Validation of the Mobil-O-Graph: 24 h-blood pressure measurement device.
Wei W¹, Tölle M¹, Zidek W¹, van der Giet M¹/¹Department of Nephrology, Medizinische Klinik IV, Berlin, Germany.

Abstract

OBJECTIVE:
Twenty-four-hour blood pressure measurement is of importance not only in the detection of hypertension but also in the detection of blood pressure changes in hypertensive and non-hypertensives over the day to identify, for example, non-dipper hypertensives. This study describes the validation of the Mobil-O-Graph according to the criteria of the British Hypertension Society (BHS).

METHODS:
For each patient three readings obtained by the Mobil-O-Graph were compared with auscultatory sphygmomanometric readings obtained by two trained clinicians. The sphygmomanometric reference measurements were alternated with the readings obtained by the device. Eighty-five patients (mean age 53.4 +/- 18.4 years) were recruited for the BHS protocol. Differences between blood pressure values of the test device and the mercury reading were calculated for each measurement.

RESULTS:
In the BHS validation procedure the mean differences of the observer readings and the test device were -2.2 +/- 6.7 (systolic) and -0.6 +/- 5.6 mmHg (diastolic) for observer 1 and -2.2 +/- 7.3 mmHg (systolic) and -0.4 +/- 6.1 mmHg (diastolic) for observer 2. The device achieved grade A for systolic and diastolic blood pressure for both the observers 1 and 2 leading to a final grade A/A. According to the BHS protocol the measurements of the device have to be considered 'very accurate and with no error of clinical relevance'.

CONCLUSION:
The device met the accuracy requirements of the BHS standard and can be recommended for clinical use.

Evaluation of the Mobil-O-Graph new generation ABPM device using the ESH criteria. Franssen PM¹, Imholz BP² / ¹Department of Internal Medicine, Radboud University Nijmegen Medical Centre, The Netherlands, ²Twee Steden Ziekenhuis, Waalwijk, The Netherlands

Abstract

We report on the validation of the new generation Mobil-O-Graph 24/48 h ambulatory blood pressure monitor according to the criteria of the European Society of Hypertension. In 15 individuals participating in phase I for systolic pressure, all 45 measures differed less than 15 mmHg, 43 and 33 out of 45 differed less than 10 and 5 mmHg. As for diastolic pressures even better scores were reached when the device passed the EHS score. In phase II, data were collected in an additional 18 individuals leaving a total of 33 individuals and 99 measures. The phase counts the achieved percentages of two or three measures per individual within 15, 10 and 5 mmHg limits. Systolic pressures exceeded the required 95, 80 and 65% for 15, 10 and 5 mmHg differences with values of 98, 94 and 71%, respectively. As again for diastolic pressure the values were even better, the device passed phase II also. Thus, all phases of the European Society of Hypertension procedure were passed and the results of this study can recommend the use of the Mobil-O-Graph new generation ambulatory blood pressure monitor device in clinical practice.
Oscillometric estimation of central blood pressure: validation of the Mobil-O-Graph in comparison with the SphygmoCor device. Weiss W¹, Gohlisch C¹, Harsch-Gladisch C¹, Tölle M¹, Zidek W¹, van der Giet M¹ /¹ Med. Klinik mit Schwerpunkt Nephrologie, Charite-Campus Benjamin Franklin, Berlin, Germany

Abstract

BACKGROUND
Hypertension is a major risk factor for a wide range of cardiovascular diseases and is typically identified by measuring blood pressure (BP) at the brachial artery. Although such a measurement may accurately determine diastolic BP, systolic BP is not reflected accurately. Current non invasive techniques for assessing central aortic BP require additional recording of an arterial pressure wave using a high-fidelity applanation tonometer. Within one measurement cycle, the Mobil-O-Graph BP device uses brachial oscillometric BP waves for a non invasive estimation of central BP. We therefore validated the Mobil-O-Graph against the SphygmoCor device, which is widely known as the commonly used approach for a non invasive estimation of central BP.

METHODS
For each individual, we compared three readings of the central BP values obtained by the Mobil-O-Graph and SphygmoCor device consecutively. One hundred individuals (mean age 56.1 ± 15.4 years) were recruited for measurement. Differences between the central BP values of the test device and the SphygmoCor device were calculated for each measurement.

RESULTS
The mean difference (95% confidence interval) for the estimated central systolic BP between both devices was -0.6 ± 3.7 mmHg. Comparison of the central BP values measured by the two devices showed a statistically significant linear correlation (R=0.91, P<0.0001). The mean between-method difference was 0.50 mmHg for central systolic BP estimation. The reproducibility between both the devices was also comparable. Bland and Altman analyses showed that the mean differences (95% confidence interval) between repeated measurements were 1.89 (0.42-3.36) mmHg and 1.36 (-0.16 to 2.83) mmHg for the SphygmoCor and the Mobil-O-Graph device, respectively. Thus, neither of these differences was statistically significantly different from 0. The limits of agreement were -16.34 to 19.73 and -15.23 to 17.17 mmHg for the SphygmoCor and the Mobil-O-Graph device, respectively.

