Cerebrovascular Autoregulation is Altered During Pediatric cfVAD Support

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BACKGROUND

- Cerebrovascular autoregulation maintains relatively constant cerebral blood flow (CBF) over a range of blood pressures, and it prevents cerebral ischemia/hyperemia from pressure-passive CBF
- Impaired cerebrovascular autoregulation is associated with mortality *in adults* with traumatic brain injury and with peri-operative stroke *in adults* during cardiopulmonary bypass
- Maintaining blood pressure within a range that optimizes CBF autoregulation is associated with improved outcomes *in adults* at risk of cerebral ischemia
- Children on continuous-flow ventricular assist device (cf-VAD) support are at risk for neurological complications
- The cerebrovascular impact of long-term cfVAD support in children is unknown

SPECIFIC AIMS

1) To determine if persistently attenuated pulse pressure with cfVAD negatively influences the preservation of cerebrovascular autoregulation
2) To measure the change in optimal mean arterial pressure (MAPopt) for cerebrovascular autoregulation after long-term cfVAD support

METHODS

- Cerebrovascular autoregulation can be measured using the Hemoglobin Volume Index (HVx), which represents the relationship between relative tissue hemoglobin (a surrogate for cerebral blood volume; CBV) and mean arterial pressure (MAP)
- HVx: cerebral near-infrared spectroscopy (NIRS)-derived index (-1 to 1)
- When cerebrovascular autoregulation is functional, HVx is negative or near zero because MAP and CBV are either not correlated or negatively correlated **(Figure 1A)**[1]
- MAP_{OPT} is derived from the nadir of the curve fit of HVx across a range of blood pressures **(Figure 1B)**[2]
- MAP and cortical hemoglobin density (derived from cerebral NIRS) were synchronously recorded during cfVAD implant and/or explant to determine HVx and MAP_{OPT} values
- cfVAD implant and explant HVx and MAP_{OPT} values were then compared to each other

Figure 1A: Calculation of HVx

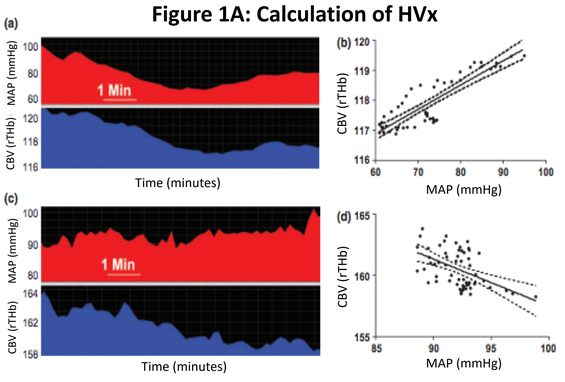
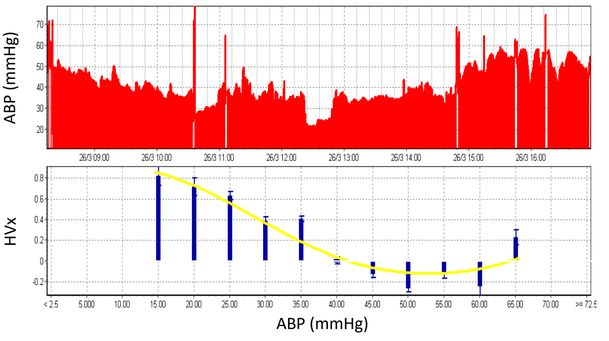


Figure 1B: Calculation of MAP_{OPT}



RESULTS

- Sufficient data to determine HVx and MAPopt were available in 13 cfVAD implants and 6 cfVAD explants (median support duration of 268 days; IQR 73-385)
- Cerebrovascular autoregulation was intact in all subject recordings (both at implant and explant; **Table 1**)
- MAPopt was significantly higher at implant vs explant **(Figure 2A)**
- This phenomenon was confirmed for 3 patients with MAPopt assessment at both implant and explant; individually paired implant-explant data showed a consistent decline in MAPopt following long-term cfVAD support **(Figure 2B)**

Table 1: cfVAD Implant vs Explant

	IMPLANT (n = 13)	EXPLANT (n=6)	p - value
Age (years; median/IQR)	12.1 (8.9 – 15.9)	10.1 (8.3 – 17.5)	0.90
Height (cm; median/IQR)	152.5 (127.0 – 168.5)	123.0 (121 – 170.75)	0.42
Weight (kg; median/IQR)	45.7 (28.2 – 70.9)	24.5 (23.2 – 66.1)	0.60
DCM (n, %)	8 (62%)	3 (50%)	1.0
HVx at MAPopt (median, IQR)	-0.05 (-0.18 – 0.02)	-0.06 (-0.18 – 0.19)	1.0

Figure 2A: Implant vs Explant MAP_{opt} in cfVAD

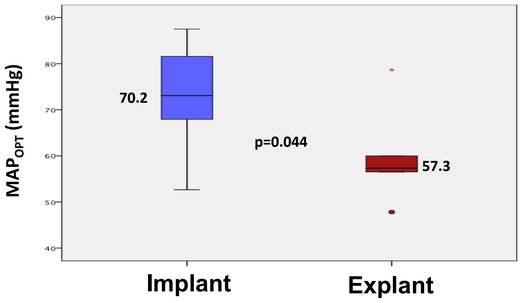
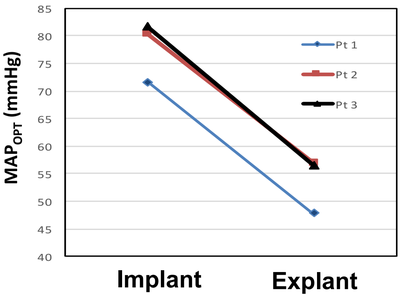


Figure 2B: Paired Implant-Explant MAP_{opt} in cfVAD



CONCLUSIONS

- Long-term, non-pulsatile circulation with cfVAD support does not appear to impair the ability to autoregulate CBF
- CBF autoregulation is optimized at a higher MAP in children with heart failure (implant) than children supported with cfVAD (explant)
- This emphasizes the importance of individualized blood pressure management strategies to optimize brain perfusion in patients supported with long-term cfVAD

We will not discuss off label use and/or investigational use of any drugs/devices. *No Disclosures*

1. *From Lee JK, et al. Cerebrovascular autoregulation in pediatric moyamoya disease. Paediatr Anaesth. 2013;23:547-56.* 2. Courtesy of Dr. K. Brady