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Room C301

Using the CAS Cerebral Oximeter To Estimate Cerebral Venous Oxygen Saturation

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Introduction: Near-infrared spectroscopy (NIRS) is a non-invasive, optically-based technique to monitor brain oxygenation continuously by determining the cerebral tissue oxygen saturation (S_tO_2). When used in combination with the finger pulse oximetry (S_pO_2), the S_tO_2 may be used to estimate the cerebral venous oxygen saturation (S_vO_2). The validity of this relation was measured by determining the correlation between the derived S_vO_2 and the known oxygen saturation of a venous blood sample taken from a jugular bulb catheter ($S_{jb}O_2$).

Methods: After obtaining written informed consent, 12 healthy adult ASA 1 subjects (6 males, 6 females) were enrolled in this volunteer study. A right internal jugular bulb catheter and a left radial arterial line were inserted. Two prototype NIRS sensors (CAS Medical Systems, Branford, CT, USA) were placed on the right and left sides of the forehead. A Sequential Gas Delivery system was used to deliver hypoxic gas mixtures in stepwise decrements ascending and descending from 21% to a minimum of 8% inspired oxygen whilst maintaining normocarbica (end-tidal CO_2 tension of 40 mmHg). Upon completion of the ascent to 21% the inspired concentration was increased to 100%. The protocol was stopped if the finger pulse oximeter (S_pO_2) value reached < 70%. Each step was maintained for 5 minutes. Blood samples were drawn simultaneously from the jugular bulb ($S_{jb}O_2$) and radial arterial (S_aO_2) catheters and analyzed for oxygen tension using a co-oximeter (IL-682). NIRS S_vO_2 was calculated from the following equation: $NIRS\ S_vO_2 = (S_tO_2 - 0.3 \times S_pO_2) / 0.7$ (ref 1). The correlation between the derived S_vO_2 from right & left forehead NIRS and the $S_{jb}O_2$ was measured using linear regression.

Results: All 12 subjects completed the study protocol with no adverse events. A total of 171 samples were analyzed. The results of the analysis are shown in figure 1. [figure1]NIRS S_vO_2 showed a strong correlation with the reference $S_{jb}O_2$ over the spectrum of S_pO_2 values between 70 and 100%. Normative NIRS S_vO_2 values recorded from subjects breathing room air averaged 63.3% (range: 54.7 - 70.6).

Conclusion: This study supports the feasibility of non-invasive NIRS S_vO_2 as an estimate of cerebral tissue oxygenation during episodes of oxygen desaturation. There was a strong correlation with the global indices of tissue oxygen supply and demand, arterial and jugular bulb oxygen saturations respectively. Small differences between the reference $S_{jb}O_2$ and NIRS S_vO_2 may reflect inter-individual variability and/or differences in the regional blood flow of the cerebral tissue. Determination of S_vO_2 is based on the assumption that the ratio of venous to arterial blood volume in cerebral tissue is fixed. Disruption of cerebral hemodynamics from diseased states or clinical interventions may cause inaccuracies in calculating S_vO_2 by NIRS due to variable cerebral tissue venous to arterial blood volume ratios.

References:

1. Benni PB, et al. Validation of the CAS neonatal NIRS system by monitoring VV-ECMO patients: Preliminary Results. Adv Exp Med Biol. 2005;566: in press.

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Figure 1

