Background

Real-time three- dimensional echocardiography (RT3DE) is well suited for volumetric and functional assessment of the right ventricle (RV). We evaluated the clinical utility of the newly introduced 4D RV 2.0 in pediatric and congenital heart disease with regard to feasibility and analyses times.

Methods

We prospectively studied children with normal and abnormal hearts using RT3DE. Full volume 3D data sets from the ultrasound system (iE33 or SC 2000) were transferred to a workstation for offline analysis (4DRV 2.0, TomTec). The software analyzed ultrasound backscatter intensities within a user-defined coordinate framework, and a statistic RV shape model was adapted using the input data. This model was speckle-tracked over the entire cardiac cycle. The user adjusted the resulting dynamic surface model in end-systole and end-diastole, and the changes applied were propagated to all frames of the cardiac cycle. 3D volumes over time were computed from the dynamic surface model for calculation of volumes and ejection fraction (EF). In addition, the surface model intersected with the RV focused 4chamber view to derive tricuspid annular plane excursion (TAPSE), fractional area change (FAC) and RV free wall and septal longitudinal strain (LS), making a comprehensive assessment. Five patients had cardiac magnetic resonance (CMR) measurement of RV volumes on the same day of RT3DE.

Results

The study cohort (n=100) had a mean age of 15.0 years (0.5-41), mean heart rate of 82.7 bpm (52-151), and consisted of 51 normals, 5 patients with hypoplastic left heart syndrome (HLHS), 11 heart transplants (HT) and 33 patients with tetralogy of Fallot (TOF). RV volumes, EF, TAPSE, FAC and free wall and septal LS were obtained in all subjects. Analyses times were 2.2± 1 min in normals. In HLHS, HT and TOF, times were 7.2± 1, 5.4±0.9, and 3.2±0.9 respectively. Analysis times were shorter in older subjects, however abnormal RV's took longer time for analyses ($p<0.001$). Regression of RV 2.0 against CMR volumes and EF were linear with high correlation coefficients ($p<0.001$), but with RV 2.0 estimating smaller volumes compared to CMR. The mean percentage differences for volumes and EF between RT 3DE and CMR were 4-9 %

Conclusion

4D RV 2.0 is a promising tool for RV volume and EF measurements from RT3DE datasets in children with normal and abnormal hearts. Analyses times may improve with increasing experience.