Cardiovascular Magnetic Resonance-derived Tricuspid Annular Motion Indices in the Assessment of Right Ventricular Function in Patients with Repaired Tetralogy of Fallot

Shuang Leng*, Ru-San Tan, Ju Le Tan, Ping Chai, Lynetto Teo, Marielle V Fortier, Teng Hong Tan, Wen Ruan, Xiaodan Zhao, Ching Ching Ong, Devinder Singh, John C Allen, Ghassan S Kassab, James W Yip, Liang Zhong

National Heart Centre Singapore, Singapore

Background: Quantitative assessment of tricuspid annular (TA) deformation is essential for patients with repaired tetralogy of Fallot (rTOF). Tissue Doppler imaging (TDI) is well-established technique that enables measurements of regional right ventricular (RV) myocardial velocities. However, the application of TDI depends on the angle of insonation and measures only the vector of motion that is parallel to the direction of the ultrasound beam. This study investigates the feasibility, reliability and clinical utility of cardiovascular magnetic resonance (CMR)-derived TA motion indices in the assessment of RV function.

Methods: An in-house developed program based on adaptive feature tracking is used to semi-automatically track the RV septal and free wall in 4-chamber CMR view.[1-4] Four clinically useful indices are extracted: Sm_{CMR}, peak systolic velocity; Em_{CMR}, peak early diastolic velocity; Am_{CMR}, peak late diastolic velocity during atrial contraction; and $TAPSE_{CMR}$, TA plane systolic excursion. This method was applied in 81 rTOF patients and 52 normal controls that had undergone CMR scans. 56 out of the 81 rTOF patients had cardiopulmonary exercise testing (CPET).

Results: Analysis was feasible in all subjects and took < 1 minute per subject. In comparison to controls, patients with rTOF had significantly reduced Sm_{CMR}, Am_{CMR} and $TAPSE_{CMR}$, and larger Em_{CMR}/Am_{CMR} ratio. $TAPSE_{CMR}$ had better predictive performances for exercise capacity as measured by maximal oxygen consumption (VO_2max) during CPET (Area under the curve (AUC) = 0.823) than RV end-systolic volume index (AUC = 0.718), end-diastolic volume index (AUC = 0.714) and ejection fraction (AUC = 0.447). On multivariate analysis, only $TAPSE_{CMR}$ was independently associated with VO_2max ($\beta = -0.097$, $p < 0.001$). In addition, the study showed high reproducibility for assessment of TA motion parameters on CMR.

Conclusions: CMR-based measurements overcome the limitation of angle dependency of TDI, thus effectively extending routine CMR's capability for RV systolic and diastolic function assessment.

1. Leng S et al (2016) Ann Biomed Eng; 2. Leng S et al (2015) Am J Physiol Heart Circ Physiol; 3. Leng S et al (2018) Sci Rep; 4. Leng S et al (2019) Int J Cardiol Heart Vasc.