

Multimodal assessment of vascular function in patients with Fontan circulation

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Introduction: Arterial stiffening is a well-established marker of cardiovascular morbidity in the general population, but there is a relative paucity of data on patients with a functional single ventricle following Fontan palliation. However, due to the unique challenges and long term complications associated with Fontan physiology, understanding vascular function in this population appears particularly important. The aim of this study is to characterize vascular function in Fontan patients using a multimodal approach.

Methods: Patients with Fontan physiology as well as healthy controls were included in this prospective observational study. Central blood pressure (BP), central augmentation index corrected to a heart rate of 75/minute (AIx75) and carotid-femoral pulse wave velocity (PWV) were determined using SphygmoCor XCEL (AtCor). Digital Acceleration Plethysmography (Meridian) was used to obtain an aging index (AI). The reactive hyperemia index (RHI), marker of endothelial function, was determined using EndoPAT (Itamar). Carotid intima-media thickness (cIMT) and distensibility were measured with ultrasound. Laser Doppler (Perimed) with iontophoresis of Acetylcholine (ACh) and Sodium Nitroprusside (SNP) was used to assess endothelium dependent versus independent changes in microcirculation. For statistical analyses Mann-Whitney U and Chi-square tests were used as appropriate to assess difference between groups.

Results: 24 Fontan patients and 24 controls were included in the study. Median age 16, range 7-33 years. There was no significant difference between groups for age, height, weight, gender, heart rate and brachial BP. Central systolic but not diastolic BP was higher in patients versus controls ($p=0.029$). AIx75 (12,5 [IQR 4,3-17,6] vs -6,8 [IQR -14,5 - 0,88]) and AI (-0,596 [-0,67 – (-0,48)] vs -0,82 [-1,02 - (-0,62)]) were higher in patients versus controls ($p<0.001$). There was no significant difference in PWV, cIMT, carotid distensibility, microvascular perfusion or RHI between groups.

Conclusion: Fontan patients have abnormal wave reflection (AIx75 and AI) which is already apparent in childhood. This study demonstrates no significant abnormalities in cIMT, carotid distensibility, generalized large artery stiffness, microvascular or endothelial function. Future clinical trials should focus on pharmacologic optimization of AIx75, AI and central blood pressure in Fontan patients.