

STRESZCZENIE ROZPRAWY DOKTORSKIEJ W JĘZYKU ANGIELSKIM

Title: The role of exercise echocardiography in functional assessment of Fontan circulation.

Background

The term “functionally single ventricle” (FSV) refers to a group of heart defects with one chamber properly developed. A surgical correction of a single ventricle to “biventricular” heart is not feasible. Fontan procedure connects systemic veins directly to pulmonary arteries, bypassing the heart. The efficacy of Fontan circuit depends on low pulmonary vascular resistance, unobstructed venous return and preserved ventricular systolic and diastolic function. A return flow is generated by the difference between venous and pulmonary capillary pressure difference. The main unfavorable consequences of Fontan circulatory system are chronic venous congestion and low cardiac output.

The assessment of single ventricle function is difficult because of structural and functional abnormalities. The role of standard imaging technics is established for biventricular heart. Exercise echocardiography with FSV deformation assessment by speckle tracking technics is a novel and promising diagnostic method.

Galectin-3 is a cardiac fibrosis marker. It is a protein of the lectin family that binds the beta-galactosides. Galectin-3 is responsible for cell growth and differentiation and cell cycle regulation. It is involved in procollagen to collagen conversion. The role of galectin-3 in the cardiac fibrosis process was established in variable cardiac abnormalities. A galectin-3 concentration was associated with physical performance, cardiac function and the prevalence of adverse events among adult patients with congenital heart defects. Fibrosis was proved to be the main trigger responsible for single ventricle function deterioration. Galectin-3 concentration might reflect a degree of single ventricle fibrosis in patients after Fontan palliation.

Aims

The study aims to establish the utility of exercise echocardiography including deformation parameters in Fontan circulation assessment and reveal the role of fibrosis in single ventricle function impairment.

Methods

37 patients with functionally single ventricle after Fontan palliation were enrolled in the study between 2019 and 2021. The patients were hospitalized in the Department of Congenital

Heart Defects of the National Institute of Cardiology. Anthropometric data and past surgical treatment technique information were obtained from medical history and patients' documentation. The echocardiography was performed on Vivid E95 (GE Medical System) on a semi-supine cycloergometer. The echocardiography views were registered during the examination. The deformation parameters analysis was performed on EchoPac Station (GE Health Care). A functionally single ventricle free wall longitudinal strain and longitudinal strain of three layers: subendocardial, midendocardial and subepicardial were measured with subsequent calculation of transmural gradient (TG).

A venous blood sample was obtained for further analysis of galectin-3 concentration. The results of diagnostic tests performed routinely during planned hospitalizations, i.e. the cardiopulmonary test and magnetic resonance imaging of the heart, were included in the study.

Results

An increase in functionally single ventricle free wall longitudinal strain was observed. Maximal oxygen uptake during the cardiopulmonary test was lower than the reference value predicted for age and sex among patients after Fontan palliation. A negative correlation between functionally single ventricle free wall strain during exercise and age as well as elapsed time from a total cavo-pulmonary connection was found. Functionally single ventricle free wall strain at rest and during exercise were not associated with maximal oxygen uptake during a cardiopulmonary test. There was no difference in deformation parameters among patients in NYHA I and NYHA II groups. TG was correlated with exercise performance parameters. Exercise TG was associated with ejection fraction calculated during cardiac magnetic resonance imaging. There was a linear correlation between the transmural gradient and galectin-3 serum concentration.

Conclusions

The study revealed that functionally single ventricle free wall strain decreases with age and time from a total cavo-pulmonary connection. Functionally single ventricle free wall strain is not associated with physical performance parameters and NYHA class. Exercise transmural gradient was associated with ejection fraction calculated during cardiac magnetic resonance imaging and physical performance. Transmural strain gradient at rest correlated with galectin-3 serum concentration.

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