Invasive Validation of the N-Point Moving Average Method

We read with great interest the recent paper by Williams et al. (1) introducing and validating a new method to derive central aortic systolic blood pressure (cSBP). We fully agree that simpler methods to derive cSBP will facilitate the distribution of this important measure into large clinical trials and, eventually, into clinical routine. However, some questions about the invasive validation need to be addressed.

Typically, in studies of this kind, mean differences between measured and calculated cSBPs are small (1 to 2 mm Hg), and SDs of differences are in the range of 7 to 11 mm Hg (2,3). Williams et al. (1) present the data as mean \( \pm \text{SE} \), which is unusual. SE is approximately a factor \( \sqrt{n} \) smaller than SD, which must be kept in mind when interpreting the results. In the first paragraph of the section on invasive validation, the authors use the SE on the basis of \( n^{1/2} \) (invasive cSBP 139.6 \( \pm \) 4.3 mm Hg) and then proceed to use the SE on the basis of \( n^{1/2} \) (invasive cSBP 139.6 \( \pm \) 1.4 mm Hg) and stay unclear when presenting the differences between calculated cSBP and invasive cSBP (\( \pm 0.41 \) \( \pm \) 2.5 mm Hg). Supposing again \( n = 20 \) for SE, the usual presentation of these data on the basis of mean \( \pm \text{SD} \) leads to mean difference of \( 0.41 \) mm Hg and an SD of 11.2 mm Hg, which would be in line with the published literature.

The presentation of data stays unusual for Figure 5 of their paper (1). The assumption that data based on multiple sampling windows of 10 s, using the same calibration, are independent is questionable. Such data may not be suitable for regression analysis and provide misleading coefficients and p values. This is even visually unveiled by the vertical data clustering along the regression line (Fig. 5A of their paper [1]). It would be informative to see the corresponding Bland-Altman plot on a per-patient basis.

To summarize, we have significant questions about the presentation of the results of the invasive part of the validation study.

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Please note: Drs. Wassertheurer and Hametner are employees of the Austrian Institute of Technology, developing new methods for noninvasive hemodynamic monitoring. Drs. Weber and Eber have reported that they have no relationships relevant to the contents of this letter to disclose.

REFERENCES

Reply

We thank Dr. Wassertheurer and colleagues for their interest in our study (1) and note their agreement about the importance of developing simpler noninvasive methods for deriving central aortic systolic blood pressure (CASP) in man. They comment on the level of agreement between invasive and noninvasive measure-

![Bland-Altman Plots Comparing Invasive Aortic Root Systolic Pressure With Noninvasively Derived CASP](image-url)

**Figure 1** Bland-Altman Plots Comparing Invasive Aortic Root Systolic Pressure With Noninvasively Derived CASP

(A) All radial pressure waveform blocks calibrated to the initial brachial blood pressure and processed using the AtCor processing algorithm (GTF CASP); (B) initial waveform block calibrated to brachial blood pressure with auto-updating of subsequent waveform blocks using the A-pulse device and processed using an N-point moving average (NPMA-CASP). Data show mean difference (dashed line) together with 2 SDs of the mean difference (dotted lines). CASP = central aortic systolic blood pressure.