF) in patients undergoing cardiac surgery with cardiopulmonary bypass (CPB). However, set targets do not account for cerebral autoregulation (CA) variability between patients[1]. Prolonged periods of CPB flow rate changes leading to decreases in CBF, can impede cerebral metabolism and can cause tissue damage[2,3]. Maintenance of CBF and perfusion with knowledge of limit of CA of individual patient is crucial to prevent severe neurological complications associated with CPB. Previous studies proposed using changes of cerebral tissue saturation (S_tO_2) against MAP to calculate cerebral oximetry autoregulation index (COx); however, S_tO_2 is still not a direct marker of cerebral blood flow. In this study, a novel hybrid diffuse correlation spectroscopy (DCS)/hyperspectral near-infrared spectroscopy (hsNIRS) system was used to continuously monitor CBF and S_tO_2 during cardiac surgery[3]. In addition to COx, the correlation index between MAP and CBF (CBFx) was also calculated to characterize autoregulation. The purpose of this study was to assess the feasibility of real-time intraoperative CA monitoring with optical techniques and to compare the autoregulation indices in adults undergoing cardiac surgery with CPB.

Sixteen adult patients undergoing elective cardiothoracic surgery with CPB were monitored. during surgery. COx, and CBFx were calculated for 3 different periods: going on CPB, during CPB, and off CPB. Good agreement was observed between COx, and CBFx,(kappa=0.44, $p<0.001$). Intact CA in both COx and CBFx, defined as values ≤ 0.4, was present in 13 patients before going on CPB, 12 patients during CPB, and 13 patients off CPB. Impaired CA was present in 2 patients. These results demonstrated the ability of the hybrid system to provide continuous monitoring of brain health. Future work will investigate the relationship between impaired CA and cerebral metabolism, with the aim of reducing the incidence of neurological complications associated with CPB.

Reference

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[3] Rajaram et al. Biomed Optics Express 2020;11:5967