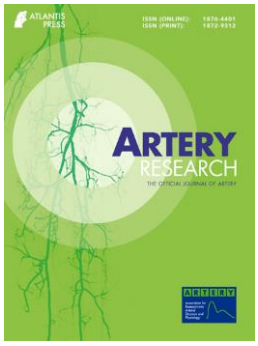

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10.7: NON-INVASIVE ESTIMATION OF CENTRAL SYSTOLIC PRESSURE: A COMPARISON BETWEEN RADIAL ARTERY TONOMETRY AND A NEW DIRECT CENTRAL BLOOD PRESSURE ESTIMATION METHOD (DCBP)

Denis Chemla, Sandrine Millasseau, Edmund Lau, Nathalie Richard, Pierre Attal, Mabrouk Brahimi, Alain Nitenberg

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95 % Limits of Agreement (LoA) for the mean interarm difference for a single measurement was 13.2 mmHg.
Conclusion: Microlife WatchBP measurement is a feasible method to determine IAD in a clinical setting. Bilateral BP measurements should be performed at first visit to help the clinician choose the right arm for further BP evaluations.

10.4
COMPARISON OF BLOOD PRESSURE VARIABILITY CALCULATED FROM PERIPHERAL AND DERIVED AORTIC BLOOD PRESSURE

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Background: Systolic blood pressure variability (SBPV), conventionally calculated from peripheral sites such as the arm or finger, may be of more utility when computed from central aortic values, as this has greater applicability to the heart and the baroreceptor function, due to central location of baroreceptors. As the relationship between aortic and peripheral blood pressure is frequency dependent, particularly in the range of physiological heart rate frequencies, peripheral and aortic SBPV may not be identical. Differences between peripheral and aortic SBPV have not been previously quantified.
Methods: In this study, peripheral and derived aortic SBPV was calculated in 30 healthy subjects (25- 62 years). Continuous finger blood pressure was measured for 10 minutes in each subject (Finapres) and aortic blood pressure derived using a general transfer function. SBPV was quantified using a Short Time Fourier Transform in a time-frequency method to calculate the ratio of average power across the low frequency power band (0.05-0.15 Hz) to the high frequency power band (0.15-0.4 Hz).
Results: Aortic SBPV (power band ratio) was correlated with peripheral SBPV (r^2=0.961, p<0.001) with a mean difference of -0.67±2.07. However, there was a bias toward peripheral SBPV overestimation compared to aortic SBPV for higher values of SBPV.
Conclusions: This study demonstrates that peripheral SBPV cannot be taken as equivalent to aortic SBPV, particularly where the low frequency to high frequency power ratio of SBPV is of higher magnitude.

10.5
COMPARISON OF ARTERIAL STIFFNESS ASSESSED BY POPMÈTRE® WITH ARTERIAL STIFFNESS ASSESSED BY APPLANATION TONOMETRY: A CLINICAL STUDY

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Background: Large artery stiffness is recognized as a strong, independent marker of cardiovascular risk, mainly through aortic pulse wave velocity (PWV). pOpmètre® is a new non-invasive method, which estimates aortic PWV through finger-toe (FT) wave analysis. In a previous study, Alivon et al. have shown an acceptable correlation (r^2 = 0.43 for PWV) between pOpmètre® and the reference method Sphygmocor. However this study led to the necessity to optimize the algorithm and the procedures because of the presence of several outliers involving mainly obese and elderly subjects.
Materials and Methods: The pOpmètre® has 2 photodiodes sensors, positioned on the finger and on the toe. A particular attention was drawn on positioning of the toe sensor so that the pulp was in contact with the photodiode. Different signal processing chains were applied and no cut-off value was used for pulse height. Applanation tonometry was performed for CF PWV measurements.
Results: 45 subjects were included: 18 healthy subjects and 27 patients with essential hypertension aged 32± 7 years and 58 ±18 years respectively. The correlation between FT PWV and CF PWV was good and significant (r^2 = 0.77 p<0.0001). A better correlation was found in terms of transit time (r^2 = 0.83 p<0.0001). The standard deviation of the difference was 0.87 m/s versus 6.73 ms, classifying the device as good agreement with reference (Wilkinson, ARTERY RES 2010).
Conclusion: pOpmètre® with optimized algorithm and procedure qualifies as excellent agreement with the reference technique for PWV assessment, however, outcome studies must confirm the value of this new device.

