Impact of postoperative hemodynamics on cerebral blood flow, microcirculation and oxygen metabolism in neonates and infants after repair or neonatal palliation of complex congenital heart disease

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Objectives. Cerebral protection is a major issue in the perioperative treatment of infants with complex congenital heart defects (CHD) or functional univentricular heart (UVH). Combined laser-Doppler spectroscopy and photo-spectrometry allows transcranial monitoring of regional cerebral oxygen saturation (cSO2) and relative cerebral blood flow (rcFlow). The aim of this study was to analyse differences in cerebral blood flow (CBF), cerebral microcirculation (rcFlow) and cerebral oxygen metabolism (CMRO2) after biventricular repair or palliative surgery.

Methods. In 43 neonates and infants after repair of biventricular CHD (n=30) or neonatal palliation of UVH (n=13) cSO2, rcHb and rcFlow were measured 24-36 hours after surgery. CBF was assessed by duplex sonography. The amount of diastolic run-off (DRO) was calculated by a quotient of systolic and diastolic blood pressure. Cerebral fractional tissue oxygen extraction (cFTOE) was determined. CMRO2 was calculated from CBF and approximated CMRO2 (aCMRO2) was calculated from rcFlow. Results. cSO2 (54.64% (35.67-64.02) vs 59.72% (44.47-81.70); p=0.000325), CBF (20.55ml/100g/min (9.70-38.60) vs 29.40ml/100g/min (9.10-54.00); p=0.002) and SaO2 (81.70% (71.70-91.70) vs 98.00% (91.40-99.50); p=0.000000) were significantly lower after neonatal palliation of UVH compared to biventricular repair of complex CHD, whereas Hb (14.95g/dl (10.50-17.00) vs 12.10g/dl (9.00-17.30); p=0.000001) was significantly higher in patients after neonatal palliation. rcFlow (69.72AU (42.49-165.25) vs 76.96AU (41.23-168.12); p=0.064339), cFTOE (0.34 (0.24-0.82) vs 0.38 (0.17-0.55); p=0.627186) showed no significant difference. aCMRO2 was significantly lower in patients after neonatal palliation compared to biventricular repair (3.96AU (2.07-6.31) vs 4.93AU (2.15-15.62); p=0.017792). CMRO2 showed a trend towards lower values after neonatal palliation (1.59ml/100g/min (0.64-3.05) vs 1.79ml/100g/min (0.24-3.17); p=0.214227). There was a significant negative correlation between cSO2 and CBF and DRO (p=0.000702; p=0.044526).

Conclusions. Cerebral oxygen saturation, CBF and a CMRO2 are significantly lower in patients with UVH after neonatal palliation as compared to children following biventricular repair. These findings provide an explanation for the increased cerebral vulnerability to minor changes in the hemodynamics in infants with UVH.