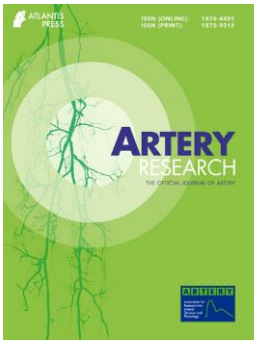

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P1.32: BRACHIAL-ANKLE PULSE WAVE VELOCITY: A NEW METHOD FOR CLINICAL EVALUATION OF ARTERIAL STIFFNESS COMPARED WITH CAROTID-FEMORAL PULSE WAVE VELOCITY

F. Santini, C. Palombo, C. Morizzo, E. Malshi, P. Spontoni, M. Kozakova, Di Stefano R, A. Balbarini

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(24±6y) and 11 old (60±12y) subjects. Continuous beat-to-beat changes in CCA diameter were used to determine FMD magnitude in percentage change in end diastolic diameter (ΔD/D) and mean centre stream blood velocity (ΔV/V). Endothelial function (EF) is estimated by the relative response of ΔD/D to ΔV/V.
Results: Heart rate increases significantly during and post hypercapnia. No significant changes are seen in peripheral blood pressure. Hypercapnia stimulus induces significant increases in flow velocity and diameter in both populations, reaching a steady state after 3 minutes. EF=0.6±0.03 (young), and EF=0.4±0.08 (old).
Conclusions: CO2 stimulated FMD response at the CCA exposes the dynamic interrelationship between blood velocity and diameter. It provides a direct and well-tolerated tool to quantify endothelial function in atherosclerotic prone arteries.

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P1.29

ONE CLINIC MEASURE OF LIGHT EXERCISE CENTRAL BLOOD PRESSURE IS A STRONGER CORRELATE OF LEFT VENTRICULAR MASS THAN 24 HOUR AMBULATORY BLOOD PRESSURE MONITORING

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Background: Twenty four hour ambulatory blood pressure (24ABPM) is the gold standard for assessing blood pressure (BP) control. However, central BP during daily activity may be a stronger determinant of cardiovascular risk. This study aimed to compare 24ABPM with light exercise central BP (mimicking daily activity) for predicting left ventricular (LV) mass.
Methods: Study population comprised 54 patients (aged 58±7 years; 20 men) including those with treated hypertension (n=16), untreated masked hypertension (n=23) and normotensive controls (n=15). Subjects underwent 2D echocardiography for determination of LV mass (indexed; $g/m^{2.7}$), resting brachial BP, 24ABPM and estimated central BP by radial tonometry during graded cycle ergometry. Central systolic BP (SBP) was estimated from the radial second systolic peak (P2) as well as the derived central waveform.
Results: The range of LV mass index and 24ABPM SBP were 17.8-55.1 $g/m^{2.7}$ and 107-153 mmHg respectively. As expected, 24ABPM SBP was significantly associated with LV mass index (r=0.30, p=0.02), but not with clinic resting brachial (r=0.21; p=0.14) or central SBP (r=0.20; p=0.14). However, the strongest correlates of LV mass index were light exercise (50% heart rate reserve) radial P2 (r=0.54, p<0.001) and central SBP (r=0.47; p<0.001). On multiple regression analysis, radial P2, but not 24ABPM SBP, was independently associated (β=0.45; p<0.01) with LV mass index after accounting for other confounding variables.
Conclusion: A one-off clinic estimate of light activity central SBP outweighs 24ABPM for predicting LV mass. This rapid, noninvasive technique may provide a superior measure of BP control compared with the current gold standard.

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P1.30

INDICES OF ARTERIAL STIFFNESS AND RAISED BLOOD PRESSURE AMONGST PUBLIC SCHOOL CHILDREN IN GUJARAT, INDIA

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Background: Pediatric hypertension is increasing in prevalence with the global childhood obesity epidemic. The burden of paediatric hypertension and prehypertension are poorly understood in areas of the Indian subcontinent.
Methods: Using standardised methods for anthropometry (International Society for the Advancement of Kinanthropometry), and blood pressure (British Hypertension Society guidelines) - paediatric obesity, blood pressure and a marker of arterial stiffness (stiffness index using digital volume pulse analysis PCA Micromedical) were measured within 303 school children (4-14 years) in rural Gujarat, India.
Results: The prevalence of prehypertension was 13.3% in boys and 13.7% in girls, which were markedly higher those reported for the US (3.4%). Many of the Indian children were deemed not have reached their true growth potential, where 82.5% of children were below the 50th percentiles for height, gender and age as advised by consensus US guidelines. On logistic regression, prehypertension was associated with waist to height ratio (P<0.001) and body-mass index (P<0.001). Median stiffness index was comparable in boys 6.89 m/s (IQR: 2.95-7.79) and girls - 6.62 m/s (5.58–7.72). Prehypertension was unrelated to indices of arterial stiffness, which were associated with waist to height ratio (r = −0.34, P<0.001).
Conclusion: Low birth weight and an early manifestation of aberrant endocrine activity are likely to be implicated in higher blood pressure for these children, for which further research is warranted given the impeding threat of over nutrition that looms with the rising epidemic of obesity across the Indian subcontinent. Given the healthcare challenge of cardiovascular morbidity that faces Asia, the assessment of paediatric hypertension and obesity amongst children is an important consideration for prevention strategies.

