Near-Infrared Spectroscopy to Monitor Cerebral Oxygen Saturation in Single-Ventricle Physiology

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This study examined the relationship between cerebral oxygen saturation (rSO2) measured by near-infrared spectroscopy and arterial oxygen saturation (SaO2), jugular venous oxygen saturation (jvSO2), arterial oxygen content (CaO2), cerebral oxygen delivery, and cerebral blood flow (CBF) in a newborn piglet model of single ventricle physiology (SVP).

SVP was created by means of an aortopulmonary shunt, atrial septostomy, tricuspid valve avulsion, and main pulmonary artery occlusion. Measurements were performed at baseline and after conversion to SVP (30 minutes, 120 minutes, and during afterload augmentation by inflation of a balloon in the descending thoracic aorta).

Creation of SVP resulted in lower rSO2, jvSO2, CaO2, and cerebral oxygen delivery. Afterload augmentation increased rSO2, jvSO2, and CaO2, but cerebral oxygen delivery was unaffected because of a lower CBF. Linear relations were observed between rSO2 and jvSO2, SaO2 and CaO2, but no association was found with cerebral oxygen delivery, which decreased in parallel with rSO2 when the SVP model was established but failed to increase during afterload augmentation. The authors concluded that in SVP changes in rSO2 need to be interpreted in the context of changes in arterial oxygenation.

Comment: Changes in rSO2 should always be interpreted in the context of changes in arterial oxygenation. With biventricular physiology and unchanging pulmonary function, SaO2 and CaO2 are likely to be stable, so that if cerebral oxygen consumption remains constant, changes in cerebral venous oxygen saturation and therefore rSO2 can be assumed to reflect changes in CBF and cerebral oxygen delivery. However, with SVP, changes in SaO2 can occur rapidly because of varying pulmonary and systemic vascular resistance. As demonstrated by an increased pulmonary-to-systemic blood flow ratio associated with the increased systemic vascular resistance caused by balloon inflation, cerebral perfusion decreased although the SaO2 and rSO2 increased. In other words, an increase in rSO2 in the setting of SVP is not always associated with an increase in cerebral oxygen delivery. A practical application in which the situation from this study could be observed is lowering the pulmonary vascular resistance and increasing pulmonary blood flow by ventilation with 100 % O2 in a patient with a parallel circulation.