Intraoperative Doppler echocardiography of pulmonary venous flow is useful in predicting reoperation in pulmonary artery banding

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Introduction

- Bilateral pulmonary artery banding (PAB) is used to treat congenital heart disease in some high-risk neonates.
- Until recently, the appropriate PAB size depended on pulmonary artery pressures, partial pressure of oxygen in the arterial blood (PaO₂), and stable hemodynamics. However, high reoperation rates exist due to insufficient or excessive restriction of pulmonary blood flow.
- Pulmonary venous Doppler flow is an effective quantitative evaluation of pulmonary blood flow.

We hypothesized that the pulmonary venous velocity time integral (PV-VTI) in transesophageal echocardiography (TEE) during bilateral PAB surgery can predict the need for reoperation.

Figure 1: Before and after the PV VTI in the TEE pulsed doppler study

Methods

Study population

- Patients with congenital heart diseases underwent bilateral PAB at our hospital from January 2011 to September 2016.

Study design

- We investigated PV-VTI before PAB (pre-VTI) and after PAB (post-VTI) from the intraoperative TEE record.
- PV VTI was defined as the total value obtained by measuring the blood flow of four pulmonary veins.
- De-PAB group : Reoperation due to excessive PBF restriction.
- Re-PAB group : Reoperation due to insufficient PBF restriction.
- Outcome was defined as reoperation within 3 months after the initial PAB surgery.
- We compared the two groups to a no-reoperation group.
- We retrospectively examined the association between the PV-VTI ratio (post VTI / pre VTI) and incidence of reoperation.

Statistical analysis

- Comparisons were made with the Student's t-test and $p < 0.05$ was considered significant.
- Data are expressed as mean $\pm$ SD.

Results

Figure 2 : Study inclusion/exclusion flow diagram

Table1 : Baseline characteristics and Intraoperative hemodynamic variables of patients

	No reoperations N = 11	Re-PAB N = 2	De-PAB N = 6
Characteristics			
Gender (Female/Male)	5/9	1/1	4/2
Age (days)	mean 5.8 range 2-12	4.5 2,7	5.3 2-8
Body Weight (kg)	mean 2.8 range 2.0-3.5	3.4 2.9,4.0	2.4 1.8-3.6
Diagnosis			
AVSD	1		
DORV	0		
SRV	1	1	2
CoA	1		
HLHS	3		2
MA	1	1	
IAA	3		1
Truncus	1		1
Hemodynamic variables			
SaO ₂ (post ope) (%)	84.8 $\pm$ 10.1	81.1 $\pm$ 4.4	77.3 $\pm$ 2.9
PaO ₂ (post ope) (mmHg)	43.9 $\pm$ 12.7	43.0 $\pm$ 4.0	35.3 $\pm$ 3.6
Mean BP post-pre (mmHg)	12.9 $\pm$ 7.8	8.1 $\pm$ 5.8	7.5 $\pm$ 7.8

Table2 : Bil. PAB PV VTI post/pre

PV VTI	No reoperation N = 11	Re-PAB N = 2	P	De-PAB N = 6	P
Pre VTI	64.7 $\pm$ 22.3	60.5 $\pm$ 23.9	0.80	70.0 $\pm$ 20.4	0.63
Post VTI	36.5 $\pm$ 10.7	46.1 $\pm$ 12.5	0.28	29.7 $\pm$ 10.7	0.23
PV VTI ratio	0.57 $\pm$ 0.12	0.78 $\pm$ 0.10	0.05	0.41 $\pm$ 0.07	0.01

Figure3 : PV VTI ratio

Discussion

- In the no reoperation group, the PV-VTI ratio showed an approximately 60%.
- In the De-PAB group, the PV-VTI ratio was significantly reduced.
- In the Re-PAB group, the PV-VTI ratio showed a tendency to increase.
- This study suggests that the PV-VTI ratio may be useful to determine the optimal PAB size in bilateral PAB surgery.

Conclusion

Intraoperative Doppler echocardiographic PV-VTI ratio using TEE during bilateral PAB surgery is effective in predicting the need for reoperation.

AVSD, atrioventricular septal defect; DORV, double outlet right ventricle; SRV, single right ventricle; CoA, coarctation of the aorta; HLHS, hypoplastic left heart syndrome; MA, mitral atresia; IAA, interrupted aortic arch; Truncus, truncus arteriosus