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Patient-specific MRI-based active contraction and relaxation right ventricle models with different zero-load diastole and systole geometries for better stress and strain calculations

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Background: Accurate assessment of ventricular stress and strain is critical for cardiovascular investigations. From a mechanical point of view, zero-stress ventricular geometry information is required for correct stress/strain calculations. Sarcomere shortening in active contraction leads to change of ventricular zero-stress configurations during the cardiac cycle. A new model using different zero-load geometries (diastole and systole) was introduced to provide more accurate diastolic and systolic stress/strain calculations.

Methods & Results: Cardiac magnetic resonance (CMR) data were obtained from 16 patients with repaired tetralogy of fallot (TOF) prior to pulmonary valve replacement (8 male and mean age 34.5 years). CMR-based patient-specific computational right and left ventricular (RV and LV) model using one zero-load geometry (old model) and two zero-load geometries (no-load diastole and systole geometries, new model) were constructed and RV mechanical stress and strain were obtained for analysis. Based on the average values from the 16 patients, peak-systolic stress from the new model was 28% higher than that from the old model. Peak-systolic strain from the new model was 40% higher than that from the old model. The new model also provided end-systole and end-diastole stress and strain values that were not available from the old model.

Conclusion: The new 2-geometry model may be able to provide more accurate ventricular stress and strain calculations by using different zero-load geometries for the diastole and systole phases, respectively. The new model can be used in patient's studies to further examine its impact on risk stratification and planning surgical interventions.

Biography

Dalin Tang has received his PhD from UW-Madison in 1988. He is a Professor of Mathematics and Biomedical Engineering at WPI (since 1988). He was named as John E Sinclair Professor of Mathematics in 2003-2006. He received WPI Trustee's Research Award, the highest honor for faculty research at WPI. He was elected Fellow of AHA in 2011, Fellow of ASME in 2016. His research interest is Image-based Modeling for Ventricles and Vulnerable Plaques. He has received 29 grants including 3 NIH R01 grants and one NSF/NIGMS grant (\$1.8M). He has served on various NSF, NIH, and AHA panels.

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