Journal of Cardiovascular Magnetic Resonance

BioMed Central

Meeting abstract

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1065 Three-directional myocardial motion in patients with univentricular hearts using velocity-encoded phase contrast MRI

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from 11th Annual SCMR Scientific Sessions
Los Angeles, CA, USA. 1–3 February 2008

Published: 22 October 2008

Journal of Cardiovascular Magnetic Resonance 2008, **10**(Suppl 1):A190 doi:10.1186/1532-429X-10-S1-A190

This abstract is available from: http://jcmr-online.com/content/10/S1/A190

Introduction

Patients with univentricular hearts rely on a single functioning ventricle to provide blood flow to both the systemic and pulmonary circuits following completion of the Fontan circulation. Tracking the function of the remaining ventricle in these patients is of interest as their long-term survival continues to improve and the ability of this single ventricle to sustain an increased load or serve an atypical role, as in the case of systemic right ventricles, is continually tested. Velocity-encoded phase contrast magnetic resonance imaging (PC MRI) may provide an efficient technique with high spatial resolution to attain three-component myocardial tissue velocities in addition to flow information throughout the cardiac cycle which could be useful in the monitoring of these patients.

Purpose

This study investigated the use of velocity-encoded PC MRI to produce three-directional velocity fields of myocardial motion throughout the cardiac cycle for analysis of ventricular wall motion and function in pediatric patients

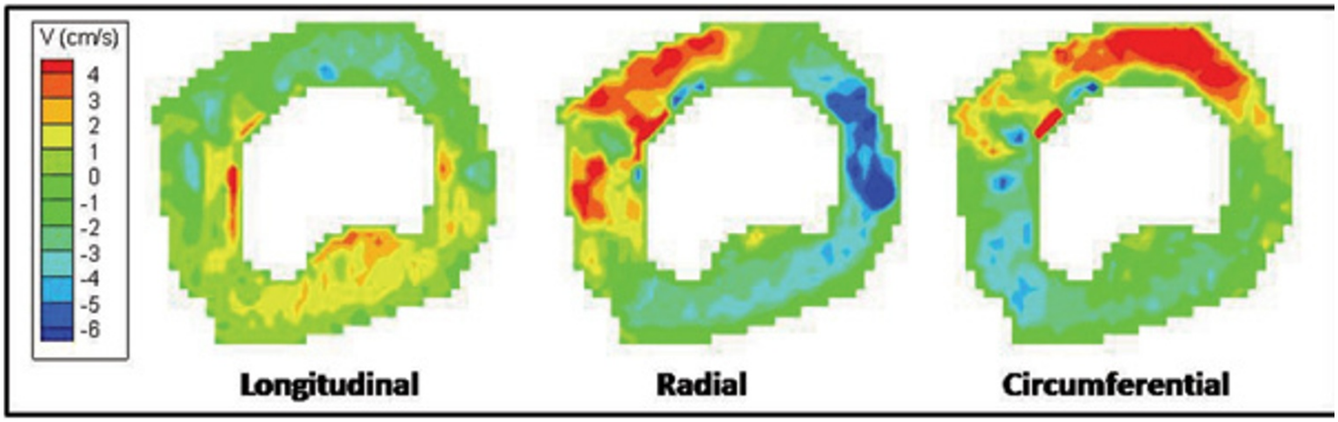

Figure 1
Three-directional velocity contours for single left ventricle in early systole.

