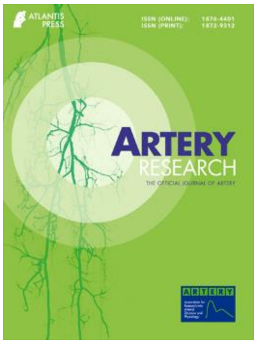

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P1.12: COMPARISON OF CLINICAL USEFULNESS BETWEEN STIFFNESS PARAMETER BETA (SPB) AND PULSE WAVE VELOCITY (PWV)

T. Murakami, T. Kaneda, S. Ono, K. Shibata, H. Satta, T. Iwamoto, K. Sugimoto, Y. Toya, S. Umemura

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Oscillometric bSBP/bDBP was used for brachial waveform calibration. Radial and brachial waveforms were consecutively obtained with applanation tonometry. Brachial MAP (bMAP) was derived from brachial tonometry by area method. Radial waveforms were calibrated to bSBP/bDBP and to bMAP/bDBP; cPP values were obtained for each calibration method, PPa was calculated as bPP/cPP, and brachio-radial PPa was the difference between the two PPa values.
On average, bSBP/bMAP/bDBP was 129/94/72±16/12/9mmHg. PPa was 1.42±0.25 when radial wave was calibrated to bSBP/bDBP, and 1.20±0.13 after calibration to bMAP/bDBP. Brachio-radial PPa was 0.22±0.17, and on average represented 52±18% of central-to-peripheral PPa. In a multivariate regression model, age, male gender, heart rate and cPP were all independent predictors of brachio-radial PPa.
Conclusions: Results suggest that brachio-radial PPa may represent a significant proportion of central-to-peripheral amplification. These findings require confirmation with invasive measurements.

	B	β	Multiple R	p
Heart rate, bpm	0.01	0.43	0.21	<0.01
Age, years	-0.01	-0.62	0.28	<0.01
Central PP, mmHg	0.01	0.58	0.49	<0.01
Gender, M	0.09	0.18	0.52	0.02

Stepwise multiple linear regression Constant is -0.86
Brachio-to-radial PP amplification as dependent variable
BMI, height, hypertensive status: n.s.

P1.09

VALIDATION OF A NEW NON-INVASIVE TONOMETER FOR DETERMINING AORTIC PULSE WAVE VELOCITY IN RATS

E. Tartagni [1,2], G. Simon [1], C. Labat [1], N. Sloboda [1], L. Joly [1], C. Borghi [2], A. Benetos [1], P. Lacolley [1], P. Salvi [1,2]
[1]*INSERM U961 and Dept of Geriatrics - University of Nancy, Nancy, France*
[2]*Dept of Internal Medicine University of Bologna, Bologna, Italy*

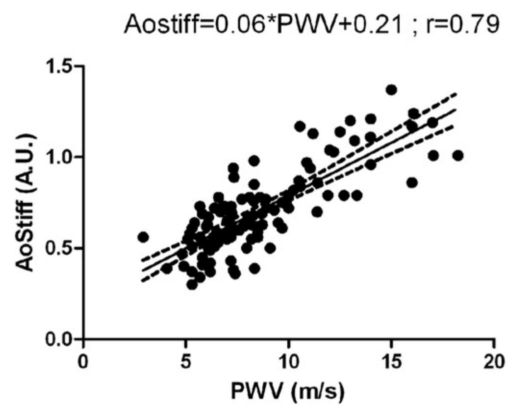
Carotid-femoral pulse wave velocity (PWV) is an established method for characterizing aortic stiffness. At present, to determine PWV in rats, the gold standard method is a surgical invasive measurement; inevitably this leads to the animal's death. The objective of this study is to validate a new device for determining non-invasive PWV measurements which allows longitudinal studies in rats.
The PulsePenLab (DiaTecne), the device validated in this study, was derived from the PulsePen model, a validated high-fidelity tonometer, currently used to assess PWV non-invasively in humans. Two PulsePen tonometers recorded simultaneously carotid and femoral blood pressure pulse wave. The probes were positioned and fixed on the arteries by means of mechanical arms. The acquisition sample rate was 1KHz. Carotid-femoral PWV was determined by two operators, and measurements were repeated after a week. Immediately after this second test, a surgical invasive measurement of PWV was performed. The real sternum-carotid and sternum-femoral distances were compared with the external distances previously acquired by the two operators.
Now we present the preliminary data concerning the early 8 rats (Zucker fa/fa and Fa/Fa) included in this study. PWV determined by the PulsePenLab was compared with the traditional invasive measurement: the difference between the values of two measurements was 0.13±0.66 m/s, R=0.71. All values of difference were <1.0 m/s. Reproducibility of measurements was determined by inter-observer coefficient of repeatability (0.92 m/s) and coefficient of variation (9.79%).
These preliminary data suggest that PulsePenLab is an efficient device for determining a non-invasive measurement of PWV in rats.

