Knowledge-based 3D reconstruction compared to MRI for evaluation of right ventricular volumes and function in congenital heart diseases affecting the right ventricle

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Background

Right ventricular (RV) volume and ejection fraction (RVEF) measurements are essential in the management of children with congenital heart disease. Cardiac magnetic resonance imaging (MRI) is considered the reference method for RV volumes and RVEF measurements. Three-dimensional knowledge-based reconstruction (3D-KR) derived from two-dimensional echocardiographic imaging is a novel technique. The aim of this study was to assess the feasibility and reliability of this technique in children with diverse CHD involving the right ventricle.

Methods

103 children (range age 0.1 to 18 years) referred for cardiac MRI, were included. Among them, 33 patients had barometric overload, 40 patients had volumetric overload, 18 patients had mixed overload, and 12 had Fontan circulation. Echocardiographic image acquisition was performed using a standard ultrasound probe linked to a Ventripoint Medical Systems unit. Parameters analysed were end-diastolic volume (EDV), end-systolic volume (ESV), and RVEF. The method of disk was used for CMR RV volumes. Intra-observer, inter-observer, and inter-technique variability was assessed using coefficients of variation (COV), and Bland-Altman analysis.

Results

(Fig. 1) Feasibility of 3D-KR was 100%. Echocardiographic RV volumes correlated well with CMR (EDV, CC = 0.96; ESV, ICC = 0.93; RVEF, ICC = 0.75). For inter-observer analyses, COV were 8% for EDV, 15% for ESV, and 17% for EF. For intra-observer analyses, COV were 4% for EDV, 7% for ESV, and 9% for EF. The correlation of volumes and RVEF with MRI was slightly worse in the group with mixed overload compared with patients with volumetric or barometric overload. 3D-RVEF was overestimated compared with MRI whereas the volumes tend to be underestimated.

Conclusions

3D-KR is feasible in children. It provides accurate and reproducible measurements of RV volumes. This new technique can be used as an accurate routine tool to assess RV function in CHD with pure barometric or volumetric overload.