Response to A New Exercise Central Hemodynamics Paradigm: Time for Reflection or Expansion?

We thank Drs Heffernan and Lefferts for their interesting comments and request to expand on the implications of the late-systolic forward decompression (suction) wave (FDW) during exercise. Parker et al were the first to suggest that the FDW generated by the left ventricle is related to left ventricular (LV) performance and that wave reflections from the peripheral circulation were less likely to play a dominant role in the modulation of the central blood pressure waveform. Other work has shown that the FDW is closely related to LV mechanics during mid-to-late systole and that FDW generation is attributed to LV relaxation and storage of energy in the left ventricle (ie, the same mechanism facilitating early diastolic filling). Notably, the total FDW energy is related to the rate of diastolic relaxation (τ) as well as end-systolic volume and correlates closely with peak reverse ejection intraventricular pressure difference. It, therefore, seems plausible that the FDW may provide insight into aspects of LV relaxation and filling in addition to late-systolic pressure loading, as suggested by Drs Heffernan and Lefferts.

During exercise, aortic pressure is increased (raising LV afterload) and because of elevated heart rate, LV diastolic filling time tends to shorten. Under normal circumstances, the positive lusitropic effects of exercise, and optimization of LV relaxation, would be expected to generate greater late-systolic suction wave energy; as was observed in our data. Adding further complexity, the positive inotropy produced to overcome raised LV afterload and maintain adequate stroke volume may compensate a relative reduction in end-systolic volume via the Anrep effect. With all this in mind, the negative relation between FDW intensity and end-systolic pressure observed by Drs Heffernan and Lefferts in their data may not be unexpected. Indeed, additional analysis of invasive exercise data from our study revealed a similar correlation (r=-0.56; P<0.09) to theirs.

Another interesting aspect of the FDW is evidence showing reduction in magnitude from the carotid to brachial and radial arteries. This dissipation occurs to a greater extent than the forward compression wave and is inversely related to vessel diameter. Therefore, FDW intensity is greatest in the aorta, where local suction energy generated by LV relaxation is greatest. Our results show that aortic wave reflection magnitude does not change during exercise, despite large increases in FDW and forward compression wave intensity, leading us to conclude that forward propagating waves present in the aorta, that are generated by LV contraction and relaxation forces, are primary contributors to the shape of the exercise central pressure waveform. We agree with the suggestion by Drs Heffernan and Lefferts that the FDW has physiological relevance to appropriate ventricular–vascular interaction. Moreover, the accentuation of the FDW with stress induced by exercise underscores the usefulness of exercise as a modality to gain further understanding on the physiology of arterial wave travel.


Disclosures

None.

Martin G. Schultz
Menzies Research Institute Tasmania
University of Tasmania
Hobart, Tasmania, Australia

Justin E. Davies
International Centre for Circulatory Health
National Heart & Lung Institute
Imperial College London
London, United Kingdom

Phillip Roberts-Thomson
J. Andrew Black
Royal Hobart Hospital
Hobart, Tasmania, Australia

Alun D. Hughes
International Centre for Circulatory Health
National Heart & Lung Institute
Imperial College London
London, United Kingdom

James E. Sharman
Menzies Research Institute Tasmania
University of Tasmania
Hobart, Tasmania, Australia

Alun D. Hughes
International Centre for Circulatory Health
National Heart & Lung Institute
Imperial College London
London, United Kingdom

James E. Sharman
Menzies Research Institute Tasmania
University of Tasmania
Hobart, Tasmania, Australia

Response to A New Exercise Central Hemodynamics Paradigm: Time for Reflection or Expansion?
Martin G. Schultz, Justin E. Davies, Phillip Roberts-Thomson, J. Andrew Black, Alun D. Hughes and James E. Sharman

_Hypertension_. 2013;62:e36; originally published online October 7, 2013;
doi: 10.1161/HYPERTENSIONAHA.113.02142

_Hypertension_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2013 American Heart Association, Inc. All rights reserved.
Print ISSN: 0194-911X. Online ISSN: 1524-4563

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://hyper.ahajournals.org/content/62/5/e36

_Permisions_: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Hypertension_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the _Permissions and Rights Question and Answer_ document.

_Reprints_: Information about reprints can be found online at:
http://www.lww.com/reprints

_Subscriptions_: Information about subscribing to _Hypertension_ is online at:
http://hyper.ahajournals.org//subscriptions/