

Cardiopulmonary Exercise Test Results According to Severity of Structural Heart Disease in Pediatric Patients

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Introduction:

Limitation in exercise capacity is present in patients with structural heart disease (SHD) even in the pediatric age group. The best indicator of cardiovascular fitness is peak oxygen uptake (peakVO₂) but when it comes to identifying the severity of SHD and prognosis, decreased ventilatory efficiency (nadir of ventilation per unit of carbon dioxide production VE/VCO₂) may be a more important variable.

Goals:

Our aim was to investigate whether peakVO₂ or VE/VCO₂nadir on the cardiopulmonary exercise testing (CPET) better reflected the severity of impairment in pediatric patients (6-17 years) with SHD.

Methods:

We utilized data from patients who underwent CPET at Mayo Clinic Stress Center between 2011-2016. We classified patients according to SHD severity from 0-3 based on 2018 AHA/ACC Guideline. Differences in peakVO₂ and VE/VCO₂nadir were analyzed according to SHD linear model (PROC GLM) age, sex, and heart rate (HR) lowering treatment.

Results:

As expected, compared to the 343 healthy individuals (185 male, 13.0±3.0yrs) the 169 SHD patients (105 male, 14.6±2.6yrs) exhibited poorer values on several CPET parameters (peakVO₂, VE/VCO₂nadir, peak HR, HR recovery, HR reserve and peak ventilation); the difference becoming more significant with age and SHD severity. Compared to controls (39.1±10.2mL/kg/min), peakVO₂ was significantly (p<.0001) lower in all of the SHD groups: 1) 32.0±10.3mL/kg/min; 2) 33.0±8.9mL/kg/min; 3) 31.3±8mL/kg/min, but differences among the SHD groups were not significant. VE/VCO₂nadir was lower in the healthy population (26.4±3.1, p<.0001) vs. the SHD groups: 1) 27.8±5.0; 2) 27.5±3.9; 3) 30.6±4.8. VE/VCO₂nadir for SHD group 3 was significantly higher than groups 1 and 2 (p<.0001).

Conclusion:

CPET in patients with SHD provides helpful parameters that better define the clinical stage. The reduced exercise tolerance of SHD patients is defined by a lower peakVO₂ and less ventilatory efficiency measured by VE/VCO₂nadir. With increasing severity of SHD there is a worsening of ventilatory efficiency though the differences in peakVO₂ among SHD groups was not significant. Mechanism of elevated VE/VCO₂nadir are likely different in pediatric versus adult patients, more related to right-to-left shunting than heart failure.

Keywords: cardiopulmonary exercise testing, pediatric patients, structural heart disease