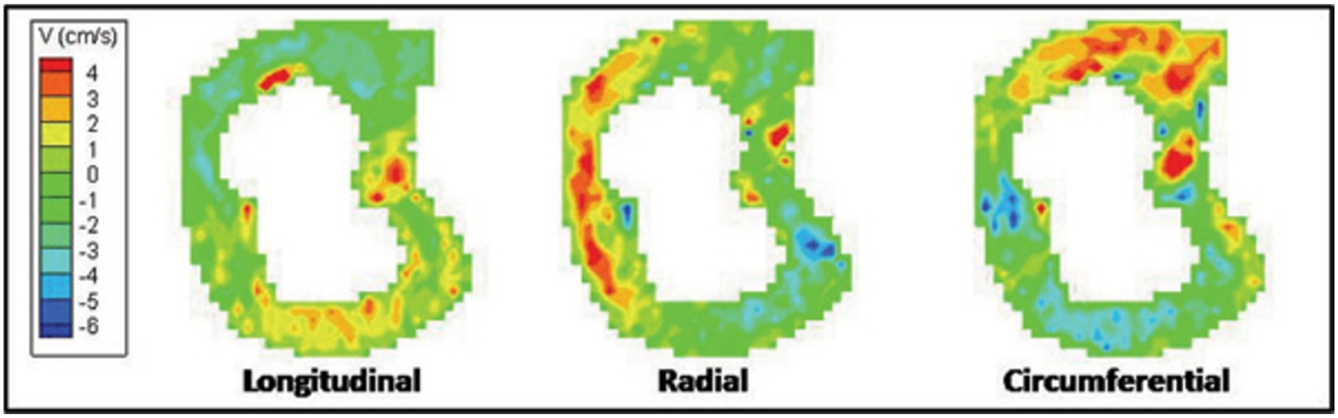

Figure 2
Three-directional veolicty contours for single right ventricle in early systole.

with univentricular hearts during conversion to and following completion of the Fontan circulation.

Methods

Myocardial velocimetry imaging was performed in a 1.5 Tesla Siemens Magnetom Avanto MRI scanner (Siemens Medical Solutions USA, Malver, PA) at The Children's Hospital of Philadelphia (CHOP). A single short-axis slice (thickness 4–6 mm) was taken at the mid-ventricular level with retrospective ECG-gating. Magnitude and phase images were acquired sequentially in the FH, AP, and RL directions with a velocity encoding value of 20 cm/s. Presaturation bands were used in two of the later patients to reduce the artifacts from flowing blood. The endocardial and epicardial surfaces of the magnitude images were segmented to produce a mask for the myocardium, excluding the papillary muscles. In-house MATLAB (The MathWorks, Natick, MA) codes at The Georgia Institute of Technology were then used to determine longitudinal, radial and circumferential velocities oriented on a new coordinate system centered at the centroid based on the center of mass of the ventricle of interest. Positive longitudinal direction was described as motion towards the apex, positive radial as motion towards the center of the ventricle of interest, and positive circumferential as motion in a clockwise fashion as viewed from the apex.

Results

Five patients aged 3 to 10 years of age with single left (3) or single right (2) ventricles who were in the process of completing or have completed the staged Norwood procedures resulting in either lateral tunnel or total cavopulmonary connections (TCPC) underwent scans in accordance with approved protocols. Longitudinal, radial and circumferential velocities fields were calculated throughout the cardiac cycle and also averaged for anterior, posterior, septal and lateral/medial (depending on single left vs. right ventricle) regions of interest for each phase. While the typical ventricular deformation was generally observed, the velocity fields revealed more inhomogeneous motion with certain areas showing discordant motion. Figure 1 shows the velocity contour plots for one of the study subjects with a single left ventricle. In comparison, Figure 2 displays the velocity plots for a patient with a single right ventricle.

Conclusion

Three-component velocity-encoded PC MRI provided a detailed three-directional velocity vector field for single ventricle motion and also revealed subtle differences in myocardial motion throughout the ventricle. These velocity fields may be further analyzed to elucidate differences in myocardial motion associated with single right vs. single left ventricles and their impact on ventricular function and cardiac output in patients with univentricular hearts.

Acknowledgements

This work was supported in part by NIH NHLBI BRP Grant R01-HL67622. CES was supported partially by Emory University NIH Medical Scientist Training Program (MSTP) T32 Training Grant.