P1522

Validating a new device for precise assessment of pulse wave velocity in arteries of various structures in patients in different age groups

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Background: Arterial stiffness (AS) is a process that develops with age and obesity, but is also an independent predictive factor for the development of hypertension, and cardiovascular complications. Measuring the pulse wave velocity (PWV) is the most common method of assessing arterial stiffness. Two methods of PWV evaluation dominate in the world (carotid-femoral and brachial-ankle). However, recent studies have indicated that the age-related increase in PWV was not even uniform in different arteries and the AS gradient is a better predictor of mortality than the classic PWV one. So we need the devices for a more accurate assessment of AS in different areas. Our group constructed a precise, multi-site system (M3S) for the simultaneous, real-time, synchronous measurement of PWV. M3S has a maximum of eight photopletysmographic (PPG) detectors – Fig. 1A.

Aim: The purpose of the study is to validate the PWV measurement by M3S device against a gold standard (SphygmoCor XCEL) for patients in different age groups.

Methods: Measurements collected from 62 subjects (36 young [19–24], 26 older [62–89]) using the M3S were compared with simultaneously recorded SphygmoCor XCEL measurements. With the 59 paired PWV values, we investigated the agreement between the M3S prototype and the SphygmoCor XCEL device using Pearson correlation analysis and Bland-Altman plot. We also performed analysis on the determinants and reproducibility of PWV measured with both devices.

Results: The correlation coefficient for PWV measured with the two devices was 0.87 ($p<0.001$) – Fig. 1B. Compared with the SphygmoCor XCEL device, the M3S prototype slightly underestimated PWV by r=–0.47 m/s (±1.96 standard deviations SD: +2.2 m/s, r=–3.2 m/s). The coefficient of variation (CV) between the difference and the average of the M3S and SphygmoCor XCEL measurements was 19% (p=0.10) – Fig. 1C.

Conclusion: This technique used by the M3S could provided a multi-site measurement of PWV. It can be potentially extended for measurement and non-invasive characterization of global arterial stiffness with the possibility of calculating the different AS gradients.

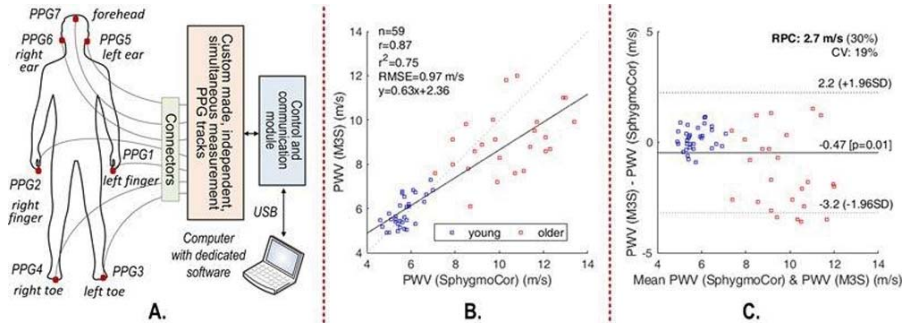

Figure 1. A. Block diagram of M3S measurement system with configuration for PWV validation. B. Relationship between PWV for SphygmoCor XCEL (carotid-femoral) and M3S (forehead-toes (right, left mean). C. Bland-Altman plot for the analysis of the difference between the SphygmoCor XCEL and M3S devices.