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Chronotropic incompetence among children and adolescents with congenital heart disease

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Introduction: Impaired exercise capacity is a common feature of congenital heart disease (CHD). In adults with CHD, it has been shown that chronotropic incompetence may contribute to exercise limitation. Systematic data in children and adolescents on this topic is limited. We therefore purposed to assess chronotropic response during treadmill exercise testing in children and adolescents with CHD compared to healthy controls.

Methods: 163 children and adolescents (103 with CHD, median age 15 years and 60 age-matched controls) performed cardiopulmonary exercise testing and were included in this study. Beyond peak oxygen consumption, increase in heart rate from resting level to peak exercise (heart rate reserve) and decrease of heart rate after peak exercise (heart rate recovery) was measured. Chronotropic index was defined as percentage of age predicted maximal heart rate reserve. According to data from adults on bicycle exercise, chronotropic incompetence was assumed for chronotropic index below 0.8.

Results: While resting heart rate was similar between both groups, peak heart rate, heart rate reserve as well as chronotropic index were lower in the CHD group than in controls. Chronotropic index was lowest in patients with single ventricle hemodynamics and correlated with peak oxygen consumption. Heart rate recovery was impaired in the CHD group 1 and 2 minutes after peak exercise compared to controls and correlated with peak oxygen consumption.
Chronotropic index below 0.8 was a relatively frequent finding even in the control group suggesting that the threshold of 0.8 appears inadequate for the identification of chronotropic incompetence using treadmill exercise testing in children. After normalizing to the 2.5th chronotropic index percentile of the control group we obtained a chronotropic incompetence threshold of 0.69.

Conclusions: As an adjunct to measurement of peak oxygen consumption, chronotropic response to exercise appears to be a physiologically important diagnostic parameter in children and adolescents with CHD. However, interpretation of chronotropic response needs to consider age-specific characteristics and the mode of exercise test. Our data may help to interpret future studies on chronotropic incompetence using treadmill ergometer protocols in children and adolescents.