References
1. Maureen ALIVON et al.2015 ARTERY research archives. Validation study of pOpmètre.

10.6
VARIATION OF THE ASYMPTOTIC DIASTOLIC PRESSURE WITH DIFFERENT FITTING TECHNIQUES IN HEALTHY HUMANS

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Background: Reservoir-wave model assumes the measured pressure (Pm) consists of two additive components: reservoir (Pr) and excess pressure (Pex)[1-2]. Calculation of Pr requires fitting the diastolic decay of Pm for calculating parameters P_∞ (asymptotical value) and b (time constant)[1]. However, there is no consensus over the value of these parameters[1-3-4]. Although many investigators use free-fitting, different degrees of freedom (dof) could be used[1-2-5]. The aim of this study was to examine the effect of varying fitting method on P_∞ ,b and calculate the peaks of Pr and Pex.
Methods: Pressure data from common carotid artery of 505 middle-aged healthy subjects were selected from the Asklepios dataset. Free-fitting methods with 3 dof (dicrotic notch not fixed) and 2 dof (dicrotic notch fixed) were used to obtain P_∞ , b and calculate Pr and Pex.
Results: Mean value of P_∞ change significantly between 3 dof and 2 dof (58 vs. 50 mmHg p<0.01) as well as b (2.3 vs. 1.9 s^{-1} p<0.01). Pr- and Pex- peaks didn't significantly change (Pr= 105 mmHg for 3 dof and 2 dof p>0.05 Pex = 30 mmHg and 31 mmHg for 3 dof and 2 dof, respectively p>0.05).
Conclusions: P_∞ and b values are method-dependent with a large variation between methods. P_∞ values in our study are higher than previously reported in literature, and variation in P_∞ and b values don't affect Pr- and Pex- peaks. Given the variability in the combination of P_∞ ,b in different subjects, the use of free-fitting is more appropriate.
References
1. Aguado-Sierra J, Alastruey J, Wang JJ, Hadjiloizou N, Davies J, Parker KH. Separation of the reservoir and wave pressure and velocity from measurements at an arbitrary location in arteries. Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine. 2008 Apr 1222(4):403-16.
2. Wang JJ, O'Brien AB, Shrive NG, Parker KH, Tyberg JV. Time-domain representation of ventricular-arterial coupling as a windkessel and wave system. American Journal of Physiology-Heart and Circulatory Physiology. 2003 Apr 1284(4):H1358-68.
3.Vermeersch SJ, Rietzschel ER, De Buyzere ML, Van Bortel LM, Gillebert TC, Verdonck PR, Segers P. The reservoir pressure concept: the 3-element windkessel model revisited? Application to the Asklepios population study. Journal of Engineering Mathematics. 2009 Aug 164(4):417-28.
4. Sridharan SS, Burrowes LM, Bouwmeester JC, Wang JJ, Shrive NG, Tyberg JV. Classical electrical and hydraulic Windkessel models validate physiological calculations of Windkessel (reservoir) pressure. Canadian journal of physiology and pharmacology. 2012 Apr 390(5):579-85.
5. Wang JJ, Shrive NG, Parker KH, Hughes AD, Tyberg JV. Wave propagation and reflection in the canine aorta: analysis using a reservoir-wave approach. Canadian Journal of Cardiology. 2011 Jun 3027(3):389-e1.