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P1.31

DETERMINING PULSE WAVE VELOCITY USING MRI: A COMPARISON AND REPEATABILITY OF RESULTS USING SEVEN TRANSIT TIME ALGORITHMS

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Aim: MRI provides a non-invasive method for assessing segmental aortic pulse wave velocity (aPWV). However, the best mathematical algorithm for transit time calculation using MRI flow waves is unclear.
Methods: 7 different algorithms were applied to aortic flow waveforms measured by MRI (10 subjects, 36±7 years, 4 male). Two measurements were recorded in each subject on different days for repeatability analysis. PWV was calculated between 5 sites along the aorta. Outlier PWV results were classed as a ''failed'' measurement and the success rate calculated. Bland-Altman plots were constructed for each algorithm, and repeatability calculated. Agreement between different methods was calculated using repeated measures analysis.
Results: The method of intersecting lines of fit during late diastole and early systole had the highest success rate followed by the Fourier analysis phase-slope method (99%; 98% respectively). Repeatability of measurement was highest using the phase-slope method followed by the method of intersecting lines (standard deviation 1.9; 2.2 m/s respectively). Methods of deviation of a systolic line of fit, maximum of second derivative, intersecting lines of fit, and the corner detection algorithm had the highest agreement, corrected for repeatability (corrected standard deviation range 1.8-1.9 m/s).
Conclusions: Whilst agreement between several PWV algorithms was high, no one algorithm was better in all categories. The intersection of lines of fit method was most robust. The phase-slope method showed the greatest repeatability. These findings are important in aPWV measurement, and for reliable and accurate PWV measurement in general.

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P1.32

BRACHIAL-ANKLE PULSE WAVE VELOCITY: A NEW METHOD FOR CLINICAL EVALUATION OF ARTERIAL STIFFNESS COMPARED WITH CAROTID-FEMORAL PULSE WAVE VELOCITY

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Background: Arterial stiffness (AS) reflects morfo-functional modifications of elastic arteries due to aging and atherosclerosis.
Carotid-femoral pulse wave velocity (PWVcf) represents an estabilished marker of aortic stiffness and predictor of cardiovascular mortality.
Recently, a new method for evaluating arterial stiffness based on brachial-ankle pulse wave velocity (PWVba) and capable to provide a stiffness index, CAVI (cardio-ankle vascular index), has been proposed.
Aim: to compare PWVba with PWVcf and to evaluate the corresponding relationships with age and blood pressure in healthy subjects and patients with major risk factors for atherosclerosis.
Methods: 46 subjects (19 controls; 27 patients with risk factors but without clinical cardiovascular disease; 31 women; age 43±18) were studied. PWVcf

was assessed by the estabilished foot to foot method (Complior Artech, Paris); PWVba and CAVI were obtained by a commercially available system (Vasera Fukuda, Tokyo), recording simultaneously brachial and tibial sphygmogram, ECG and phonocardiogram (PGC). CAVI is derived from the stiffness index Beta, according to Bramwell-Hill formula.
Results: PWba was significantly correlated with PWVcf ($r = 0.785$, $p<0.001$); in Bland Altman analysis, all points but two were included into ± 2SD of mean difference (mean difference= 0.804 ± 2.17 m/s). CAVI, PWVba, PWVcf were directly correlated with age ($r = 0.778, 0.595, 0.687$; $p<0.001$) and pulse pressure ($r = 0.504, 0.300, 0.422$; $p<0.001$).
Conclusions: PWVba, an integrated index of aortic and femoro-tibial stiffness, shows good agreement with PWVcf. CAVI index seems to provide the best associations with age and pulse pressure.

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P1.33
COMPARISON BETWEEN ULTRASONIC MEASUREMENTS OF CAROTID WALL PROPERTIES AND NEW AUTOMATED METHOD BY ANALYSIS OF IMAGING

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Echotracking (ET) devices were developed to determine elastic properties of arterial wall material with high precision. The radiofrequency provides a higher precision than with B-mode image systems, limited by the spatial resolution of pixel. New approaches to analyse the B-mode imaging (IA) with offline semi-automated boundary tracking (AMSII) could enhance accuracy and limit variability of arterial measurements, but this method should be validated.
Objectives: To compare carotid parameters assessed with echotracking and applanation tonometry to IA process.
Methods: 10 healthy volunteers had successively common carotid artery measurements with ET and B-mode image analysis (standardized probe localization and orientation). Local carotid systolic and diastolic blood pressure (SBP, DBP), pulse pressure (PP) were measured with aplanation tonometry. Systolic and diastolic diameters (SD, DD), distension were assessed with both methods. Data were analyzed independently, blinded to the results of concurrent method. Coefficient of variation (CV) and Pearson's correlation coefficient between the methods were calculated. Wilcoxon's signed-rank test for matched pairs was used for significance.
Results: No significant differences were observed through results of the two assessment methods for local SBP, DBP, PP, Distension, DD and SD. All CV were inferior to 5%. Correlation coefficients between paired parameters were at least 0.90 for all the measurements.
Conclusion: Results from analysis of IA with AMS II seem to be in accordance with those from Artlab® echotracking (BM and FBM mode). Quality of image recording is an essential factor of concordance between the two methods and this implies further investigations in patients with cardiovascular diseases.

