Forward Wave Amplitude Is Not Solely Dependent on Proximal Aortic Properties: Importance of Wave Reflections

Timothy S. Phan[a], *Julio A. Chirinos*[b], *John K-J. Li*[a]

[a]*Rutgers University, Piscataway, NJ, USA,* [b]*University of Pennsylvania, Philadelphia, PA, USA*

Background: The contribution of proximal aortic properties and wave reflections to increased pulse pressure with aging remains controversial. The forward wave amplitude (FWA) paradigm proposes an important role for mismatch between flow and proximal aortic properties. This proposition assumes that the morphology and amplitude of the forward wave depend exclusively on the aortic root. This is unlikely, since FWA depends on the LV ejection pattern, which itself is sensitive to wave reflections.

Methods: Simultaneous aortic pressure and flow were measured in anesthetized, open-chest dogs (n=5). Wave reflections were modified through i.v. infusion of methoxamine and nitroprusside to increase and decrease reflections, respectively (Figure 1). Pressure waves were decomposed into forward and backward waves using standard methods.

Results: The time of peak flow and FWA were only approximately equal in the case of minimal reflections (Figure 2). In the presence of reflections, FWA occurred later than the time of peak flow. Increased reflections impart an inflection point on the forward wave, analogous to the inflection point on measured pressure waveforms. In the presence of normal/increased reflections, FWA was systematically greater than peak flow multiplied by aortic characteristic impedance (23.3 vs. 18.5 mmHg; P=0.006)

Conclusion: Only in cases of minimal reflections does FWA primarily reveal the interaction between peak flow and proximal aortic diameter/stiffness. Forward and backward waves are derived under the assumption of steady-state oscillations, in which both the forward and backward waves are determined by reflections. FWA is therefore influenced by wave reflections. When interpreted out of context with the hemodynamic principles of its derivation, the FWA amplitude paradigm erroneously amplifies the role of the proximal aorta on pulse pressure. We conclude that the FWA paradigm reinforces rather than precludes the role of increased reflections on the increased PP with age and disease.

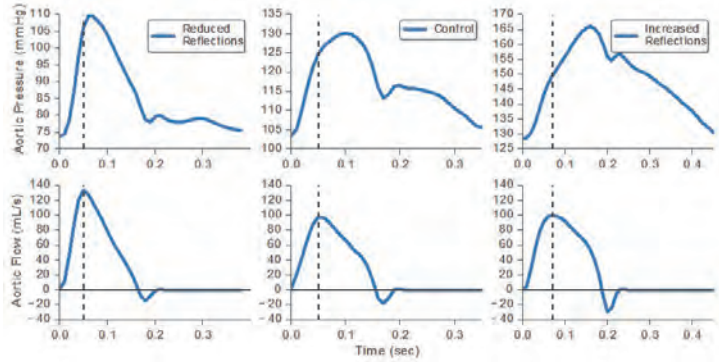

Figure 1. Simultaneously measured aortic pressure (top) and flow (bottom) waveforms. Dashed lines indicate time of peak flow.

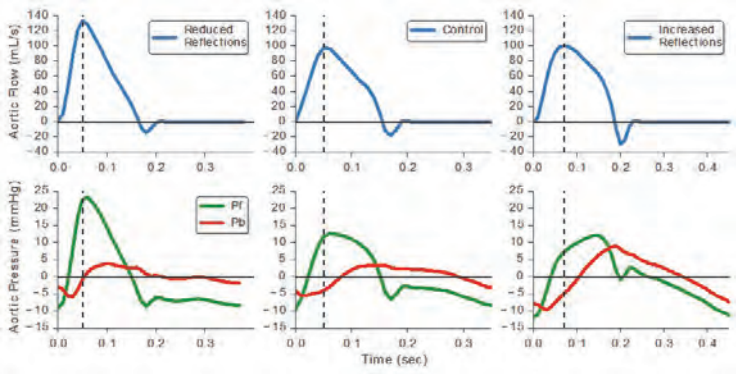

Figure 2. Measured aortic flow (top) compared with backward and forward pressure waves (bottom). The dashed lines indicate time of peak flow.