Letters to the Editor

Techniques for Studying Arterial Elastic Properties

To the Editor:

I applaud the effort of Rietzschel and colleagues to compare two techniques in wide use for studying arterial elastic properties. This is a study long in need of performance because of the controversial claims in the literature relating to the theory of systolic and diastolic wave form analysis. As we had anticipated and predicted, a reasonably good correlation was observed between the C2 measured by diastolic pulse wave analysis using a modified Windkessel analysis and late systolic augmentation index assessed using a transfer function previously described. The values from both of these techniques apparently relate, at least in part, to reflected waves from the peripheral small arteries. The augmentation index is also critically dependent on large artery pulse wave velocity that accounts for appearance of the reflected wave at the root of the aorta in late systole. The C2 also may have some dependency on large artery elasticity, but fortunately an independent assessment of this large artery elasticity is also available from the calculation of C1 in the modified Windkessel model.

The authors of the study have, however, performed a disservice by their flawed analysis of their data. They claim that the variability of C2 (33.3% by their calculation) is much greater than the variability of the augmentation index (6.7%), and they imply that this “wide gap” might make the C2 measurements of less diagnostic precision. But variability of a diagnostic tool can only be evaluated in relation to the range of absolute values to be anticipated. The range of AIx observed in their studies was from about 80% to 180%, a 125% range. The range of C2 was from about 1 to 14 mm Hg, a 1300% range. The diagnostic precision for AIx could then be estimated as 125/6.7 or 19, whereas the diagnostic precision of C2 would be 1300/33.3 or 39. Because both of these tests provide a range of values from normal (young) to abnormal (old), a 33.3% variability in C2 would have even less impact on diagnostic precision than a 6.7% variability in AIx.

The authors also demonstrate some bias in their interpretation of Figure 4, which analyzes the differences observed in regression lines describing C2 and AIx. They assume in their analysis that the C2 is inaccurate, whereas it is equally plausible that the inaccuracy is in the AIx calculation.

Critical analyses of methodology require the absence of bias and a pristine assessment of data. We regret that the authors’ analysis appears to have fallen short of that standard and thus may have misled users of these instruments.

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(Note: Dr Cohn has an equity position in Hypertension Diagnostics, the manufacturer of a pulsewave analysis device similar to the one evaluated in the publication.)

Response

We thank Dr Cohn for the interest he shows in our paper. Dr Cohn questions the manner in which we evaluated short-term reproducibility and the conclusions we drew from these analyses. We ascribed a worse reproducibility to the C1- and C2-elements of a modified Windkessel model as measured by the HDI CR-2000 device compared with the augmentation index (AIx) as measured by the SphygmoCor BPAS-II/A. Reproducibility for both devices was assessed as dual measurements (in random device order) with complete tonometer removal between measurements and reapplication on the ipsilateral radial site, within a timeframe of 5 minutes, in resting subjects. We described short-term reproducibility by all 3 most commonly used and accepted methods in contemporary literature:

Correlation coefficients between first and second measurement (data are Spearman r): C1 0.742; C2 0.848; AIx 0.945.

Coefficients of variation (calculated as standard deviation of the difference between 2 measurements divided by the mean value of the measurements): C1 32.8%; C2 33.3%; AIx 6.7%.

Bland-Altman plots depicting percentage difference between 2 measurements plotted against mean of 2 measurements; data are lower and upper limits of the 95% confidence interval of the percentage variation (span): C1 from −63.3 to +69.1% (122.4%); C2 from −57.9 to +72.8% (130.7%); AIx from −12.4 to +13.8% (26.2%).

We feel the data presented to be clear, concise, and given in a well-documented, recognized, and readable format, allowing interested readers to draw relevant conclusions. Moreover, the data we presented are not isolated but complement previously published animal data describing reproducibility problems with Windkessel models.

From a mathematical and statistical point of view, we do not feel comfortable with the measure of “diagnostic precision” as formulated in Dr Cohn’s letter, for we do not expect the proposed ratio of a percentage range of values by the coefficient of variation to yield a better estimate of variability. A source of concern is that whenever a parameter has very low values (approaching zero), the calculation of percentage ranges of values will approach infinity, invalidating the calculation.

In reply to the second point, the goal of our study was stated to be an investigation of the relation between C2 (a putative, novel marker of wave reflection) and a longstanding and documented prototype of wave reflection, the AIx. It, therefore, was logical in this setting to quantify deviations of the putative new marker versus the proven documented marker.

In conclusion, we still feel that the data published in *Hypertension* are reliable and were presented in a straightforward and scientifically valid manner.

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