

Quantification of biventricular myocardial strain from magnetic resonance images of pediatric pulmonary hypertensive patients using hyperelastic warping method



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Introduction

- Pulmonary Hypertension (PH) is a rare disease resulting from restricted blood flow in the pulmonary arterial circulation.
- This disease is diagnosed from Right Heart Catheterization, Electrocardiogram (ECG or EKG), and Echocardiograms.
- The clinical definition is having a mean pulmonary artery pressure greater than 25 mmHg at rest (or greater than 30 mmHg during exercise).
- PH can be either idiopathic (unknown cause) or primary (secondary to another disease).
- Some of the symptoms of PH for children are: exertional dyspnea, progressive fatigue, poor appetite, failure to thrive, tachypnea, tachycardia, presyncope, and chest pain.
- Without treatment, this disease can eventually lead to right heart failure.
- Past PH research primarily focuses on the effects of the Left Ventricle (LV) or pulmonary arteries.

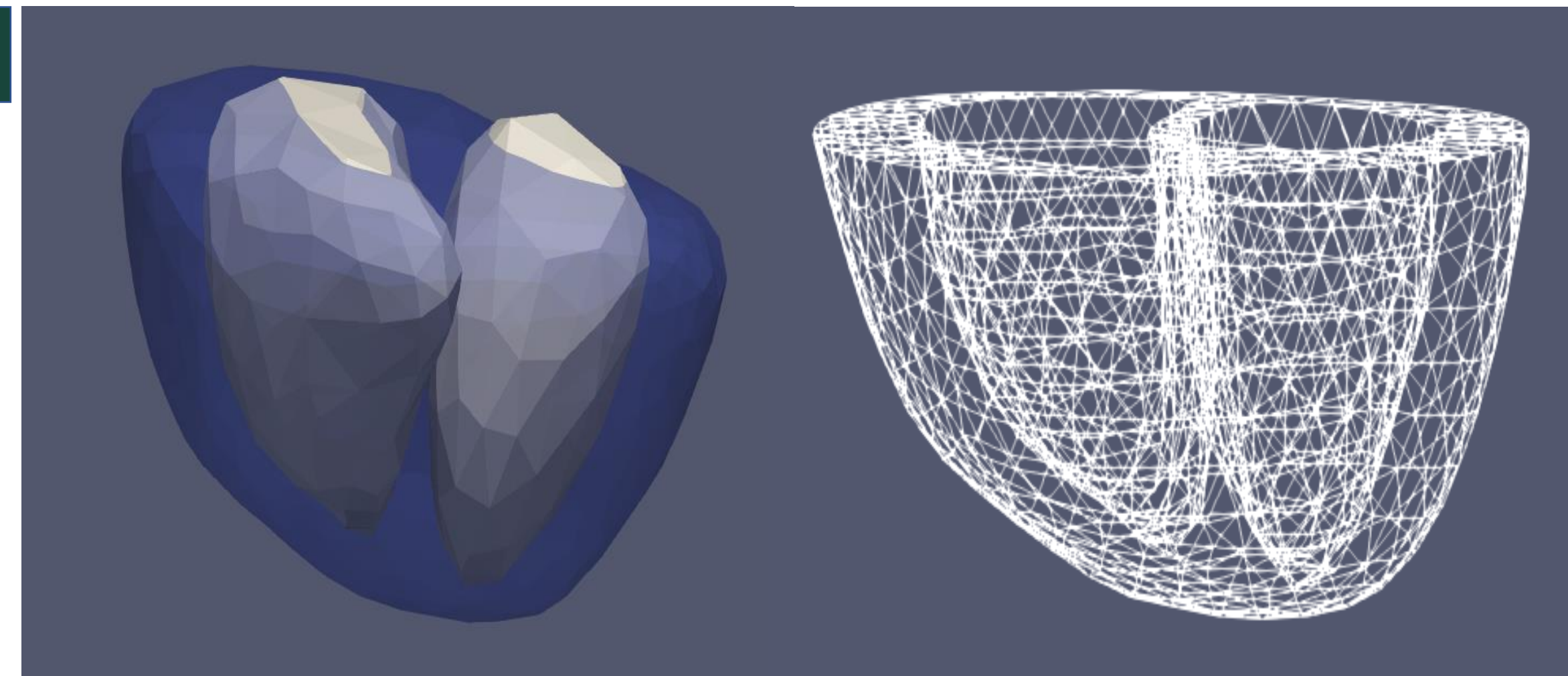


Figure 2. Geometrical model

Figure 3. Mesh of the geometrical model

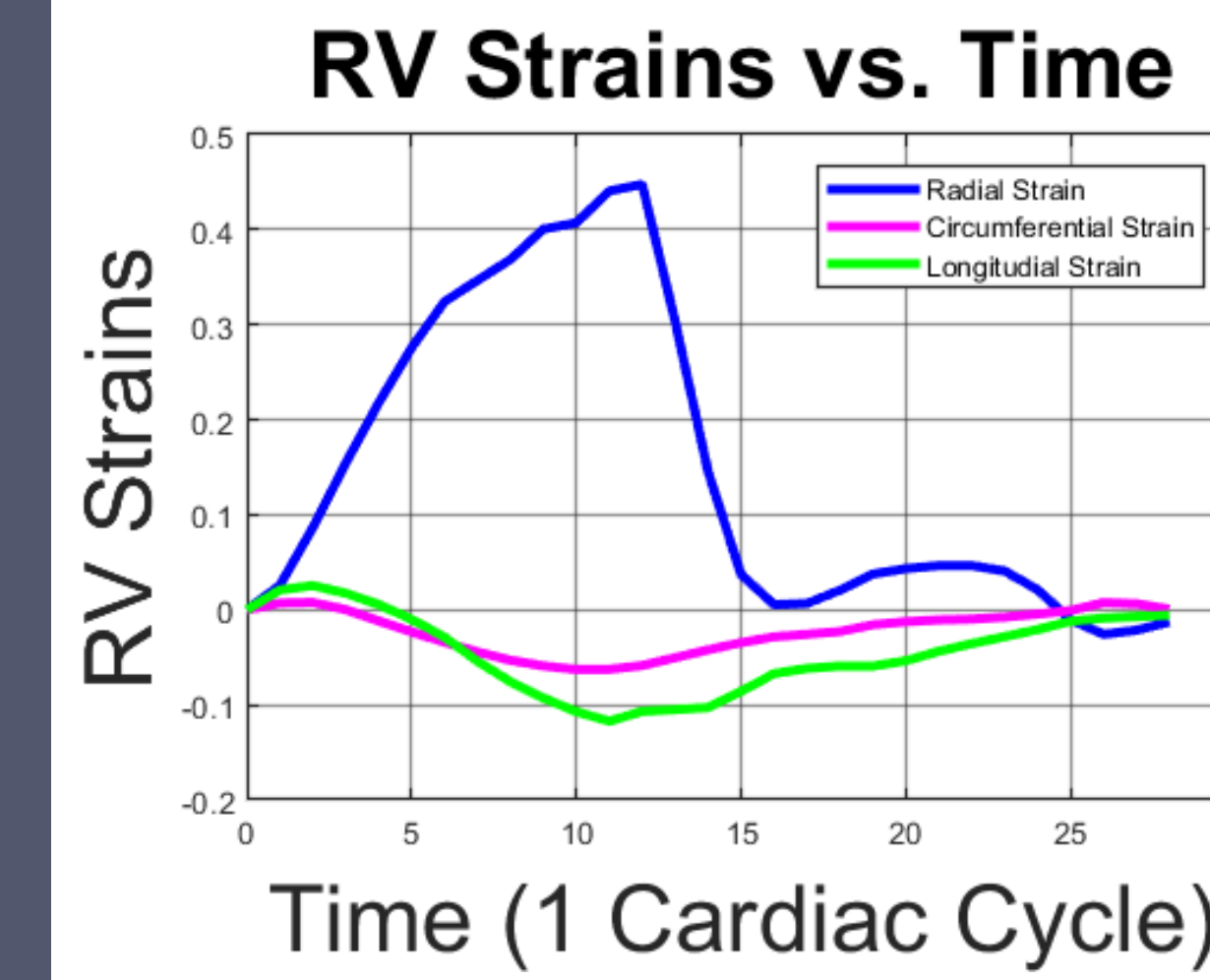


Figure 5. Post-processing of strains

A Cardiac Cycle

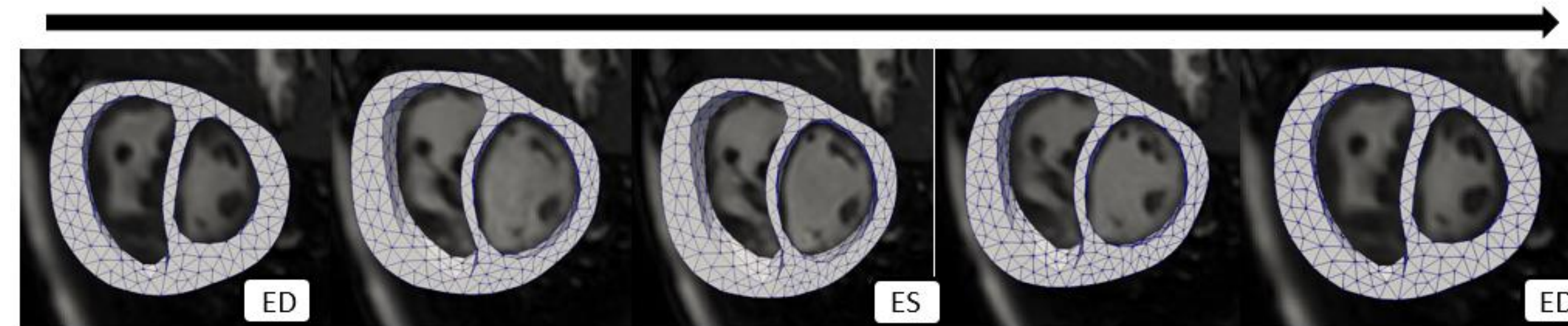


Figure 4. Registration of the bi-ventricular model with the CMR images during a cardiac cycle.

Objectives

- To compare PH patients' strain data to those of normal humans in order to detect abnormalities in the biventricular mechanics
- To investigate if there are any correlation between patients' maximum pressure, end diastolic volume (EDV), end systolic volume (ESV), and geometrical features to the maximum strain values calculated.