10.7
NON-INVASIVE ESTIMATION OF CENTRAL SYSTOLIC PRESSURE: A COMPARISON BETWEEN RADIAL ARTERY TONOMETRY AND A NEW DIRECT CENTRAL BLOOD PRESSURE ESTIMATION METHOD (DCBP)

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Background: We have developed a new proprietary method (DCBP® Direct Central Blood Pressure) to estimate central systolic blood pressure (cSBP) directly from peripheral pressure. In a previous meta-analysis of published high-fidelity pressure studies with simultaneous aortic and brachial pressure recordings, negligible mean difference between DCBP and cSBP has been documented (1). The accuracy and precision of DCBP against arterial tonometry measurements remain to be documented.

Methods: The cSBP was estimated from radial artery tonometry and a transfer function using a SphygmoCor® system (AtCor Medical, Australia) in 100 subjects (mean age+/-SD = 57+/-10 years). Pressure waveforms were calibrated from the brachial systolic and diastolic pressures, measured just prior to tonometric measurement with an oscillometric cuff system (Omron 705CP Omron, Japan). DCBP and cSBP were compared using the Bland and Altman method and subgroups were compared using unpaired Student's t test.
Results: The difference between DCBP (129.2+/-16.8 mmHg) and cSBP (129.4+/-16.4 mmHg) was -0.2+/-2.6 mmHg. The difference was not influenced by the mean (DCBP + cSBP / 2). Similar results were obtained in men (n=60) and women (n=40), and in subjects with/without hypertension (n=51/49), with/without diabetes (26/74), and with/without dyslipidemia (36/64).
Conclusions: The new DCBP® method and the transfer function applied to radial tonometry method were interchangeable in estimating central SBP. These results pertained strictly to the studied population (patients aged 57 years on average, and displaying a high percentage of cardiovascular risk factors). Further studies are needed to confirm our results.

References

1. Chemla D, Millasseau S, Lau EMT, Attal P, Nitenberg A. Direct estimation of central systolic pressure from peripheral pressures: a proof of concept based on the meta-analysis of high-fidelity pressure studies. ESH 2016 — 26th European Meeting on Hypertension and Cardiovascular Protection. 12 June 2016, Paris, France.

10.8
SYSTOLIC AORTIC PRESSURE DERIVED FROM DIFFERENT CALIBRATION METHODS IN THE GENERAL POPULATION

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Background: There is recent evidence from different research groups that accuracy [1] and prognostic value [2,3,4] of systolic aortic pressure significantly depends on the method of calibration. Although these results consistently show superiority of mean pressure calibration (aSBP2) over both, traditional calibrated aortic systolic (aSBP1) and brachial systolic pressure (bSBP), the investigated cohorts were relatively small and it is still unclear whether the observed associations between pressures are preserved in the general population.
Objective: Therefore the objective of this work is the investigation of associations between different methods of systolic pressure assessment it a large cohort and its comparison to reported outcome.
Methods: During a public health campaign cardiovascular hemodynamic data was assessed using the Mobil-O-Graph® device and ARCSolver® algorithms in a kiosk like setting. Systolic aortic pressure was derived from two different calibrations: systolic and diastolic pressure and mean and diastolic pressure. Furthermore brachial pressures, age, sex and anthropometric data were recorded and regression analysis was performed to investigate associations.
Results: Summary statistics of 7409 valid measurements are reported in Table 1. Systolic and subsequent pulse pressures significantly differed from bSPB for aSBP1 but not for aSBP2. Regression analysis unveiled that aSBP2 (R^2=0.853) is significantly ($p<0.00001$) less associated with bSBP than aSBP1 (R^2=0.937), see Figure 1.
Conclusions: Comparison of our data with literature suggests that unlike aSBP1 [5] the association between bSBP and aSBP2 is only slightly influenced by increased sample size [2] and therefore prognostic superiority over bSBP is likely to be sustainable and warrants further investigation.

