

Background: Pulmonary regurgitation (PR) and right ventricular (RV) dilation influence timing of pulmonary valve replacement (PVR) in patients with repaired Tetralogy of Fallot (rTOF). Left ventricular (LV) function is an independent marker of TOF patient outcomes. New markers of electromechanical discoordination have recently been described. *Systolic stretch fraction* (SSF) quantifies the ratio of ventricular myocardium inappropriately relaxing during systole. *Diastolic relaxation fraction* (DRF) quantifies the inappropriate myocardial contraction during diastole. We analyzed LV electro-mechanical discoordination (EMD) using SSF and DRF in rTOF patients with PR who do not meet commonly used criteria for PVR and have mild to moderate RV dilation. LV intracavitary flow (LVICF) organization was also assessed to examine correlation with RVEDVi.

Hypothesis: Patients with rTOF will have abnormal LV EMD and abnormal LVICF.

Methods: Patients (n=18) and healthy controls (n=20) with rTOF and PR underwent cardiac MRI. LV EMD was analyzed using SSF and DRF derived from strain and strain rate analysis considering individual LV myocardial segments. Temporal-geometric LV end-diastolic volumes were separated and quantified as percentage of direct flow, retained inflow, delayed ejection flow, and residual volume. Rank-sum test was used to compare groups. SSF and DRF were assessed for linear correlations with RVEDVi by Pearson method.

Results: There were 9 male and 9 female TOF patients (Mdn age 15, range 9-55). TOF patients had increased RVEDVi (118 ± 23 ml/m², $p < 0.001$) and increased RVESVi (56 ± 13 ml/m², $p < 0.001$) compared to controls. RV EF was lower in TOF patients but within normal physiologic range ($53 \pm 6\%$, $p = 0.008$). LV size indices and EF did not differ. TOF patients had increased SSF (Mdn 0.035, IQR 0.015-0.052, $p = 0.002$) and significantly decreased DRF (Mdn 2.735, IQR 2.358-2.959, $p < 0.0001$). RVEDVi correlated with increased SSF ($R = 0.51$, $p = 0.011$) and decreased DRF ($R = 0.62$, $p = 0.007$). Direct flow was significantly decreased in the rTOF patients (26.1% vs 35.5%, $p = 0.011$), whereas residual volume was significantly increased (24.6% vs 16.6%, $p = 0.014$).

Conclusions: TOF patients with PR and mild to moderate RV dilation have significant LV EMD during both systole and diastole. The degree of systolic and diastolic EMD correlates with RV dilation. SSF and DRF are unique and sensitive early markers of LV dysfunction compared to conventional MRI metrics.