Longitudinal and Circumferential Strain of the Proximal Aorta

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Objectives: Proximal aortic stiffness increases with age and contributes to pathogenesis of wide pulse pressure and epidemic proportions of isolated systolic hypertension, which is difficult to control. Elucidation of factors that contribute to abnormal mechanical properties of the proximal aorta may facilitate development of more effective interventions. During systole there is substantial aortic long axis displacement and longitudinal strain, which we hypothesize causes overestimation of ascending aortic stiffness calculated from circumferential strain.

Methods: We performed magnetic resonance imaging in 375 participants (72 to 94 years of age, 204 women) in the Age, Gene/Environment Susceptibility-Reykjavik Study and measured circumferential and longitudinal strain along the aortic arch. Local pulse wave velocity (PWV) was calculated from circumferential strain and central pulse pressure using the Bramwell-Hill equation.

Results: Observed circumferential area strain was lower (geometric mean [95% confidence interval], 7.7 [7.3, 8.1] vs. 12.7 [12.2, 13.2] %, P<0.001) and PWV was higher (11.0 [10.7, 11.3] vs. 8.5 [8.3, 8.8] m/s, P<0.001) in the proximal ascending versus proximal descending thoracic aorta. In contrast, peak flow was similar at the two locations (39 [38, 40] vs. 39 [38, 40] cm/s, P=0.78), which was inconsistent with observed differences in strain and PWV. When ascending aortic circumferential strain was corrected for longitudinal strain (7.8±2.6%), PWV was comparable in the ascending and descending aorta (8.3 [8.2, 8.5] vs. 8.5 [8.3, 8.8] m/s, P=0.074), consistent with comparable flow velocities.

Conclusion: Longitudinal strain represents a substantial and previously ignored component of proximal aortic volume storage that should be considered in order to avoid misclassification of ascending aortic stiffness.