References

1. Papaioannou et al. Accuracy of commercial devices and methods for noninvasive estimation of aortic systolic blood pressure a systematic review and meta-analysis of invasive validation studies. J Hypertens. 2016 Jul34(7):1237-1248.
2. Wassertheurer et al. Assessment of systolic aortic pressure and its association to all cause mortality critically depends on waveform calibration. J Hypertens. 2015 Sep33(9):1884-8
3. Negishi et al. Importance of Calibration Method in Central Blood Pressure for Cardiac Structural Abnormalities. Am J Hypertens. 2016 Apr 16. pii: hpw039. [Epub ahead of print]
4. Protogerou et al. Left-ventricular hypertrophy is associated better with 24-h aortic pressure than 24-h brachial pressure in hypertensive patients: the SAFAR study. J Hypertens. 2014 Sep32(9):1805-14.
5. Vlachopoulos et al. Prediction of cardiovascular events and all-cause mortality with central haemodynamics: a systematic review and meta-analysis. Eur Heart J. 2010 Aug31(15):1865-71.

10.9
ARTERIAL STIFFNESS INDEX BETA AND CARDIO-ANKLE VASCULAR INDEX INHERENTLY DEPEND ON BLOOD PRESSURE, BUT CAN BE READILY CORRECTED

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Objectives: Arterial stiffness index β and cardio-ankle vascular index (CAVI) are widely accepted to quantify the blood pressure (BP)-independent, intrinsic exponent (β_0) of the BP-diameter relationship. CAVI and β assume an exponential relationship between pressure (P) and diameter (d). We aim (1) to demonstrate that, under this assumption, β and CAVI as currently implemented are inherently BP-dependent and (2) to provide corrected, BP-independent forms of CAVI and β.
Methods and results: In $P=P_{ref}*\exp[\beta_0(d/d_{ref}-1)]$, usually reference pressure (P_{ref}) and reference diameter (d_{ref}) are substituted with diastolic BP and diameter to accommodate measurements. Consequently, the resulting exponent is not equal to the pressure-independent β_0. CAVI does not only suffer from this reference pressure effect, but also from the approximation of dP/dd.
For example, assuming $\beta_0=7$, an increase of systolic/diastolic BP from 110/70 to 170/120 mmHg increased β by 8.1% and CAVI by 14.3%. We derived corrected forms of β and of CAVI ($CAVI_0$) that did not change with BP and represent the pressure-independent β_0.
To substantiate the BP effect on CAVI in a typical follow-up study, we realistically simulated patients (n=161) before and following BP-lowering treatment (assuming no follow-up change in intrinsic β_0 and therefore in actual P-d relationship). Lowering BP from 160±14/111±11 to 120±15/79±11 mmHg ($p<0.001$) resulted in a significant CAVI decrease (8.1±2.0 to 7.7±2.1, $p=0.008$) $CAVI_0$ did not change (9.8±2.4 and 9.9±2.6, $p=0.499$).
Conclusions: β and CAVI as currently implemented are inherently BP-dependent, potentially leading to erroneous conclusions in arterial stiffness research. BP-independent forms were derived to overcome this problem.

Summary statistics

	Male			Female		
	N	Median	2.5 — 97.5 P	N	Median	2.5 — 97.5 P
Age	2276	54,000	24,000 to 83,000	5133	54,000	20,000 to 81,000
aSBP1	2276	120,803	98,754 to 153,254	5133	114,872	91,723 to 152,578
aSBP2	2276	133,102	108,651 to 172,962	5133	124,914	100,692 to 167,257
SBP	2276	131,000	107,000 to 168,000	5133	124,000	100,000 to 165,000
MBP	2276	106,000	85,000 to 133,000	5133	99,000	79,000 to 129,000
DBP	2276	84,000	63,000 to 109,000	5133	77,000	58,000 to 102,175
BMI	2276	26,219	20,065 to 35,774	5133	23,875	18,218 to 36,634

Regression between bSBP, aSBP1 and aSBP2 respectively.