The Effect of Caudal Anesthesia on Spinal Cord Tissue Oxygenation as Assessed by Tissue Oximetry

Neethu Chandran MD1, Richard J. Levy MD2, Alvin Kim MS1, Barbara Braffett PhD1, and Nina Deutsch MD1

1Division of Anesthesiology, Sedation and Perioperative Medicine, Children’s National Health System
George Washington University, Washington DC; 2Department of Anesthesiology, Columbia University Medical Center, New York, NY

Introduction

Local anesthetics have the properties to disrupt the balance of tissue oxygen supply and demand by their potential direct and indirect effects on blood flow and tissue mitochondrial function. Bupivacaine is commonly used for caudal anesthesia and is known to have a dose-dependent biphasic vascular effect, with subclinical doses causing net vasoconstriction and higher doses causing net vasodilation.

The aim of this study was to investigate the effect of bupivacaine on spinal tissue oxygenation in vivo in children. Determining the effects on spinal tissue oxygenation may help guide anesthetic decision making for patients that may have compromised perfusion to the spinal cord. We hypothesized that bupivacaine would increase oxygenation due to vasodilation and inhibition of mitochondrial oxidative phosphorylation.

Near Infrared Spectroscopy (NIRS) was used to measure regional tissue oxygenation by recording the scattering properties of different wavelengths in tissue. The probe is a non-invasive sticker that can be placed on the surface of the skin to take measurements.

Methods

This was a prospective observational study involving 20 ASA Status I and II male patients between 5 months and 3 yrs undergoing urologic surgical procedures under general anesthesia with a caudal block as part of their routine care. The patients were compared with 20 observed controls that did not receive caudal block, ages between 1 month and 2 yrs, both male and female patients. Spinal cord tissue oxygenation was measured using NIRS monitor probes that were placed on the lumbar region to measure spinal regional saturation ($\text{rSO}_2$) as well as on the forehead to measure cerebral regional saturation. Measurements were taken at baseline before the procedure and every 5 minutes after induction for 30 minutes. Differences between groups were compared using the t-test.

Results

Figure 1: Mean cerebral tissue oxygenation with caudal anesthesia vs control

Oxygenation in both the caudal and control groups decreased over 30 min. Cerebral oxygenation decreased in the caudal group (-9.7%) and the control group (-4.3%). The difference between groups was statistically significant, p=0.018. Data are means ± SD.

Figure 2: Mean spinal tissue oxygenation with caudal anesthesia vs control

Oxygenation in both the caudal and control groups decreased over 30 min. Spinal oxygenation decreased in the caudal group (-6.4%) and the control group (-2.8%), however the difference was not statistically significant, p=0.10. Data are means ± SD.

Conclusions

Bupivacaine, injected caudally, decreased spinal tissue oxygenation, however did not reach statistical significance. The etiology of this effect is unclear and requires further study. Changes in $\text{rSO}_2$ also provide an opportunity to develop NIRS as a non-invasive tool to identify successful caudal anesthesia as a diagnostic confirmatory finding.

References