



Different predictabilities of fluid responsiveness by pulse pressure variation in children after surgical repair of ventricular septal defect or tetralogy of Fallot

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Objective

Volume expansion therapy is considered the first-line treatment in infants after cardiopulmonary bypass (CPB), but excessive volume is harmful. Pulse pressure variation (PPV) derived from pressure record analytical method (PRAM) is based on heart-lung interaction during mechanical ventilation. The heart-lung interaction might be different between ventricular septal defect (VSD) and tetralogy of Fallot (TOF) due to different right ventricular function and pulmonary vasculature, potentially affecting the predictability of fluid responsiveness using PPV after surgical repair.

Methods

Infants undergoing CPB for complete repair of ventricular septal defect (Group VSD, n=29, aged 0.7 ± 0.2 years) and tetralogy of Fallot (Group TOF, n=36, aged 0.8 ± 0.3 years) were enrolled. After CPB and before chest closed, mechanical ventilation was set with tidal volume 10 ml/kg. 5% albumin or blood plasma routinely was given ($16 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$) over 15 minutes. PPV was recorded using PRAM along with diastolic blood pressure (DBP), heart rate (HR), stroke volume index (SVI), cardiac index (CI) before and after volume replacement. Patients were considered as responders to fluid loading when CI increased $\geq 15\%$.

Results

Demographic variables were not significantly different between groups and responding subgroups. In Group VSD, 12 were responders and 14 non-responders. PPV in responders was higher than that in non-responders ($25.6 \pm 6.2\%$ vs. $16.4 \pm 5.0\%$, $P < 0.05$). Area under the curve (AUC) was 0.85 (95% confidence interval, 0.69~1, $P = 0.01$) and cutoff value 19% with a sensitivity of 92% and a specificity of 71%. In Group TOF, 15 were responders and 21 non-responders. PPV in responders were not different from that in non-responders ($11.6 \pm 4.6\%$ vs. $10.1 \pm 2.0\%$, $P > 0.1$). AUC was 0.52 (95% confidence interval, 0.31~0.72, $P = 0.01$) and cutoff value 10% with a sensitivity of 53% and a specificity of 47%.

Table 1. Demographic variables

Group	R/NR	No. of patients	Male/Female	Age (year)	Weight (kg)	Inotropic score
VSD	R	12	6/6	0.47 ± 0.21	5.6 ± 1.3	5.3 ± 2.9
Group	NR	14	6/8	0.41 ± 0.22	6.0 ± 1.6	3.1 ± 2.3
TOF	R	15	9/6	0.60 ± 0.25	6.3 ± 1.3	4.7 ± 7.2
Group	NR	21	8/13	0.51 ± 0.25	6.4 ± 1.3	5.9 ± 4.0

R, responders; NR, non-responders.

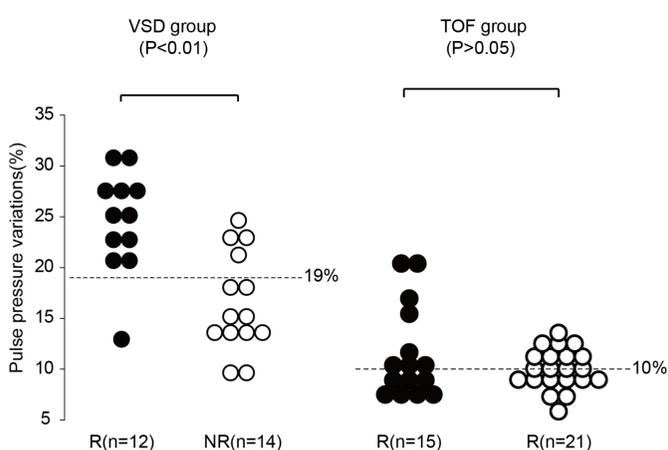


Fig 1. Individual values of PPV before volume replacement in responders and non-responders in VSD group and TOF group. R, responders; NR, non-responders.

Conclusions

PPV by PRAM can be used to predict fluid responsiveness in children after surgical repair of VSD, but not in children with TOF.

Table 2. Hemodynamic parameters recorded before and after volume replacement

Hemodynamic parameters	R/NR	VSD group		TOF group	
		Before VR	After VR	Before VR	After VR
DBP (mmHg)	R	43 ± 10	50 ± 9^{aa}	48 ± 11^b	58 ± 10^{aa}
	NR	46 ± 7	46 ± 6	57 ± 10	56 ± 8
HR (Beats/min)	R	141 ± 18	144 ± 16	153 ± 13	150 ± 12
	NR	148 ± 22	146 ± 11	157 ± 12	157 ± 14
CI ($\text{L} \cdot \text{min}^{-1} \cdot \text{m}^{-2}$)	R	2.5 ± 0.5	3.3 ± 0.6^{aa}	2.5 ± 0.5^{bb}	3.3 ± 0.6^{aab}
	NR	2.9 ± 0.6	3.0 ± 0.7	3.0 ± 0.4	2.8 ± 0.5^a
SVI (ml/m^2)	R	17.5 ± 5.0	23.0 ± 5.0^{aa}	16.8 ± 3.2^b	21.1 ± 3.8^{aab}
	NR	19.5 ± 3.7	20.4 ± 4.8	19.2 ± 3.2	17.7 ± 4.1^a
PPV (%)	R	25.6 ± 6.2^{bb}	13.6 ± 5.2^{aa}	11.6 ± 4.6	11.5 ± 5.4
	NR	16.4 ± 5.0	14.6 ± 5.6	10.1 ± 2.0	11.9 ± 4.3

R: responders; NR: non-responders; VR: volume replacement; ^a, $P < 0.05$ compared with before volume replacement within a group; ^{aa}, $P < 0.01$ compared with before volume replacement within a group; ^b, $P < 0.05$ compared with non-responders. ^{bb}, $P < 0.01$ compared with non-responders.

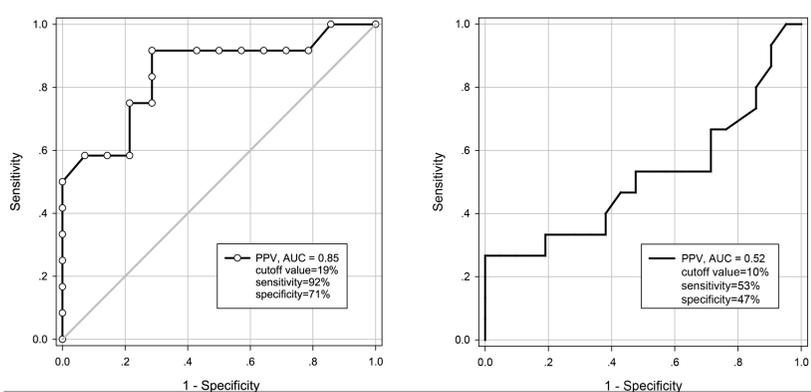


Fig 2. Prediction of fluid responsiveness. ROC curves for predicting a $\geq 15\%$ increase in CI in VSD group and TOF group.