CONCLUSION
Oscillometric non invasive estimation of central BP with the Mobil-O-Graph BP device is as effective as using the well-established SphygmoCor applanation tonometry device. In comparison, the Mobil-O-Graph combines the widespread benefits of brachial BP measurement and also provides central BP within one measurement.
Validation of a brachial cuff-based method for estimating central systolic blood pressure. Weber T¹, Wassertheurer S¹, Rammer M¹, Maurer E¹, Hametner B¹, Mayer CC¹, Kropf J¹, Eber B¹.¹ Cardiology Department, Klinikum Wels-Grieskirchen, Wels, Austria

Abstract
The prognostic value of central systolic blood pressure has been established recently. At present, its non-invasive assessment is limited by the need of dedicated equipment and trained operators. Moreover, ambulatory and home blood pressure monitoring of central pressures are not feasible. An algorithm enabling conventional automated oscillometric blood pressure monitors to assess central systolic pressure could be of value.

We compared central systolic pressure, calculated with a transfer-function like method (ARCSolver algorithm), using waveforms recorded with a regular oscillometric cuff suitable for ambulatory measurements, with simultaneous high-fidelity invasive recordings, and with non-invasive estimations using a validated device, operating with radial tonometry and a generalized transfer function. Both studies revealed a good agreement between the oscillometric cuff-based central systolic pressure and the comparator. In the invasive study, composed of 30 patients, mean difference between oscillometric cuff/ARCSolver-based and invasive central systolic pressures was 3.0 mm Hg (SD: 6.0 mm Hg) with invasive calibration of brachial waveforms and -3.0 mm Hg (SD: 9.5 mm Hg) with non-invasive calibration of brachial waveforms.

Results were similar when the reference method (radial tonometry/transfer function) was compared with invasive measurements. In the non-invasive study, composed of 111 patients, mean difference between oscillometric cuff/ARCSolver-derived and radial tonometry/transfer function-derived central systolic pressures was -0.5 mm Hg (SD: 4.7 mm Hg). In conclusion, a novel transfer function-like algorithm, using brachial cuff-based waveform recordings, is suited to provide a realistic estimation of central systolic pressure.

24-h ambulatory recording of aortic pulse wave velocity and central systolic augmentation: a feasibility study.
Luzardo L¹, Lujambio I¹, Sottolano M¹, da Rosa A¹, Thijs L¹, Noboa O¹, Staessen JA¹, Boggia J.¹ /¹ Unidad de Hipertensión Arterial and Centro de Nefrología, Hospital de Clínicas, Universidad de la República, Montevideo, Uruguay.

Abstract
We assessed the feasibility of ambulatory pulse wave analysis by comparing this approach with an established tonometric technique. We investigated 35 volunteers (45.6 years; 51.0% women) exclusively at rest (R study) and 83 volunteers (49.9 years; 61.4% women) at rest and during daytime (1000-2000 h) ambulatory monitoring (R+A study). We recorded central systolic (cSP), diastolic (cDP) and pulse (cPP) pressures, augmentation index (cAI) and pulse wave velocity (PWV) by brachial oscillometry (Mobil-O-Graph 24h PWA Monitor) and radial tonometry (SphygmoCor). We applied the Bland and Altman's statistics.

In the R study, tonometric and oscillometric estimates of cSP (105.6 vs. 106.9 mmHg), cDP (74.6 vs. 74.7 mmHg), cPP (31.0 vs. 32.1 mmHg), cAI (21.1 vs. 20.6%) and PWV (7.3 vs. 7.0 m/s(-1)) were similar (P=0.11). In the R+A study, tonometric vs. oscillometric assessment yielded similar values for cSP (115.4 vs. 113.9 mmHg; P=0.19) and cAI (26.5 vs. 25.3%; P=0.54), but lower cDP (77.8 vs. 81.9 mmHg; P<0.0001), so that cPP was higher (37.6 vs. 32.1 mmHg; P<0.0001). PWV (7.9 vs. 7.4 m/s(-1)) was higher (P=0.0002) on tonometric assessment. The differences between tonometric and oscillometric estimates increased (P<0.004) with cSP (r=0.37), cAI (r=0.39) and PWV (r=0.39), but not (P=0.17) with cDP (r=0.15) or cPP (r=0.13).