P1.10

LOCAL AORTIC STIFFNESS ESTIMATED BY A BIOELECTRICAL IMPEDANCE TECHNIQUE

M. Collette [1,2], A. Humeau [2], C. Chevallier [1], G. P. N. Leftheriotis [1]
[1]*Université d'Angers, IFR 132, UMR CNRS 6214-INSERM 771, Faculté de Médecine, Rue Haute de Reculée, Angers, France*
[2]*Laboratoire d'Ingénierie des Systèmes Automatisés (LISA), Université d'Angers, 62, Avenue Notre Dame, Angers, France*

To date, aortic stiffness is evaluated by the reference tonometric technique via the pulse wave velocity (PWV) measured in two points (i.e. regional aortic stiffness): the carotid and the femoral arteries. Based on a bioelectrical impedance signal processing recorded at the chest level, we have developed a new method for the determination of the aortic stiffness in one point (i.e. local aortic stiffness). The local aortic stiffness (AoStiff) was computed from two basic indices: The aortic flux resistance (AoRes) and the aortic distensibility (AoDist) indices.
The study was carried out on 129 consecutive patients at rest (89 men, mean age 50 ± 13) recruited on the occasion of a vascular screening for atherosclerosis. Carotid-femoral PWV was determined by a trained operator and bioelectrical impedance signals were recorded at the chest for 2 min for AoStiff, AoRes and AoDist determination. Brachial arterial blood pressure was taken at the same time. Relationship between AoStiff index and PWV was evaluated by linear regression.
A Pearson's correlation coefficient of r=0.79 was found between both variables (95% confidence interval 0.71-0.85; P<0.0001; AoStiff= 0.06*PWV+0.21).
Our results show that the local and the regional methods can provide a reliable estimate of the aortic stiffness. The variability between both variables is likely explained by differences between the local and the regional elastic properties along the aortic tree.



P1.11

A PHOTOPLETHYSMOGRAPHIC PULSE WAVE ANALYSIS FOR ARTERIAL STIFFNESS IN EXTREMITIES

M. J. Huotari [1], K. Määttä [1], G. L. Nadasy [2], J. Kostamovaara [1]
[1]*University of Oulu, Oulu, Finland*
[2]*Semmelweis University, Budapest, Hungary*

Peripheral arterial disease (PAD) is a problem over the world. It manifests in extremities as arterial stiffness. The diagnosis of the PADs it can be done by photoplethysmography (PPG). PPG is a non-invasive optical technique for detecting the arterial pulse waves and changes of waves. The PPG signal can contain clinically valuable information about status of conducting arteries and veins.
In this study, we present an examination of the pulse wave analysis by its time domain features for characterizing and quantifying arterial pulse wave components which were measured by a new PPG device. The issue of wave component separation by logarithmic normal function (LNF) both index finger and toe tip PPG in parallel measurements on healthy subjects are addressed. A comparative test procedure for pulse wave analysis based on a wave component separation was applied in addition to a second derivative method of the PPG signal (SNPPG), and a Lissajous-like plot. These tests were applied to arterial pulse wave time series for human ages between 5 and 81 years on 85 subjects. The results show good correlation of pulse wave changes as a function of age, thus support on the arterial pulse wave analysis based on blood pressure. The LNF model fitted to the PPG signals according to the correlations over 0.995 and residues represent the difference to be almost zero between the LNF and the PPG data points. The Lissajous plots demonstrate a high asymmetry dependent on age.

