Comparison of Near-Infrared Spectroscopy-Derived Cerebral and Somatic Oxygenation Indices During Pediatric Scoliosis Surgery

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Background: Posterior spinal instrumentation and fusion (PSIF) for scoliosis surgery is a long surgical procedure, commonly performed in pediatrics. As such, patients are exposed to significant physiologic insult, including significant blood loss,[1] and thus inadequate end-organ perfusion. Near-infrared spectroscopy (NIRS) is a non-invasive technique to continuously quantify tissue oxygenation and may allow anesthesiologists to better understand individual patient physiology. However, NIRS monitoring has not been established as a measure of systemic tissue perfusion in many elective surgical procedures and the relationship between NIRS-derived regional cerebral oxygenation (ScO_2) and tissue oxygen saturation (StO_2) is currently unclear.

Objective: To evaluate the association and agreement between ScO2 and StO_2 during scoliosis correction surgery.

Methods: A prospective observational pilot study of children undergoing single-stage PSIF was undertaken. After induction of general anesthesia, Fore-Sight Elite (Edwards Lifesciences, USA) NIRS sensors were applied to the forehead and forearm to measure ScO_2 and StO_2, respectively. Anesthetic management was left to the discretion of the attending anesthesiologist, who was blinded to the NIRS recordings for both sensors. We conducted repeated measures correlations to assess the within-subject associations across sensors (i.e. separate parallel regression lines are fit to each participant's data using the same slope but with varying intercepts)[2]. To quantify the mean bias and level of agreement between the two NIRS sensors, repeated measures Bland Altman analysis was implemented[3].

Results: Data from 48 children (39 female), with a median [IQR] age of 16.3 [14.8-18.0] years, and a BMI of 20.5 [18.6-23.2] kg/m^2, were available for analysis. All 48 children underwent successful dual-sensor placement; sensors recorded similar levels of NIRS-derived oxygen saturation throughout the period of recording with a median [IQR] ScO_2 of 79.1 [74.6-84.8] and StO_2 of 79.3 [75.6-82.4]. The repeated measures correlation between the cerebral and somatic sensors (Figure 1A) indicated a significant positive association ($r = 0.42$, 95% CI 0.39-0.45, $p < 0.001$). Bland Altman analysis indicated that the mean difference (i.e., bias) between the sensors was 0.77, which indicates that the somatic sensor on average records 0.77% lower than the cerebral sensor. However, the lower and upper limits of agreement (-17.1% and 18.6%, respectively) were wide, indicating that the 2 sensors display low agreement (Figure 1B).

Conclusions: Although ScO_2 and StO_2 signals were positively correlated, Bland Altman analysis indicated that ScO_2 and StO_2 had wide and unacceptable limits of agreement. These results indicate that further research is needed in a larger cohort to validate our current findings and to characterize the physiologic determinants of the two NIRS signals. As regional tissue perfusion might be an earlier indicator of perfusion deficits, further elucidation of these signals may provide anesthesiologists with physiologic information to help guide therapy during scoliosis correction surgery.

REFERENCES: [1] *Anaesth Crit Care Pain Med*. 2018; *37*(2):141-146. [2] *Front Psychol*. 2017;8:456. [3] *J Biopharm Stat*. 2007;17(4):571-82

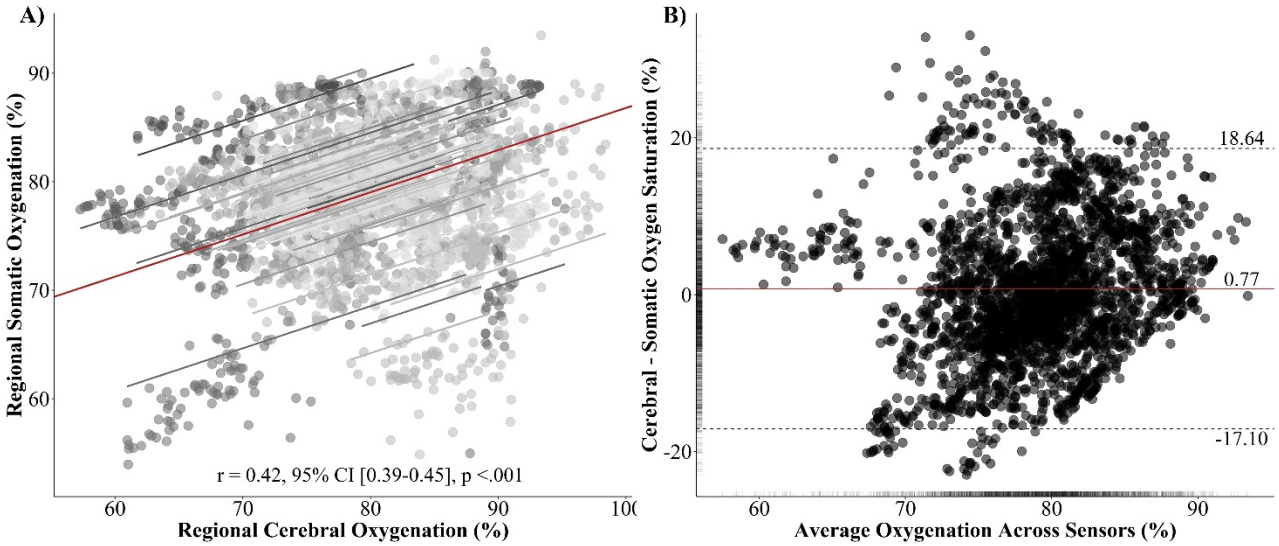

Figure 1: A) Scatterplot indicating the association between near-infrared spectroscopy derived regional cerebral and somatic oxygenation. The corresponding repeated measures correlation coefficient and 95% confidence intervals are mapped onto a gray scale indicating different patients and their individual line of fit. The red line indicates the linear model fit to the entire sample. **B)** Bland Altman plot indicating that the pooled data across the cerebral and somatic sensors display a wide range of agreement. The dotted black lines indicate the 95% limits of agreement (i.e., the two sensors mean minus 1.96 SD and plus 1.96 SD). The red line represents the mean (i.e., bias) of recordings across sensors. Black dots represent repeated recordings of regional cerebral and somatic oxygenation across 48 participants.