

The improved cardiac function is a key protective factor for infants delayed recovery after cardiac surgery

Mingwei Li, Shuangxing Wang and Hui Zhang

Children's Hospital of Capital Institute of Pediatrics, China

Background: The improvement of technology in diagnosis, surgical operation and postoperative critical care enables younger infants with Congenital Heart Disease (CHD) to be treated. Some evidence has supported the belief that despite the immature myocardial cell, early operation benefits patients with simple CHD more with the eradication of the etiology for respiratory infection or heart failure caused by the large shunt. However, the appropriate timing for operation is disputed, especially for small infants with the clinical syndrome of ventricular dysfunction when admitted to the hospital. We observed that in some cases, patients who underwent surgical repair too soon without enough preoperative supports had more postoperative complications, longer Duration of Mechanical Ventilation (DMV), Intensive Care Unit (ICU) stays and hospital stays. Sensitive indexes for evaluation on the improvement of cardiac function by the preoperative treatment, which can predict with better postoperative outcomes, still remain unknown.

Objective: We conducted a single-center retrospective study aiming to reveal preoperative factors associated with postoperative recovery in infants less than 6 months old, who underwent surgical treatment for CHD in the Children's Hospital of Capital Pediatric Institute, during the past 5 years.

Methods: Clinical variables were collected via medical records. Electrical Cardiometry based ICON devices (Osyka Medical, Berlin, Germany) were used for daily monitoring to assess patients' cardiac function from the first day when admitted to the hospital to the day before the operation. Statistic data included average values of Cardiac Index (CI), ICON (representing ventricular contractility), Thoracic Fluid Capacity (TFC), Systolic Time Ratio (STR) as well as each of their maximum values. The improvement of cardiac function was defined as $\Delta X\% = (X_{\max} - X_{\text{first day}}) / X_{\text{first day}} \times 100\%$, ($X = \text{CI, ICON, TFC, or STR}$). 'Delayed recovery' was defined as the appearance of postoperative complications, DMV longer than 12h, ICU stays over 1 day and hospital stays over 7 days. Otherwise, patients were considered to have 'normal recovery'. Risk factors for postoperative prognosis and the odds ratio (OR) were analyzed with logistic regression analysis.

Results: A total of 53 infants under 6 months with simple heart defects (VSD, ASD or PDA) who underwent open-chest repair from January 2017 to June 2022 were included. 20 (37.7%) patients were considered to be 'normal recovery' and 33 (62.3%) to be 'delayed recovery'. The univariate analysis showed that age (5.68 ± 0.51 VS 3.34 ± 0.36 months, $p < 0.001$), height (64.95 ± 0.84 VS 58.85 ± 1.14 cm, $p < 0.05$), average CI (4.84 ± 0.16 VS 4.41 ± 0.13 L/(min·m²), $p < 0.05$), $\Delta \text{CI}\%$ (27.87 ± 7.13 VS 12.05 ± 2.92 , $p < 0.05$), ICON max (160.98 ± 5.25 VS 148.25 ± 5.48 , $p < 0.05$), and $\Delta \text{ICON}\%$ (33.45 ± 6.95 VS 11.68 ± 3.36 , $P < 0.001$) were significantly different between the patients in a normal recovery group and delayed recovery group. ROC showed that average $\text{CI} \geq 4.59$

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(AUC=0.68, SE=0.70, SP=0.65) and Δ ICON% \geq 40% (AUC=0.71, SE=0.91, SP=0.55) are reasonable predictors for better prognosis. Logistic regression analysis suggested that protective factors for delayed recovery were age (OR=0.488, P<0.05), average CI (OR=0.296, P<0.05) and Δ ICON% (OR=0.944, P<0.05).

Conclusion: In conclusion, in this study we emphasize the that preoperative cardiac function is essential for prognosis after cardiac surgery and electrical cardiometry monitoring data can provide us with reference for the appropriate timing of surgery. Small infants with older age, higher average CI and obvious improvement of ventricular contractility after receiving preoperative treatment can be expected to have better postoperative recovery.