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## **Cuffless Ring Photoplethysmography for 24-Hour Blood Pressure Monitoring in Hemodialysis Patients: Validation Against Ambulatory BP Monitoring and Assessment of Dipping Pattern Agreement**

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**Objectives :** Hemodialysis patients have a high cardiovascular risk, and nocturnal B) dipping is an important prognostic marker. Although ABPM is the reference standard for 24-hour BP assessment, cuffless photoplethysmography-based devices may provide a more convenient alternative. However, their performance in hemodialysis patients remains insufficiently validated.

**Methods :** We prospectively enrolled 36 hemodialysis patients at Gangnam Severance Hospital. ABPM (TM-2441, A&D Medical; n = 33) and a cuffless ring-based BP device (CART; n = 34) were simultaneously recorded; 32 patients had paired measurements for analysis. Daytime and nighttime periods were defined using device-specific sleep annotations. Agreement was evaluated using Pearson correlation and Bland–Altman analysis with limits of agreement (LOA). Nocturnal dipping patterns were classified to assess concordance using Cohen's kappa.

**Results :** Ring BP showed strong correlations with ABPM for 24-hour systolic BP (SBP) and diastolic BP (DBP) (SBP r = 0.829; DBP r = 0.855; both p < 0.0001). However, the ring device systematically underestimated BP values, with a mean SBP difference of  $-14.2 \pm 14.5$  mmHg (LOA  $-42.6$  to  $+14.2$  mmHg) and DBP difference of  $-7.8 \pm 6.3$  mmHg. The degree of underestimation was greater in sustained hypertension ( $-22.1 \pm 12.5$  mmHg) than in normotension ( $+1.6 \pm 9.6$  mmHg), suggesting proportional bias at higher BP levels. ABPM classified patients as reverse dippers (45%), non-dippers (42%), and dippers (13%). Binary agreement for dipper versus non-dipper status was 90.3% ( $\kappa = 0.37$ ), largely driven by concordance in non-dippers (27/27). However, the ring device detected only 1 of 4 true dippers (sensitivity 25%, specificity 100%), reflecting a compressed distribution of dipping percentage (SD 4.6% vs. 12.3% with ABPM).

**Conclusions :** In hemodialysis patients, cuffless ring-based BP monitoring correlated with ABPM but underestimated BP, particularly at higher levels. Non-dipping patterns were largely concordant, but detection of true dippers was limited, requiring calibration refinement before replacing ABPM.

Figure 1.jpg



Figure 1.

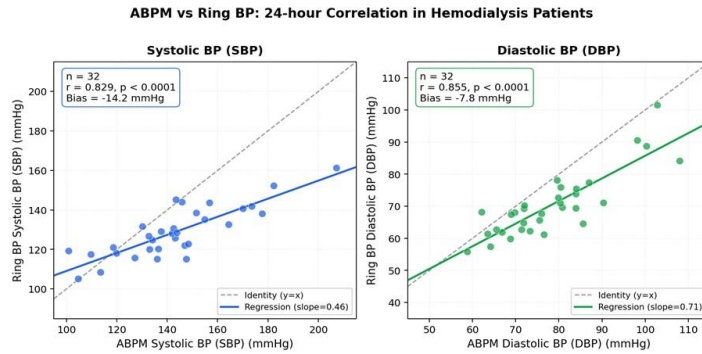


Figure 1.jpg

Figure 2.

