

Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

The Decay of Vortex Ring Circulation in Left Ventricular Filling

KELLEY STEWART, SUNGHWAN JUNG, Virginia Tech, WILLIAM LITTLE, Wake Forest University School of Medicine, PAVLOS VLACHOS, Virginia Tech — Radially confined vortex rings have been previously investigated and shown to exhibit a decay in circulation after vortex ring pinch-off. A semi-empirical model for the evolution of the vortex ring circulation subject to the effect of confinement was previously developed and displayed strong agreement with experimental observations. In this work the model was applied to clinical phase contrast Magnetic Resonance Imaging data to track and potentially predict the rate of vortex ring circulation decay within the filling left ventricle (LV) subject to changing physiological characteristics in normal and diseased conditions. From our previous work and clinical observations, we hypothesize that variations in vortex ring dynamics within the LV are caused by changes in ventricular geometry. Therefore impaired ventricular relaxation causes a decreased LV volume during filling, results in a more rapid decay of early diastolic hydrodynamic circulation. This model may be used to more completely understand the filling dynamics and potentially lead to improved diagnostic techniques.

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Date submitted: 09 Aug 2011

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