P1.12

COMPARISON OF CLINICAL USEFULNESS BETWEEN STIFFNESS PARAMETER BETA (SPB) AND PULSE WAVE VELOCITY (PWV)

T. Murakami [1], T. Kaneda [1], S. Ono [1], K. Shibata [2], H. Satta [2], T. Iwamoto [1], K. Sugimoto [3], Y. Toya [4], S. Umemura [4]
[1]*Saiseikai Yokohama-shi Nanbu Hospital, Yokohama, Japan*
[2]*Yokohama Minami Clinic, Yokohama, Japan*
[3]*Yokosuka City Hospital, Yokosuka, Japan*
[4]*Yokohama City University, Yokohama, Japan*

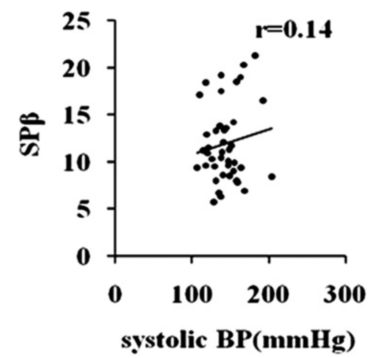
Aims: Brachial-ankle PWV (baPWV) is widely used to evaluate arteriosclerosis, however, it is easily influenced by occasional blood pressure (BP).

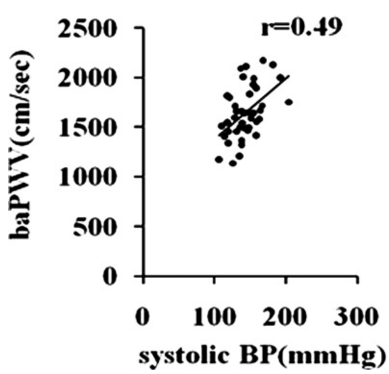
Recently, SPβ, an index of vascular elasticity, become easy to measure. SPβ is adjusted by BP, thus it is less affected by occasional BP. In this study, we examined differences between SPβ and baPWV.

Methods: SPβ and PWV were measured in 26 HD and 16 non-HD patients. SPβ was calculated from BP and the diameter of common carotid artery measured by ultrasound examination.

Results: Nevertheless age, gender and BP were matched in two groups, SPβ in HD patients was significantly higher ($p=0.004$). Also in this study, there was no correlation between SPβ and systolic BP.

Conclusions: These results suggest that SPβ reflects elastic properties of arteries without influence of occasional BP, and that arteriosclerotic change is accelerated in HD population.





P1.13

COMPARISON OF TWO NON-INVASIVE DEVICES (SPHYGMOCOR® VS. A-PULSE®) FOR MEASUREMENT OF CENTRAL HAEMODYNMAICS WITH INVASIVE MEASUREMENT DURING CARDIAC CATHETERIZATION

C. Ott [1], S. Haetinger [2], M. Pauschinger [2], R. E. Schmieder [1]
[1]*Department of Nephrology and Hypertension, Universityhospital Erlangen, Erlangen, Germany*
[2]*Department of Cardiology, Hospital Nueremberg, Nueremberg, Germany*

Objective: The estimation of central haemodynamics is discussed to assess more preciously the pressure load on the cardiovascular system in hypertension. In addition to SphygmoCor® (Atcor Medical, Sydney Australia), a new device for non-invasive assessment of central haemodynamics (BPro® device with A-Pulse®, HealthSTATS, Singapore) was approved by FDA.

Design and Method: Patients ($N=52$) undergoing invasive elective cardiac evaluation were tagged prior to the cardiac catheterization with a standard oscillometric blood pressure device and the BPro® device at the same arm. Immediately after the invasive measurement of central haemodynamics, radial artery waveforms were sampled by two non-invasive techniques, the B-Pro® with A-Pulse® and with the SphygmoCor® System. Thereafter, central haemodynamics was measured invasively for a second time.

Results: There was a high agreement between the invasively recorded central systolic blood pressure (cSBP) (137±27mmHg) and both non-invasively assessed cSBP by B-Pro® (136±21mmHg, $p=0.627$ vs. invasive cSBP) and by SphygmoCor® (136±23mmHg, $p=0.694$ vs. invasive cSBP). Moreover, there was a high correlation of cSBP between invasively recorded and both non-invasively assessed cSBP by B-Pro® ($r=0.893$, $p<0.001$) and by SphygmoCor® ($r=0.860$, $p<0.001$). Given in absolute values, cSBP differed only in 0.1±6mmHg ($p=0.913$) between the two non-invasive devices. However, only SphygmoCor® showed an acceptable assessment of heart rate. Conclusions: Both non-invasive devices showed an accurate agreement in cSBP compared with invasively measured cSBP. However, only SphygmoCor® showed an acceptable assessment of heart rate in contrast to B-Pro® compared to invasive recording.

