Left Ventricular Electro-Mechanical Discoordination is Present in Patients with Tetralogy of Fallot not Meeting Conventional Criteria for Pulmonary Valve Replacement

University of Colorado Anschutz Medical Campus

Alexis Gerk[1], Michal Schäfer PhD[1,2], Benjamin Frank MD[2], Johannes von Alvensleben MD[2], Dunbar Ivy MD[2], Max B. Mitchell MD[2]

[1]University of Colorado School of Medicine; [2]Children's Hospital Colorado Dept. of Pediatric Cardiothoracic Surgery

Children's Hospital Colorado

Background

- Pulmonary regurgitation (PR) and RV dilation influence timing of pulmonary valve replacement (PVR) in patients with repaired Tetralogy of Fallot (rTOF).
- LV function is an independent marker of TOF patient outcomes.
- New markers of electromechanical discoordination (EMD) have been developed.
  - **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.
    - DRF has been used as a marker for LV diastolic discoordination in patients with pulmonary hypertension. However DRF has not been examined in patients with rTOF.

Aims

1. Analyze LV EMD using SSF and DRF in repaired TOF patients with pulmonary regurgitation who do not meet commonly used criteria for PVR and have mild-to-moderate RV dilation (<150 mL/m^2)
2. Determine if SSF and DRF correlate with RVEDVi in this group of TOF patients.
3. Analyze LV intracavitary flow (LVICF) organization to examine correlation with RVEDVi.

Hypothesis

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

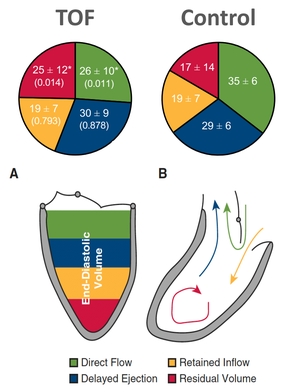
Methods

- Patients w rTOF and mild-moderate PR <150 mL/m^2 (n=18) and healthy controls (n=20) underwent cardiac MRI.
- LV EMD was analyzed using SSF and DRF derived from strain and strain rate analysis considering individual LV myocardial segments. LV myocardium was analyzed using feature-tracking module within CVI42 platform.
  - Under ideal conditions, all the segments of the LV myocardium are in the ejection phase and contracting. This is indicated by a negative strain rate (Figure 2)
- Temporal-geometric LV end-diastolic volumes were separated and quantified as percentage of direct flow, retained inflow, delayed ejection flow, and residual volume (Figure 1)

Results

Table 1: Patient demographics and hemodynamic characteristics.

	rTOF (n=18)	Control (n=20)	P-value
Gender (F)	9 (50%)	10 (50%)	NA
Age [yrs]	15 (9-55)	17 (7-44)	0.137
RVEDVi [ml/m^2]	118 ± 23	85 ± 14	<0.001
RVESVi [ml/m^2]	56 ± 13	36 ± 8	<0.001
RVEF [%]	53 ± 6%	58 ± 6%	0.008
LVEDVi [ml/m^2]	83 ± 11	80 ± 15	0.379
LVESVi [ml/m^2]	37 ± 7	33 ± 8	0.884
LVEF [%]	55 ± 6	60 ± 5	0.174
SSF	0.03 (0.01-0.05)	0.007 (0.006-0.013)	0.002
DRF	2.735 (2.358-2.959)	3.362 (3.122-3.904)	0.001



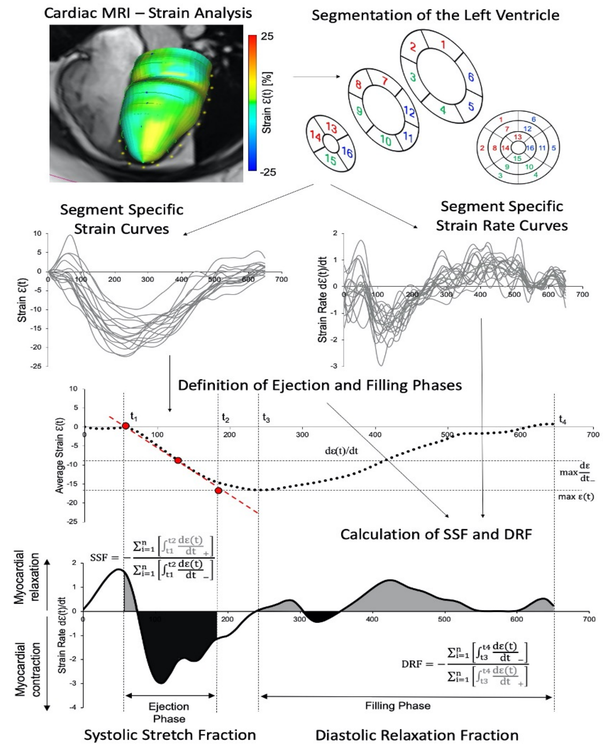


Figure 1 (Left): Left ventricular end diastolic volume flow organization [11]. Values represent proportion of LV end diastolic volume categorized as direct flow (green), delayed ejection (blue), retained inflow (yellow), and residual volume (red). *Patients with rTOF demonstrated significantly decreased direct flow and significantly increased residual volume compared to the control group.

Figure 2 (Below): Individual LV myocardial segment strain and strain rate are used to derive SSF and DRF for analysis of EMD.

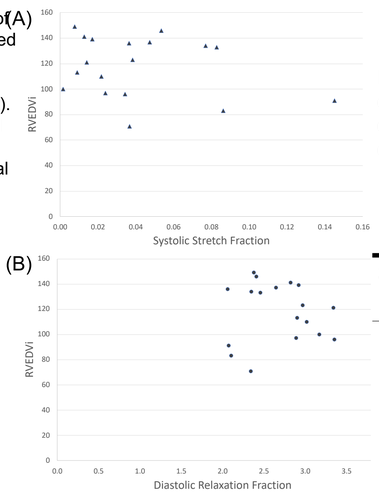


Figure 2. RVEDVi correlates with degree of systolic (A) and diastolic (B) EMD.

	RVEDVi
SSF	R=0.51 *p*=0.011
DRF	R=0.62 *p*=0.007

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.
- rTOF patients demonstrate abnormal diastolic LVICF with significantly decreased direct flow and significantly increased residual volume.
- SSF and DRF are unique and sensitive early markers of LV dysfunction compared to conventional MRI metrics.
- Future directions:
  - Determine if PVR favorably impacts SSF and DRF.
  - Determine if SSF and RF may guide PVR timing in TOF patients.

Disclosures

The authors report no disclosures.