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P1.34
VALIDATION OF THE WORKING PRINCIPLE OF THE ARTERIOGRAPH, A NEW DEVICE TO MEASURE PULSE WAVE VELOCITY

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The Arteriograph, a device basically consisting of a brachial cuff, has recently been launched as a new tool to measure pulse wave velocity (PWV). Brachial blood pressure is measured during supra-systolic pressure inflation of the cuff, yielding pressure waveforms with pronounced first and secondary peaks. The second peak is ascribed to a reflection from the aortic bifurcation, and PWV is calculated as the ratio of 2 times the jugulum-symphysis distance (∼ aortic root − bifurcation) and the time difference between the two peaks ($DT_{s1\text{-}s2}$). To test this working principle, we used a numerical model of the arterial tree to simulate pressure and flow in the normal configuration, and in a configuration with an occluded brachial artery (∼supra-systolic over-inflation). A pronounced second peak in the pressure signal was found at the location of the cuff for the occluded configuration. Wave intensity analysis showed that this peak was caused by a forward compression wave, confirming the Arteriograph hypothesis. Simulations with 6 different stiffness values showed a linear correlation between $1/DT_{s1\text{-}s2}$ and PWV ($R^2=0.97$). It was, however, hard to locate the reflection site which, in combination with the transit time, reproduced the correct PWV. The distance to the aortic bifurcation was 45 cm, whereas the effective length of the simulated arterial tree was 27 ± 3 cm. The distance needed to reproduce PWV from $DT_{s1\text{-}s2}$ was 70 ± 6 cm. In conclusion, although the numerical model supports the basic working principle of the Arteriograph, measurement of actual PWV using the device might be more challenging.

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P1.35
A NEW NON-INVASIVE ANALYSIS FOR THE DETERMINATION OF LOCAL PULSE WAVE VELOCITY AND WAVE INTENSITY: APPLICATION TO THE CAROTID ARTERY

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Background: Local Pulse Wave Velocity (LPWV) and Wave Intensity (WI) are used to assess arterial stiffness and the arrival time of reflected waves; indices of clinical importance. We present a new non-invasive analysis which directly uses flow velocity (U) and arterial diameter (D) measurements for the determination of LPWV and WI.
Methods: From the water hammer equation it can be shown that $LPWV = \frac{D}{2}\frac{dU_\pm}{dD_\pm}$ where dU and dD are the changes in U and D, and ± indicates the forward and backward directions. The separation of WI can also be determined using $WI_\pm = \pm\frac{1}{4(D/2c)}(dD \pm \frac{D}{2c}dU)^2$, where c is LPWV. We studied 28 patients (58±15 years, 21 male) with good systolic function (EF>55%) and no valve disease. We measured U and D in the left carotid artery using Doppler ultrasound and a wall tracking system (Aloka, SSD-5500). ECG was also recorded and data were sampled at 1kHz.
Results: LPWV in patients > 50 years ($n=11$) were higher by 20% ($p < 0.05$) than in patients < 50 years. Reflected waves in patients > 50 years arrived earlier by 35% ($p < 0.05$) than in patients <50 years. Neither the size of reflected waves nor the forward compression and expansion wave differed significantly between the two age groups.
Conclusions: Results of the new technique are in agreement with other approaches for determining LPWV and WI. The new technique offers the possibility of studying arterial sites that are not accessible by applanation tonometery, and does not assume a linear relationship between arterial diameter and arterial pressure.

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P1.36
A PRELIMINARY STUDY FOR THE EVALUATION OF LARGE ARTERY STIFFNESS: A NON CONTACT APPROACH

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The evaluation of carotid-to-femoral pulse transit time (PTT) is required to estimate the carotid-femoral pulse wave velocity, a parameter considered as the gold standard for the quantification of large artery stiffness. In this study we propose a novel, non contact laser-based technique (laser class II ∼ laser pen), named optical Vibrocardiography (VCG), for evaluating PTT from synchronous recorded vibrations of the skin at the carotid and femoral artery site. It has been demonstrated that these skin vibrations are directly related to the radial displacement of the underlying arteries, and are hence related to the passage of the pressure pulse. In this feasibility study, measurements were performed on 14 young male healthy subjects (25.3 ± 0.8) using 2 commercially available vibrometers (Polytec Gmbh, Waldbronn ,