Uncertainties in Estimating the Site of Arterial Wave Reflection

To the Editor:

We read with interest the article by Westerhof et al,1 which sheds new light into the old and still controversial issue of the site of arterial wave reflection in humans. To this aim, the authors examined 2 previously described models of the arterial system (a uniform tube ended with a 3-element Windkessel and a model of the entire arterial system consisting of 121 vascular segments2) under different loading and stiffness conditions. Because manipulation of both distal load and aortic stiffness were found to influence the apparent reflection site, the authors concluded that aortic pulse wave velocity cannot be estimated reliably from the time of return of the reflected wave at a single proximal site.

Some questions need to be clarified, however. First, in the uniform tube model, return time increased significantly when distal occlusion was replaced by a distal 3-element Windkessel (Figure 2A and 2B), thus suggesting the shifting of the reflection site toward periphery. However, in the model with closed tube (Figure 2A) the characteristic impedance was infinite at the point of the occlusion; thus, wave reflection could be observed from this point, whereas in the model displayed in Figure 2B this obstacle was removed and replaced by a Windkessel with the same impedance of the tube. Consequently, in the model reported in Figure 2B, wave can only be reflected behind the fitting point of the Windkessel to the tube, and, in a sense, an increase in effective length is expected. This is at variance with the 121-segment model in which no differences in the return time of the pulse wave in ascending aorta were observed in the normal system (Figure 3B) and after occlusion of the aorta at its bifurcation (Figure 3A). This suggests that, at least at “average” aortic stiffness levels, the wave was reflected (mainly) from the bifurcation.

In another experiment (Figure 3C), Westerhof et al1 doubled aortic wave speed by modifying aortic stiffness and observed that this was not accompanied, as would be expected, by a correspondent halving of the return time of the pulse wave to the proximal aorta. Instead, the doubling of aortic wave speed was seriously underestimated when using the foot-to-foot method and completely missed when using the inflection point analysis. The absence of a significant change in inflection point–based return time with increasing pulse wave velocity needs to be reconciled with the in vivo findings of Segers et al.3 In a population with a relatively narrow age range (35 to 56 years, and an average age difference of 15 years from the first to the fourth quartile), inflection point–based return time of the aortic pressure curve decreased significantly with increasing age (−10.4% ongoing from the first to the fourth age quartile in men), and such reduction was about as large as the corresponding increase in aortic pulse wave velocity (+14.6%).3

Disclosures

None.

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Hypertension. 2009;53:e7; originally published online November 17, 2008;
doi: 10.1161/HYPERTENSIONAHA.108.123505
Hypertension is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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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:
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