
Purpose: Right ventricular (RV) volume and function assessments are essential in the management of pulmonary arterial hypertension (PAH) but are often difficult to perform. Three-dimensional echocardiography is limited by acoustic dropout of the RV free wall in dilated ventricles. We hypothesized that knowledge-based reconstruction, a novel method for three-dimensional modeling of RV endocardium from two-dimensional transthoracic echocardiographic (TTE) images, could provide accurate measurements of RV volumes and systolic function in PAH patients.

Methods: 39 PAH patients were prospectively recruited for TTE and cardiac magnetic resonance (CMR), which was used as a reference standard and performed within 24 hr of TTE. TTE images were acquired with spatial localization equipment to allow for three-dimensional reconstruction. Images were analyzed with dedicated software to obtain RV end-diastolic and end-systolic volumes (EDV, ESV) and ejection fractions (EFs; Figure). The method of disks was used to determine CMR volumes.

Results: TTE RV volumes correlated well with CMR (EDV, R=0.86; ESV, R=0.90; EF, R=0.72; Figure). On Bland-Altman analyses, volumes were slightly larger by TTE (EDV, +12±38.5 ml; ESV, +92±32.0 ml; Figure), while EFs were slightly smaller by TTE (±10.0±8.6%). For intra-observer variability analyses (in a subset of 27 patients), coefficients of variation were: EDV, 7.8±7.0%; ESV, 10.2±8.0%; and EF, 15.4±13.8%. For intra-observer analyses (in same 27 patients), coefficients of variation were: EDV, 7.1±5.1%; ESV, 8.3±7.0%; and EF, 10.9±9.2%.

Conclusion: Knowledge-based reconstruction provides accurate, reproducible measurements of RV volumes in PAH patients. Larger studies are needed to confirm these results and to determine the practicality of this approach in clinical care.

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Three-dimensional modeling of the right ventricle from two-dimensional transthoracic echocardiographic images: utility of knowledge-based reconstruction in pulmonary arterial hypertension

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Background: Right ventricular (RV) function plays an important role in determining cardiac symptoms in several diseases. It has been demonstrated that the new imaging modality of three-dimensional echocardiography (3DE) is interchangeable to cardiac magnetic resonance in reproducibility and accuracy. Speckle Tracking is a sensitive tool to quantitatively assess regional deformation with pulmonary hypertension in fasting and glucose loading conditions. The present study provides normal reference values for RV volumes and RVEF by 3DE and normal longitudinal RV deformation values in young people. 3DE is an alternative imaging modality for quantification of RV volumes and EF, showing improved accuracy and lower interobserver and intraobserver variability compared to 2D echocardiography; it overcomes the limitations due to the complex anatomy of the RV.

Methods: Twelve patients (16±11 years old) with moderate or severe pulmonary regurgitation after Fallot correction in childhood underwent percutaneous pulmonary valve implantation (PPVI). Deployment of the valve with a balloon results in a complete occlusion of the RV outflow tract (RVOT) for a mean time of 15 seconds. Echocardiography (Echodoppler) and immediately after (Echodoppler) balloon occlusion as well as at the end of the procedure (Echodoppler 3). Conventional echocardiographic and tissue Doppler based deformation indices of the RV were assessed.

Results: See figure. Acute severe increase in RV afterload after balloon inflation resulted in a significant decrease in fractional area change (FAC), tricuspid annular (±10.0±8.6%). For interobserver variability analysis (in a subset of 27 patients), coefficients of variation were: EDV, 7.8±7.0%; ESV, 10.2±8.0%; and EF, 15.4±13.8%. For intra-observer analyses (in same 27 patients), coefficients of variation were: EDV, 7.1±5.1%; ESV, 8.3±7.0%; and EF, 10.9±9.2%.

Conclusion: Acute severe increase in RV afterload induces a transient myocardial dysfunction which recovers within minutes. The underlying mechanism is unclear, but observed changes have similarities with ischemic stunning. Further studies are needed to explore this phenomenon.

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Acute severe increase in afterload as a new mechanism for “stunning” in the right ventricle

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Purpose: To determine the effects of an acute severe afterload increase on right ventricular (RV) function.

Methods: Twenty-nine patients (16–61 years old) with moderate or severe pulmonary regurgitation after Fallot correction in childhood underwent percutaneous pulmonary valve implantation (PPVI). Deployment of the valve with a balloon results in a complete occlusion of the RV outflow tract (RVOT) for a mean time of 15 seconds. Echocardiography (Echodoppler) and immediately after (Echodoppler) balloon occlusion as well as at the end of the procedure (Echodoppler 3). Conventional echocardiographic and tissue Doppler based deformation indices of the RV were assessed.

Results: See figure. Acute severe increase in RV afterload after balloon inflation resulted in a significant decrease in fractional area change (FAC), tricuspid annular (±10.0±8.6%). For interobserver variability analysis (in a subset of 27 patients), coefficients of variation were: EDV, 7.8±7.0%; ESV, 10.2±8.0%; and EF, 15.4±13.8%. For intraobserver analyses (in same 27 patients), coefficients of variation were: EDV, 7.1±5.1%; ESV, 8.3±7.0%; and EF, 10.9±9.2%.

Conclusion: Acute severe increase in RV afterload induces a transient myocardial dysfunction which recovers within minutes. The underlying mechanism is unclear, but observed changes have similarities with ischemic stunning. Further studies are needed to explore this phenomenon.

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Correlations between right ventricular function and increased 18F-fluorodeoxyglucose uptake of the right ventricle in patients with pulmonary hypertension in fasting and glucose loading conditions

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Purpose: This study was designed to measure glucose uptake of Right Ventricle (RV) in PH patients by 18F-Fluorodeoxyglucose (FDG) Positron Emission Tomography (PET) imaging in fasting and glucose condition, and attempted to investigate the correlations between FDG uptake and right ventricular function as well as hemodynamics.

Methods: Thirty eight patients with PH were observed prospectively. 18F-FDG PET scanning was performed in fasting and glucose loading conditions in all the patients, and the standardized uptake value (SUV) of RV was measured after corrected for partial volume effect. The ratio of RV to Left Ventricle (LV) SUV (RV/LV-SUV) was calculated. Right heart catheterization, echocardiography and Cardiac Magnetic Resonance (CMR) were performed in all patients within 1 week.

Results: RV/SUV and LV/SUV were higher in glucose loading than in fasting condition. RV/SUV and LV/SUV in fasting condition showed significant relations with right ventricular ejection fraction (RVEF) derived from CMR (r=-0.34, P=0.035 and r=-0.345, P=0.034), and in glucose loading condition (r=-0.362, P=0.028 and r=-0.512, P=0.001). RV/LVSUV in glucose loading condition also correlated significantly with TAPSE (r=-0.347, P=0.035), IVA (r=-0.417, P=0.011) and RVFAC (r=-0.326, P=0.049).

Conclusions: The glucose uptake of right ventricle increases with right ventricular systolic function decrease in PH patients, which is more significant in glucose loading than in fasting condition.