NON-INVASIVE OPTICAL MEASURMENT OF CEREBRAL CRITICAL CLOSING PRESSURE IN PEDIATRIC HYDROCEPHALUS

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Hydrocephalus is a common disorder of cerebral spinal fluid (CSF) physiology that results in elevated intracranial pressure (ICP) and progressive expansion of cerebral ventricles.[1] It affects 1-2 of every 1000 live births, making it the most common disease treated by pediatric neurosurgeons in the US.[1] In roughly half of infants with hydrocephalus, ventricular expansion requires surgical intervention whereby a shunt is placed in the ventricles to divert CSF and relieve elevated ICP. Although timely treatment of elevated ICP is important for brain tissue viability, its implementation is hindered by the lack of tools for non-invasive ICP measurement. This study aims to validate non-invasive intracranial pressure (ICP) assessment with the near-infrared diffuse correlation spectroscopy (DCS) technique in infants with hydrocephalus.

DCS employs near-infrared light to measure local, microvascular cerebral blood flow (CBF) continuously at the bedside. In addition to CBF, a novel approach for measurement of cerebral critical closing pressure (CrCP) based on DCS measurements of pulsatile CBF in arterioles was recently demonstrated.[2-4] CrCP, which depends on ICP, defines the arterial blood pressure at which CBF approaches zero. Intraoperative non-invasive CrCP measurements with DCS on the prefrontal cortex were performed concurrently with invasive ICP measurements in 9 infants with hydrocephalus at the Children's Hospital of Philadelphia. Invasive ICP was measured during surgical shunt placement.

A significant correlation (R^2=0.6) between non-invasive CrCP and invasive ICP measures was observed (Figure 1). CrCP overestimated ICP at lower ICP levels, but was close to ICP at higher ICP levels.

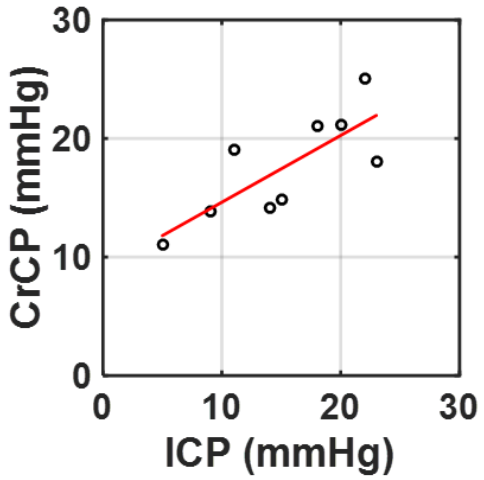

Figure 1 – CrCP measured by DCS (vertical axis) plotted against invasively measured ICP (horizontal axis) in 9 infant hydrocephalus patients. Solid red line is the linear best-fit (R^2=0.6, slope (95CI) = 0.6 (0.2, 1.0)).

This pilot data shows the potential of using DCS measurement of CrCP for non-invasive detection of elevated ICP in children. DCS probes are further well-suited for continuous, long-term monitoring. We hypothesize that CrCP overestimation of ICP at lower levels is because of CrCP's sensitivity to vasomotor tone. Enrollment of more patients is underway.

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