Methods

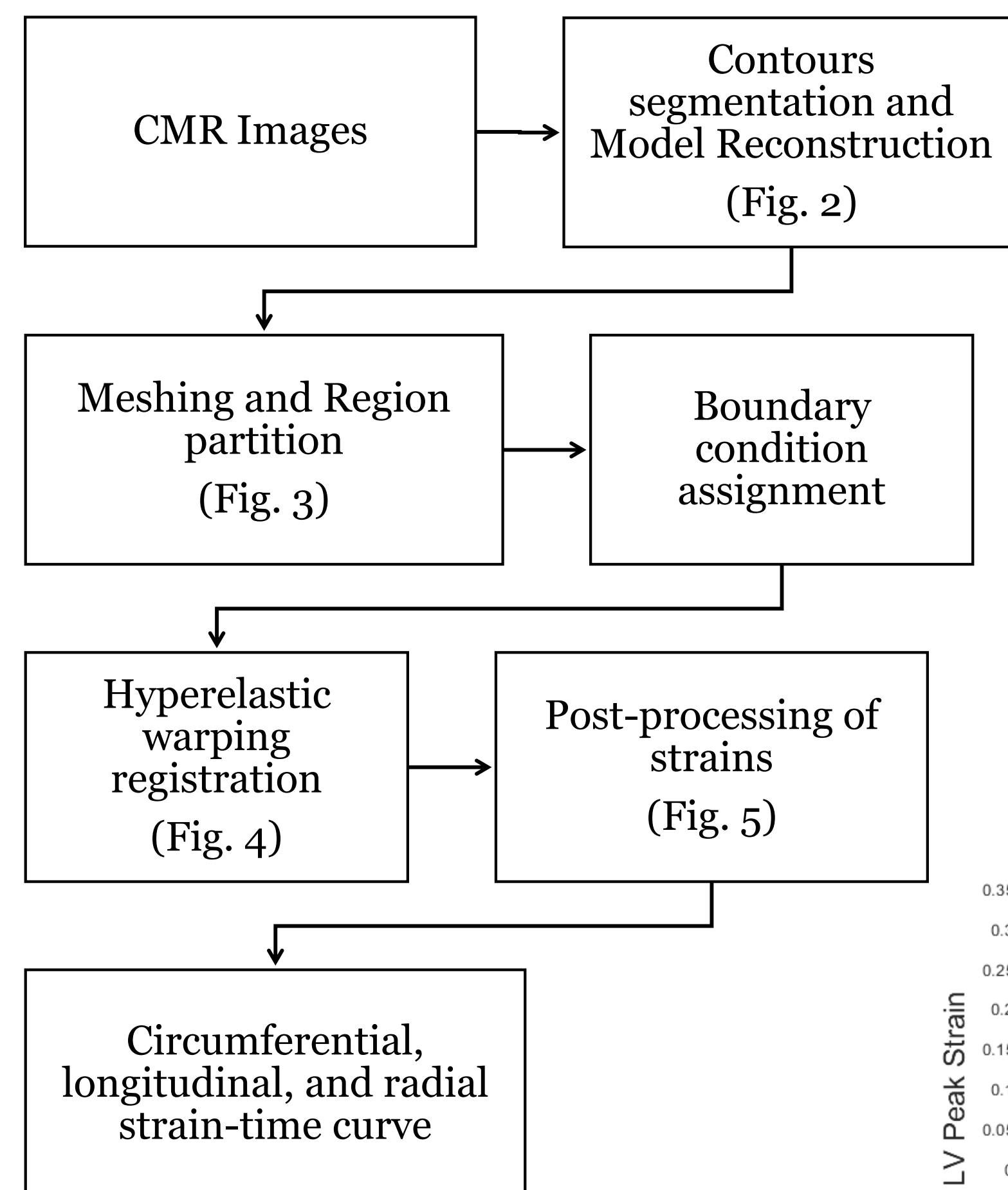


Figure 1. The overall workflow of strain measurement using Hyperelastic warping

Results

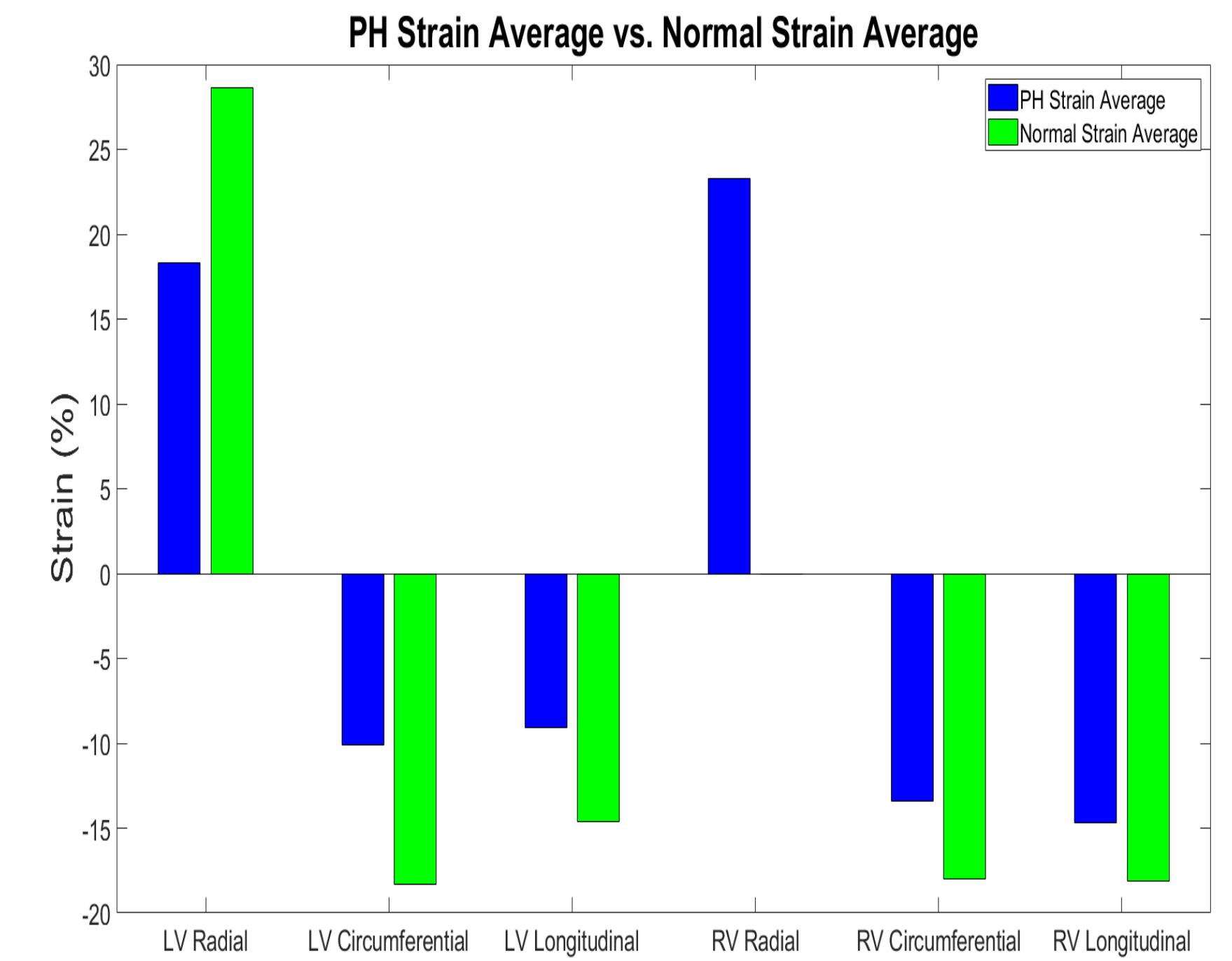
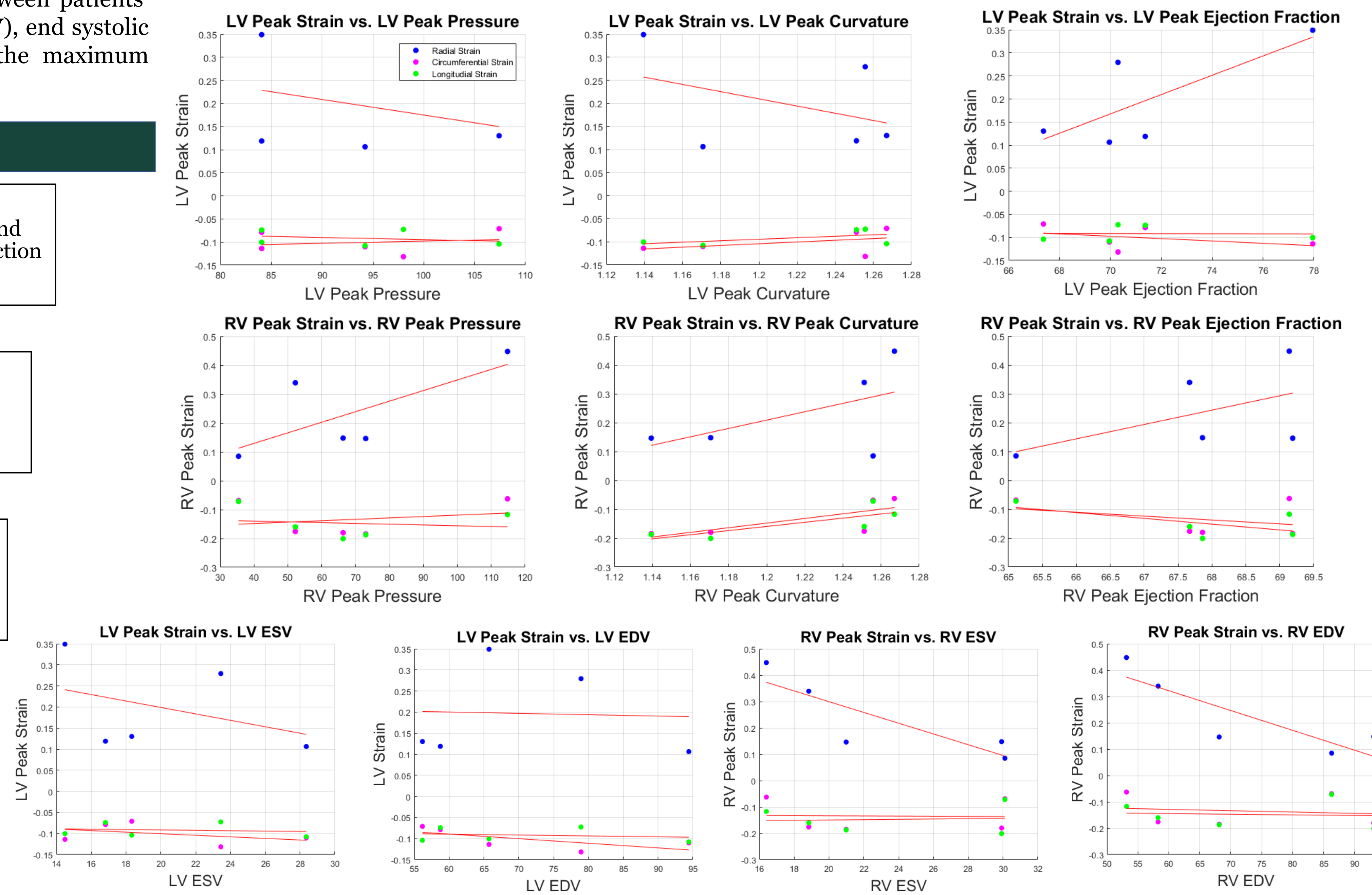


Figure 6. PH Peak Average Strain vs. Normal Average Strain

Discussion

- The mean Circumferential, Longitudinal, and Radial strains are significantly decreased from the mean normal values for both ventricles.
- Since PH is a right heart disease, it affects the RV function. The RV has to work harder to pump the blood through the blockage in the pulmonary artery.
- The ventricles are interdependent of each other. The LV function can be affected from assisting the RV in pumping blood.
- From the correlation graphs, the only strong relationships present are the RV peak radial strains vs. peak EDV and ESV.
- If the radial sizes between diastole and systole (vice versa) increases, the blood cannot properly fill and eject in the RV during the diastolic and systolic timeframes. If there is less strain (size change), the volume increases during both time periods.
- The RV strains show more of a correlation than the LV strains.

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