Irrespective of measurement conditions, brachial oscillometry compared with an established tonometric method provided similar estimates for cSP and systolic augmentation, but slightly underestimated PWV. Pending further validation, ambulatory assessment of central hemodynamic variables is feasible.
Feasibility and reproducibility of noninvasive 24-h ambulatory aortic blood pressure monitoring with a brachial cuff-based oscillometric device. Protogerou AD¹, Argyris A¹, Nasothimiou E¹, Vrachatis D¹, Papaioannou TG¹, Tzamouranis D¹, Blacher J¹, Safar ME¹, Sfikakis P¹, Stergiou GS¹ / ¹Hypertension Center and Cardiovascular Research Laboratory, 1st Department of Propaedeutic Medicine, Laiko Hospital, National and Kapodistrian University of Athens, Athens, Greece.

Abstract

BACKGROUND:
Accumulating evidence suggests the potential superiority of office aortic blood pressure (BP) over brachial in the management of arterial hypertension. The non invasive aortic 24-h ambulatory brachial BP monitoring (ABPM) is potentially the optimal method for assessing BP profile. The objective of the present study was to investigate the feasibility and reproducibility to perform noninvasively 24-h aortic ABPM with a novel validated brachial cuff-based automatic oscillometric device (Mobil-O-Graph) which records brachial BP and waveforms and assesses aortic BP via mathematical transformation.

METHODS:
Thirty consecutive subjects (mean age: 53.6 ± 11.6 years, 17 men) had a test-retest ABPM with at least 1-week interval. No modification of vasoactive drug treatment during the interval was allowed while similar 24-h activity during both recording days was recommended.

RESULTS:
The average number of valid readings for brachial vs. aortic BP were 69.9 ± 10.4 vs. 58.0 ± 13.3 in the initial 24-h assessment (P < 0.001) and 68.3 ± 10.8 vs. 56.4 ± 13.6 in the repeat assessment (P < 0.001). No differences in average 24 h aortic BP values were observed between the two assessments (systolic blood pressure (SBP) 115.9 ± 7.7 vs. 115.1 ± 6.0 mm Hg, respectively, P = 0.48, and diastolic 79.7 ± 7.4 vs. 79.2 ± 8.7, P = 0.54). Reproducibility indices of aortic pressure including, intra-class coefficient of variation (SBP: 0.80 (95% confidence interval 0.58-0.90); diastolic: 0.92 (0.83-0.96)) and SD. of differences (SBP/diastolic: 6.0/4.5 mm Hg) indicated acceptable reproducibility. The Bland-Altman plots indicated no evidence of systemic bias.

CONCLUSIONS:
In conclusion, these data suggest that non invasive 24-h ABPM is feasible and provides reproducible values. Future studies should validate the prognostic ability of 24-h aortic hemodynamics.
Oscillometric estimation of aortic pulse wave velocity: comparison with intra-aortic catheter measurements. Hametner B\(^1\), Wassertheurer S\(^1\), Kropf J, Mayer C\(^1\), Eber B\(^1\), Weber T\(^1\) / \(^1\) Department of Health and Environment, AIT Austrian Institute of Technology, Vienna, Austria.

Abstract

OBJECTIVES:
Recently, a novel method to estimate aortic pulse wave velocity (aPWV) noninvasively from an oscillometric single brachial cuff waveform reading has been introduced. We investigated whether this new approach provides acceptable estimates of aPWV compared with intra-aortic catheter measurements.

METHODS:
Estimated values of aPWV obtained from brachial cuff readings were compared with those obtained using an intra-aortic catheter in 120 patients (mean age 61.8±10.8 years) suspected for coronary artery disease undergoing cardiac catheterization. Differences between aPWV values obtained from the test device and those obtained from catheter measurements were estimated using Bland-Altman analysis.

RESULTS:
The mean difference ±SD between brachial cuff-derived values and intra-aortic values was 0.43±1.24 m/s. Comparison of aPWV measured by the two methods showed a significant linear correlation (Pearson's R=0.81, P<0.0001). The mean difference for repeated oscillometric measurements of aPWV was 0.05 m/s, with 95% confidence interval limits from -0.47 to 0.57 m/s.

CONCLUSION:
aPWV can be obtained using an oscillometric device with brachial cuffs with acceptable accuracy compared with intra-aortic readings.
A new oscillometric method for pulse wave analysis: comparison with a common tonometric method. Wassertheurer S\textsuperscript{1}, Kropf J\textsuperscript{1}, Weber T\textsuperscript{1}, van der Giet M\textsuperscript{1}, Baulmann J\textsuperscript{1}, Ammer M\textsuperscript{1}, Hametner B\textsuperscript{1}, Mayer CC\textsuperscript{1}, Eber B\textsuperscript{1}, Magometschnigg D\textsuperscript{1} / \textsuperscript{1} Health and Environment, Austrian Institute of Technology, Vienna, Austria

Abstract
In the European Society of Cardiology-European Society of Hypertension guidelines of the year 2007, the consequences of arterial stiffness and wave reflection on cardiovascular mortality have a major role. But the investigators claimed the poor availability of devices/methods providing easy and widely suitable measuring of arterial wall stiffness or their surrogates like augmentation index (Alx) or aortic systolic blood pressure (aSBP).

