PERFUSSION METHODS AND MODIFICATIONS TO THE CARDIOPULMONARY BYPASS CIRCUIT FOR MIDLIME UNIFOCALIZATION PROCEDURES

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The authors have no disclosures

Introduction (I)

Pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries (PA/VSD/MAPCAs) is a relatively rare and complex form of congenital heart disease

This entity is characterized by all of the pulmonary blood flow originating from the aorta or other systemic arteries (MAPCAs), since there is pulmonary atresia and no ductus arteriosus

The anatomy of MAPCAs is a recapitulation of early embryologic pulmonary circulation in humans

Introduction (II)

The surgical repair of PA/VSD/MAPCAs requires harvesting of the MAPCAs from their systemic source

The MAPCAs are then brought together surgically (a process known as “unifocalization”) to create a centralized pulmonary arterial bed

The VSD can then be closed and the right ventricle connected to the unifocalized MAPCAs by a conduit to complete the repair
Purpose

These are complex and very lengthy procedures that require an entirely different method of perfusion.

The purpose of this study was to review our perfusion modifications to support these unifocalization procedures.
Surgical algorithm and results for repair of pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries

Methods (I)

64 unifocalizations have been performed at our institution during the past 3 years

The median age at surgery was 4.1 months (range 5 months to 3.5 years)

The median weight was 4.5 kg (range 3.5 to 19 kg)

Methods (II)

The median duration of cardiopulmonary bypass was 352 minutes (range 128 to 629 minutes)

The median duration of cross clamp was 24 minutes (range 14 to 72 minutes)

Methods (III)

Conduct of perfusion includes:

- Systemic cooling to 23°C
- pH Stat strategy
- Del Nido cardioplegia
Results (I)

Modifications to the cardiopulmonary bypass circuit include upsizing:
- Oxygenator
- Reservoir
- Cannulae
- Vent catheter
- Tubing

Conduct of Perfusion

- Systemic High Flow
  - 200 cc/kg for initiation/cooling
  - 100 cc/kg at 25 degrees

- High Hematocrit
  - 30-40 throughout CPB
  - 45-55 at termination

- Avoidance of Volatile Gas

Results (II)

All circuits are modified to include the capability of performing an intraoperative flow study.

This study is used to determine whether the VSD can be closed during surgery.
Flow Study

The intraoperative flow study gradually ramps up to a flow of 3 liters/min/meters² to the pulmonary arteries.

The pressure in the pulmonary artery is monitored, with an acceptable peak pressure of 25 mmHg.

Those who fail the flow study would not have the VSD closed but instead would have a shunt placed.

Results (III)

A collateral flow study circuit is set up for the first time operations in patients who are eligible for a single stage complete repair.

These circuits are designed to measure the residual collateral flow after all of the MAPCAs have been harvested.

Collection occurs during the time of cross clamp.
Residual Collateral Flow vs. Pre-op Saturation

Identify patients who have significant amount of residual collateral flow. This represents flow that is being diverted away from the systemic perfusion and may be important in patients undergoing 6-8 hours of cardiopulmonary bypass time.

Identify unrecognized MAPCAs, as this would reveal itself by high amounts of collateral flow.

Potential Implications of the Collateral Flow Study

Conclusions

Patients who require midline unifocalizations will invariably require very lengthy periods of support on cardiopulmonary bypass.

We have adapted our perfusion circuitry to prepare for the demands on the bypass circuit to meet the requirements of this patient population.

Our institution has developed a systematic approach for the conduct of perfusion to best serve our patients presenting with PA/VSD/MAPCAs.