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