Prospective evaluation of circumferential and longitudinal strain in asymptomatic children with dual ventricles who underwent single ventricle repair: comparison to single LV, single RV and normal hearts

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Background
Rarely, patients with normally sized RV and LV will undergo total cavopulmonary connection (TCPC) due to the complexity of their intracardiac anatomy giving them a dual ventricle (DV) for a single cardiac output. The ventricular function in this unique physiology compared to SRV, SLV and normal hearts remains poorly understood, with few studies performed¹-³. In this study, we perform a comprehensive comparison of global and regional strain in both the circumferential (εcc) and longitudinal (εL) dimensions to conventional SV hearts and normal hearts.

Purpose
In normal subjects and asymptomatic patients with DV (LV and RV calculated independently), SLV and SRV after TCPC, to compare:
1) Global εcc and εL strain,
2) Regional circumferential and longitudinal strains at free wall (εcc-free, εL-free) and septum (εcc-sept, εL-sept),
3) εcc and εL across the ventricle from apex to base.

Methods
We performed a prospective analysis of 23 subjects (7 normal age in years: 11.8 +/− 3.1, 5 DV age: 12.4 +/− 2.7, 6 SRV age: 11.4 +/− 2.3, 5 SLV age: 12.6 +/− 4.2).

Acquisition Protocol
Strain information was acquired at three short axis slices at basal, mid-cavity, and apical locations in all 123 subjects in a 1.5T MRI scanner (Philips Acheiva) using: a) Complementary Spatial Modulation of Magnetization (CSPAMM) images: Used for generating εcc; and b) Fast-Strain Encoded (fSENC) images: Used for generating εL.

Data Analysis
εcc and εL were calculated from SAX slices using Diagno-soft™. The ventricular regions at each slice were assigned based upon the AHA 16 segment model (fig. 1). εcc-sept, εL-sept, εcc-free, and εL-free were also calculated for each slice and compared.

Results
1.) Compared to normals, there is a significant reduction in global εcc at all ventricular levels of DV patients (fig 2).
2.) Compared to normals, there is a significant reduction in global εL in mid-ventricular and apical locations of DV patients.
3.) The εcc of the LV of DV patients consistently lower than SLV for global and regional calculations.
4.) In the same DV patient at the basal location, the εcc-free was higher in the RV (75 +/− 42%), with the εL-free being higher in the LV (25 +/− 10%).
5.) Global εL progressed from base to apex in all groups.

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Conclusions

Strain values of the RV and LV in DV patients demonstrate significant differences compared to normal subjects. Additionally, the LV of DV patients had lower strain values than the SLV patients. The differences in the RV and LV within the same DV patient suggest inherent differences in ventricular biomechanics in this unique physiology. The shared workload of the LV and RV for a single cardiac output may contribute to their lower strain values.

References
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