The aim of this study was the validation of a novel method determining Alx and aSBP based on an oscillometric method using a common cuff (ARCSolver) against a validated tonometric system (SphygmoCor). aSBP and Alx measured with the SphygmoCor and ARCSolver method were compared for 302 subjects. The mean age was 56 years with an SD of 20 years. At least two iterations were performed in each session.

This resulted in 749 measurements. For aSBP the mean difference was -0.1 mm Hg with an s.d. of 3.1 mm Hg. The mean difference for Alx was 1.2% with an s.d. of 7.9%. There was no significant difference in reproducibility of Alx for both methods. The variation estimate of inter- and intra observer measurements was 6.3% for ARCSolver and 7.5% for SphygmoCor. The ARCSolver method is a novel method determining Alx and aSBP based on an oscillometric system with a cuff. The results agree with common accepted tonometric measurements. Its application is easy and for widespread use.

see also: Central blood pressure estimation for the masses moves a step closer IB Wilkinson, CM McEniery, JR Cockcroft. Journal of Human Hypertension, 24,495-497 (Aug. 2010)
Wave reflections, assessed with a novel method for pulse wave separation, are associated with end-organ damage and clinical outcomes. Weber T\textsuperscript{1}, Wassertheurer S\textsuperscript{1}, Rammer\textsuperscript{1}, Haiden A\textsuperscript{1}, Hametner B\textsuperscript{1}, Eber B\textsuperscript{1} / \textsuperscript{1} Cardiology Department, Klinikum Wels-Grieskirchen, Wels, Austria.

Abstract
We recently developed a novel method for assessment of arterial wave reflections (ARCSolver method): based on adopted Windkessel methods, flow curves are estimated from pressure waveforms, and wave separation analysis is performed, yielding the amplitudes of the forward and backward waves.

The aim of this study was to investigate their clinical correlates and prognostic impact. In 725 patients (417 men; mean age, 64 years) undergoing coronary angiography, we determined wave reflections from radial tonometry and transfer function-derived aortic waveforms using pulse wave analysis, as well as wave separation analysis.

Measures of pulsatile arterial function were statistically significant, although moderately associated with markers of cardiac load and subclinical cardiac, renal, and aortic end-organ damage. After a median follow-up duration of 1399 days, 139 patients reached the combined cardiovascular end point (death, myocardial infarction, stroke, coronary, cerebrovascular, and peripheral revascularization).

In univariate analysis, the relative risk of the combined end point increased with increasing levels of incident pressure wave height, augmented pressure, and forward and backward wave amplitude (hazard ratio for 1 SD was 1.302, 1.236, 1.226, and 1.276; P<0.01 for all, respectively). In multivariate analysis, backward wave amplitude was the most consistent predictor of the combined end point. Of note, its predictive value was independent of brachial systolic, diastolic, and mean blood pressures and was superior to brachial pulse pressure. In conclusion, the amplitude of the reflected wave, as assessed with a novel method for wave separation, is associated with hypertensive end organ damage and is an independent predictor of cardiovascular events in high-risk patients.
Wave Separation Analysis


Wave reflection quantification based on pressure waveforms alone--methods, comparison, and clinical covariates. Hametner B¹, Wassertheurer S¹, Kropf J¹, Mayer C¹, Holzinger A¹, Eber B¹, Weber T¹/¹ Health & Environment Department, AIT Austrian Institute of Technology, Vienna, Austria.

Abstract
Within the last decade the quantification of pulse wave reflections mainly focused on measures of central aortic systolic pressure and its augmentation through reflections based on pulse wave analysis (PWA). A complementary approach is the wave separation analysis (WSA), which quantifies the total amount of arterial wave reflection considering both aortic pulse and flow waves. The aim of this work is the introduction and comparison of aortic blood flow models for WSA assessment. To evaluate the performance of the proposed modeling approaches (Windkessel, triangular and averaged flow), comparisons against Doppler measurements are made for 148 patients with preserved ejection fraction. Stepwise regression analysis between WSA and PWA parameters are performed to provide determinants of methodological differences. Against Doppler measurement mean difference and standard deviation of the amplitudes of the decomposed forward and backward pressure waves are comparable for Windkessel and averaged flow models. Stepwise regression analysis shows similar determinants between Doppler and Windkessel model only. The results indicate that the Windkessel method provides accurate estimates of wave reflection in subjects with preserved ejection fraction. The comparison with waveforms derived from Doppler ultrasound as well as recently proposed simple triangular and averaged flow waves showed that this approach may reduce variability and provide realistic results.