

# Heterogeneity of the Myocardial Strains as Revealed by Applying a Wavelet De-noising Process to the Myocardial Velocities

Noa Bachner\*, Offir Ertracht, Nir Zagury, Ofer Binah and Dan Adam

Faculty of Biomedical Engineering, Technion-Israel Institute of Technology, Haifa, Israel

**Introduction** One of the novel tools in echocardiography is the measurement of 2D strain, based on speckle tracking. The tracking provides the myocardial velocities, in time and space domains, from standard echo cines. Since the measured velocities are noisy, currently only global measures are obtained. In this study we propose using a validated wavelet de-noising process for filtering the raw velocities, as this process allows preserving the high frequency spatial and temporal components of the signals.

**Methods** Echocardiography was applied to 27 normal adult Sprague-Dawley rats, and 3 short axis scan levels were obtained. The cines were analyzed by a commercial echocardiography speckle tracking program, and the myocardial velocities were de-noised by a novel 3 dimensional wavelet de-noising process. The circumferential and radial strains were calculated from the de-noised velocities for 6 segments. Single factor analysis-of-variance was performed to determine whether heterogeneity of the strain exists among the different segments.

**Results** The circumferential strain was found to be heterogeneous at the apex and base levels ( $P < 0.001$ ); while it was homogeneous at the mid-ventricular level. At the apical level, the anterior-septum exhibited circumferential strain of  $-10.3 \pm 8.4\%$ , whereas the lateral wall exhibited  $-27.4 \pm 7.2\%$ . The radial strain was found to be heterogeneous at all scan levels (apex  $P < 0.01$ , base and mid-ventricle  $P < 0.001$ ), while the radial strain at the septum (apex  $18.1 \pm 12.3\%$ , mid-ventricle  $22.9 \pm 9.1\%$ , base  $8.2 \pm 10.3\%$ ) was smaller than the one at the free wall (apex  $29.5 \pm 13.8\%$ , mid-ventricle  $29.9 \pm 12.4\%$ , base  $16.3 \pm 13.9\%$ ) for all scan levels (apex  $P < 0.001$ , mid-ventricle and base  $P < 0.05$ ).

**Conclusions** Wavelet de-noising of the myocardial velocities reveals heterogeneity of the circumferential and radial strains that was never reported before, which is important for understanding myocardial function. Identifying this heterogeneity is crucial when attempting to diagnose abnormal segmental myocardial function.