Evaluation of a cuffless watch-like sensor for 24-hour ambulatory blood pressure monitoring

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Introduction: Ambulatory blood pressure monitoring (ABPM) is increasingly used in clinical practice for the formal diagnosis of hypertension, and particularly indicated in cases of suspected white-coat effect, masked, or nocturnal hypertension. However, the use of cuffs for ABPM may be painful and cause discomfort, particularly at night, where it may even provoke arousal from sleep and lead to non-representative nighttime blood pressure (BP) values.

Purpose: To investigate the feasibility of using a cuffless watch-like photoplethysmographic (PPG) sensor for 24-hour ABPM by comparing the PPG-based BP estimates with conventional cuff-derived ABPM values.

Methods: Our study was approved by the local ethical committee and conducted in 70 participants (43±18 y, 35 with hypertension, 41 male) undergoing cuff-based ABPM. At the contralateral side of the cuff, a cuffless watch-like PPG sensor was worn at the wrist or upper arm. Systolic (SBP) and diastolic (DBP) BP values were estimated by pulse wave analysis on the measured PPG signals. Following a calibration procedure, the PPG-based daytime and nighttime BP estimates were compared to their cuff-based counterparts. The agreement between both methods was evaluated via the mean (bias) and standard deviation (SD) of their differences by Bland-Altman analysis. The agreement on the nocturnal dipping estimates of both devices was also assessed. Finally, the concordance rate (CR) was assessed as the percentage of dipping values showing a concordant direction (dipping vs. non-dipping) between both methods.

Results: The data of 4 participants were incomplete due to technical issues and had to be rejected prior to analysis. In 4 additional participants, the PPG data quality was insufficient to provide enough BP estimates, probably due to poor sensor tightening. In the remaining 62 participants, we found (see Figure 1) differences between the daytime PPG-based and cuff-based BP estimates of –0.9±3.6 mmHg and –1.4±2.9 mmHg for SBP and DBP, respectively. The differences between the nighttime estimates were –0.8±6.8 mmHg and 0.5±5.3 mmHg, resulting in dipping differences of 0.1±6.8% and –2.0±8.6% for SBP and DBP, respectively. CR on dipping was 97% for both SBP and DBP.

Conclusions: Good agreement was found between the PPG-based and the cuff-based daytime and nighttime BP averages, with generally negligible (∼1 mmHg) biases. The direction of dipping was highly concordant between both methods. The estimation of its amplitude showed a low bias (∼1%) but a non-negligible spread (SD), which can be in part attributed to the uncertainty on the cuff-based dipping estimates (95% confidence interval range of 12.5% and 16.5% on average for SBP and DBP, respectively), more than twice as large than their PPG-based counterparts (5.7% and 7.8%). Although our study was designed as a method-comparison feasibility study, these results encouragingly suggest that cuffless ABPM may soon become a clinical possibility.

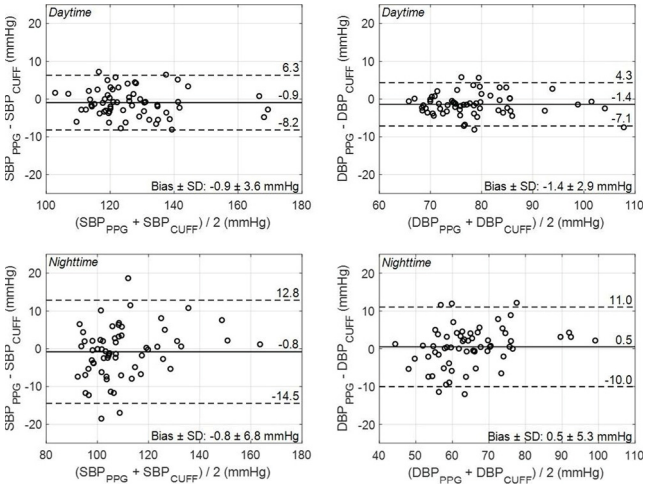

Figure 1