Volume and Function of the Right Ventricle in Ebstein Anomaly: Knowledge-based Three Dimensional Reconstruction of Echocardiographic Images Compared to Cardiac Magnetic Resonance

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Objectives: Quantification of right ventricular (RV) volume in Ebstein anomaly is challenging, given the different degrees of displacement of the tricuspid valve (TV). Echocardiographic knowledge-based 3D reconstruction (3DR) of RV volumes has been validated in normal and dilated RV. We sought to assess feasibility of 3DR in Ebstein patients and to compare the RV volumes with volumes obtained by cardiac magnetic resonance (CMR).

Methods: Ebstein patients with and without TV reconstruction were prospectively recruited in 4 centres and underwent 3DR and CMR in our core lab on the same day. Patients with pacemaker or Fontan palliation were excluded. Knowledge-based 3DR was performed with Ventripoint™ Diagnostics, USA. RV volumes were calculated using 3DR and the summation disc method on short axis images (saCMR) and on axial images (axCMR) by two independent experienced observers. Intermodality differences were assessed using correlation coefficient and Bland-Altman analysis and expressed as % mean difference ± standard deviation and 95% limits of agreement.

Results: Eighteen patients underwent 3DR and CMR examination. 3DR was feasible in 78% of the patients, image quality being insufficient in 4/18. In 14 patients significant correlation was present for all RV volumes among all imaging modalities. RVEDV in 3DR correlated best with saCMR with a mean difference of 0.6±5.4 % (-11/10). Agreement between 3DR and axCMR was 4.8± 9.4 % (-23/13.6), between axCMR and saCMR 4.2±6.8% (-9/17). For RVESV agreement was good between 3DR and saCMR -1.9±9.4% (-20/16), weaker between 3DR and axCMR was 6.5±13% (-32/19), and between both CMR methods 4.6± 14% (-24/33). Reasonable agreement was found for RV EF% between 3DR and saCMR 0.9±5.1% (-9/11). In contrast wide limits of agreement were observed between 3DR and axCMR 1.7± 8.9% (-16/19) and between saCMR and axCMR -0.9± 9.7% (-19/18).

Conclusions: 3DR echocardiography is feasible in Ebstein anomaly patients. 3DR RVEDV measurements show good agreement with saCMR and axCMR. Limits of agreement for RVESV and RV EF% are wider, but still comparable with published ranges obtained by CMR. Since volumes obtained by different techniques are not interchangeable, we recommend to use consistently the same modality for follow up of Ebstein anomaly patients.