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Noninvasive measurement of cerebral hemodynamics and oxygen metabolism in neonates and infants with congenital heart defects

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Objectives. As a result of abnormal hemodynamics and/or reduced arterial oxygen saturation (SaO2) infants with complex congenital heart defects carry an increased risk of cerebral injury due to hypoxia and ischemia. Therefore protection of cerebral perfusion in the neonatal period, during and following surgical procedures is a major issue in the treatment of these children. A novel device O2C (Oxygen to see, LEA Medizintechnik) based on combined laser-Doppler flowmetry and photo-spectrometry allows for noninvasive transcranial monitoring of the regional cerebral oxygen saturation (rcSO2), relative amount of hemoglobin (rcHb) and relative capillary venous blood flow (rCBF). The aim of this study was to analyse whether online measurements of cerebral oxygen consumption are feasable and whether there are significant differences in cerebral oxygen supply in different subgroups of infants with complex congenital heart disease.
Methods. In 50 infants with acyanotic, biventricular cyanotic and univentricular congenital heart defects, SaO2, Hb, rcSO2, rcHb and rCBF were measured preoperatively. Cerebral fractional tissue oxygen extraction (cFTOE), arterio-cerebral difference in oxygen content (acDO2) and approximated cerebral metabolic rate of oxygen (aCMRO2) were determined.
Results. Infants with cyanotic or acyanotic congenital heart defects did not differ in rcSO2. In infants with biventricular acyanotic heart defects cFTOE was significantly higher than in infants with biventricular cyanotic and univentricular heart disease ($p<0.05$). In infants with univentricular circulation rCBF was significantly lower as compared to patients with biventricular hearts ($p<0.05$), while aCMRO2 was equal in all groups.
Conclusions. Under resting conditions regional oxygen saturation did not differ between acyanotic biventricular, cyanotic biventricular and univentricular congenital heart defects. Although cFTOE was increased among patients with biventricular acyanotic defects, higher levels of hemoglobin in infants with univentricular hearts and cyanotic biventricular heart defects resulted in aCMRO2, that did not differ significantly among the 3 groups. Nevertheless infants with univentricular circulation had the lowest rCBF and highest acDO2. According to these findings neonates with functionally univentricular hearts would be more vulnerable to minor changes in their hemodynamics. These findings provide an explanation for their increased cerebral vulnerability. According to our experience O2C offers interesting additional informations concerning cerebral perfusion as compared to NIRS.