ABSTRACT

Relations Between Aortic Stiffness And Left Ventricular Mechanical Function

Vanessa C. Bell,1 Elizabeth L. McCabe,2 Martin G. Larson,2,3 Jian Rong,3 Allison A. Merz,4 Ewa Osypiuk,3 Birgitta T. Lehman,3 Plamen Stantchev,3 Jayashri Aragam,5 Emelia J. Benjamin,3,6,7 Naomi M. Hamburg,7,8 Ramachandran S. Vasan,7,b,1 Gary F. Mitchell,1 Susan Cheng,3,4

1 Cardiovascular Engineering, Inc., Norwood, MA, United States; 2 Department of Biostatistics, Boston University School of Public Health, Boston, MA, United States; 3 Framingham Heart Study, Framingham, MA, United States; 4 Division of Cardiovascular Medicine, Department of Medicine, Brigham and Women’s Hospital, Boston, MA, United States; 5 Veterans Administration Hospital, West Roxbury, MA; 6 Department of Epidemiology, Boston University School of Public Health, Boston, MA, United States; 7 Whitaker Cardiovascular Institute, Preventive Medicine and Cardiology Sections, 8 Evans Department of Medicine, Boston University School of Medicine, Boston, MA, United States.

Objectives: Left ventricular contraction produces longitudinal strain in the proximal aorta. As a result, aortic stiffening may impair optimal mechanical ventricular-vascular coupling and left ventricular (LV) systolic function, particularly in the long axis. LV global longitudinal strain (GLS) has recently emerged as a sensitive measure of early cardiac dysfunction. In this study, we investigated the relation between aortic stiffness and GLS in a large community-based sample.

Methods: In 2516 participants (age 39-90 years, 57% women) of the Framingham Offspring and Omni cohorts, free of cardiovascular disease, we performed tonometry to measure aortic stiffness and echocardiography to assess cardiac function. Aortic stiffness was evaluated as carotid-femoral pulse wave velocity (CFPWV) and as characteristic impedance (Zc), and GLS was calculated using speckle tracking-based measurements.

Results: In multivariable analyses adjusting for age, sex, height, systolic blood pressure, augmentation index, LV structure, and additional cardiovascular disease risk factors, increased CFPWV (β±SE: 0.122±0.030 SD strain per SD CFPWV, P<0.0001) and Zc (0.091±0.029 SD/SD, P=0.002) were both associated with worse (less negative) GLS. We observed effect modification by sex of the relation between Zc and GLS (P=0.004); in sex-stratified multivariable analyses, the relation between greater Zc and worse GLS persisted in women (0.145±0.040, P=0.0003) but not in men (P=0.73).

Conclusion: Higher aortic stiffness was associated with worse GLS after adjusting for hemodynamic variables. Parallel reductions in LV long axis shortening and proximal aortic longitudinal strain in individuals with a stiffened proximal aorta may represent a manifestation of abnormal direct mechanical ventricular-vascular coupling.