Methodology and Pathophysiology

P2.01

CONTINUOUS NONINVASIVE ESTIMATION OF BLOOD PRESSURE IN THE COMMON CAROTID ARTERY USING MEASUREMENTS IN THE FINGER ARTERY

T. Idzenga [1], Y. W. J. van Swelm [2], H. H. G. Hansen [1], S. Holewijn [1], K. D. Reesink [3], R. G. P. Lopata [3,4], C. L. De Korte [1]
[1]*Radboud University Nijmegen Medical Centre, Dept. of Peadiatrics, Clinical Physics Laboratory, Nijmegen, Netherlands*
[2]*Fontys University of Applied Sciences, Eindhoven, Netherlands*
[3]*Maastricht University, Biomedical Engineering, Maastricht, Netherlands*
[4]*Eindhoven University of Technology, Biomedical Engineering, Eindhoven, Netherlands*

Myocardial infarction and stroke are two leading causes of mortality. The primary trigger for these clinical events is destabilization of atherosclerotic plaques. Plaques can be identified based on their elastic properties, derived from stress and strain in the plaque. Strain can be measured noninvasively using ultrasound [1] and the corresponding stress can be derived from the blood pressure waveform.

In 7 healthy subjects we measured the pressure waveform in the right common carotid artery using two methods. The pressure waveform obtained by applanation tonometry was scaled directly to brachial blood pressure. The carotid artery diameter waveform obtained using ultrasound echotracking was scaled to pressure based on the diastolic and mean blood pressure continuously measured in the finger artery (Finapress®). The resulting pressure waveforms were characterized by their systolic, diastolic and pulse pressure.

The shape of the pressure waveforms obtained by the two methods correlated well (Pearson correlation: 0.87-0.99, $p<0.05$). There was a significant bias in the systolic (mean±se: 15.6±2.3 mmHg) and diastolic pressure (12.6±1.7 mmHg) between the two methods (Bland-Altman, $p<0.05$). The pulse pressure did not have a significant bias (3.0±1.6 mmHg).

These results suggest that the pressure waveform derived from the diameter waveform and finger blood pressure systematically underestimates mean pressure but appropriately describes pressure changes over time. Consequently ultrasound data can be used for simultaneous estimation of stress and strain in the carotid artery, which makes it possible to determine the elastic properties of plaques.

1. Hansen HHG, *et al.* IEEE Trans Med Imaging 2009.

P2.02

PREDICTION OF CARDIOVASCULAR EVENTS: A COMPARISON OF BRACHIAL-ANKLE PULSE WAVE VELOCITY AND CARDIO-ANKLE VASCULAR INDEX

I. Orlova [1], A. Plisuk [1], M. Burgalova [1], F. Ageev [1], A. Shapeton [2]
[1]*Russian Cardiology Research Center, Outpatient Department, Moscow, Russian Federation*
[2]*University of Massachusetts Medical School, Massachusetts, United States of America*

The cardio-ankle vascular index (CAVI) has been recently reported as a new index of aortic stiffness, which is less influenced by blood pressure than the previous standard, brachial-ankle pulse wave velocity (baPWV). Recent studies have shown that CAVI is a more accurate predictor of the current severity of atherosclerotic disease than baPWV. The AIM of this study was to establish which of the two parameters (baPWV or CAVI) has a higher predictive value for major adverse cardiovascular events (MACE) in men with Coronary Artery Disease (CAD). METHODS AND RESULTS: baPWV and CAVI measurement were performed on 224 men with CAD (mean age 56.2±8.9). The examination measured body mass index, blood pressure, blood glucose and total cholesterol. During the 3.5-year follow-up period 38 patients experienced MACE (acute myocardial infarction, coronary intervention, or cardiac death). A receiver operating characteristic curve demonstrated that the best cut-off point for baPWV to predict MACE was 14.0 m/s ($AUC=0.69$, $p<0.001$) whereas for CAVI the value is 8.1 ($AUC=0.61$, $p=0,027$). Univariate Cox analyses demonstrated that baPWV had a significant risk ratio (RR) for MACE ($RR=4.59$, CI95%=2.43-8.67,