

Optic nerve ultrasound and cardiopulmonary bypass: a pilot study

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Introduction

- ❑ Cardiopulmonary bypass (CPB) may alter intracranial pressure (ICP) and the blood-brain barrier (BBB).
- ❑ Ultrasound has been used to measure optic nerve sheath diameter (ONSD) as a surrogate measure of ICP.¹
- ❑ We evaluated the effects of CPB on the central nervous system by measuring ONSD in patients with and without single ventricle (Fontan) physiology.

Methods

- ❑ Patients less than 18 years of age presenting for surgery for congenital heart disease necessitating the use of CPB were enrolled.
- ❑ Bilateral ONSD was measured 3 mm posterior to the papilla. We defined elevated ONSD as greater than 4.0 mm at age <1 year and greater than 4.5 mm at age 1-18 years.
- ❑ The ONSD was recorded at three time points: time 1 immediately after the induction of anesthesia and endotracheal intubation; time 2 after separation from CPB; and time 3 following completion of surgical procedure, after wound closure, and prior to leaving the OR.
- ❑ Fontan and non-Fontan patients were compared using Wilcoxon rank sum test and Fisher's exact test. A chi-squared analysis compared the number of ONSD values that were above the normal value for age in Fontan and non-Fontan patients.

Table 1. Optic Nerve sheath diameter (in mm)

| Time | All (n=14) | Fontan (n = 5) | Non-Fontan (n = 9) | P value |
|--|----------------|----------------|--------------------|---------|
| Post induction of anesthesia (Time 1) | 3.7 (3.0, 4.6) | 4.0 (3.0, 4.6) | 3.6 (3.1, 3.9) | 0.169 |
| Following CPB (Time 2) | 3.7 (3.1, 5.1) | 4.2 (3.5, 5.1) | 3.5 (3.1, 3.9) | 0.048 |
| Following tracheal extubation in the OR (Time 3) | 3.8 (3.0, 5.3) | 4.2 (3.2, 5.3) | 3.7 (3.0, 4.3) | 0.202 |

Results

- ❑ The study cohort included 14 pediatric patients, consisting of 5 Fontan and 9 non-Fontan patients undergoing surgery.
- ❑ **ONSD was greater at all 3 times points in Fontan patients** (Table 1). The change in the ONSD from time 1 to time 2 was greater (+0.2 mm versus -0.1 mm) and the value at time 2 was significantly higher (4.2 versus 3.5 mm, p=0.048) in Fontan patients.
- ❑ During the study period, 4 of 15 ONSD values were elevated for the single ventricle patients while only 1 of 27 ONSD were elevated in non-Fontan patients (p=0.015).

Discussion

- ❑ Chronic venous congestion (CVC) which may be present in patients with single ventricle physiology prior to Fontan surgery may result in higher ONSD values than patients with two ventricle physiology even in the absence of increased ICP.
- ❑ This raises the question of whether or not the normative values for two ventricle patients can be applied to single ventricle (Fontan) patients.
- ❑ Alternatively, as the ONSD values were higher following CPB in single ventricle patients, it may also be that patients with CVC are at a greater risk of experiencing sub-clinical elevations of ICP following CPB given its impact on CNS dynamics and the BBB.

Conclusions

- ❑ Single ventricle patients may be exposed to chronic elevations in central venous pressure with CVC resulting in altered CNS dynamics at baseline and following CPB that impacts ONSD values.
- ❑ Although values were slightly elevated in single ventricle (Fontan) patients, none of the patients had clinical signs suggestive of increased ICP.

References:

1. Dubourg J et al. Ultrasonography of optic nerve sheath diameter for detection of raised intracranial pressure: a systematic review and meta-analysis. *Intensive Care Med.* 2011;37:1059-68.