Modeled Decomposition of Aortic Pressure Waveforms Does Not Provide Estimates for Pulse Wave Velocity

To the Editor:

With great interest we have read the article by Qasem and Avolio, in which they propose a new method to determine aortic pulse wave velocity (PWV) from waveform decomposition of the central aortic pressure pulse as derived from a single radial artery pulse measurement. The pulse transit time in the aorta is estimated by determining the time difference between the derived forward and backward waves. The validity of the pulse transit time assessment was tested in 2 groups of subjects. In the first group, the relation between measured carotid-femoral artery transit time and pulse transit time was determined using a regression model, and in the second group, the outcome of this relation was tested with presumed independent methods.

Measurement of aortic PWV, an important predictor of cardiovascular risk in humans, is not without pitfalls because of the uncertainties in estimating the distance between the carotid and femoral sites (C-F) of wave recording. We will not argue about the reliability of deriving a central aortic pressure pulse from a peripherally recorded pressure pulse by means of a transfer function and assume the central aortic pressure waveform can be derived properly. The central pressure waveform is decomposed into forward and backward components using an artificial triangular flow wave, the peak of which is assumed to coincide with the first inclination point in the aortic waveform and the end with the dicrotic notch. Much to our surprise, the decomposed forward and backward pressure waves are hardly used in further analysis. The early part of the backward wave up to the first inclination point in the aortic waveform is set at a constant value of half of the end-diastolic blood pressure (Figure 3). The remainder of the systolic phase of the backward and forward waves is reconstructed, the constraints being set by the time to the first inclination point in the aortic waveform and the ejection duration with an ambiguous algorithm that does not produce a unique solution. TR2 (the time lag of the maximum correlation) is determined by cross-correlation after normalization of the amplitude of the backward wave to that of the forward wave to avoid inconsistencies. Normalization of the wave, however, does not affect the position of the peak of the cross-correlation. The authors should have been more concerned regarding the reliability of cross-correlating waveforms of different shapes. Unless a uniform, nontapered, homogenous, and straight artery segment with a single reflection point is considered, the shape of the backward wave will be substantially different from that of the forward wave and will affect delay time estimation.

The clinical evaluation of TR2/2 (aortic pulse transit time) using correlation (Figure 6A) is inappropriate. The Bland-Altman plot (Figure 6B) shows a substantial level-dependent error in the agreement between measured transit time and TR2/2 of ~0.7 ms/ms. The comparison of C-F PWV and C-F Distance/TR2/2 raises additional questions (Figure 7). It is not surprising that the correlation between these parameters is pretty good, because C-F distance is part of both parameters. The bias in the Bland-Altman plot, although less pronounced, is also visible in this figure.

No arguments are given for the assumption that the site of reflection is in the femoral artery, which is crucial to obtain reliable values of aortic PWV calculated from C-F Distance/TR2/2 and using C-F PWV as an independent method for evaluation. The approach chosen will fail when the wave is reflected from another site, which is not unlikely, considering the observed time delay and invasively recorded PWVs.

The method proposed as an alternative to the conventional way of PWV determination and its evaluation raises many questions. We do get the impression that similar results could have been obtained by directly taking the first inclination point in the aortic waveform as delay time rather than TR2. Moreover, it should be realized that a good estimate of aortic pulse transit time, if any, has no meaning physically without knowledge of the pathway to the reflection site.

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