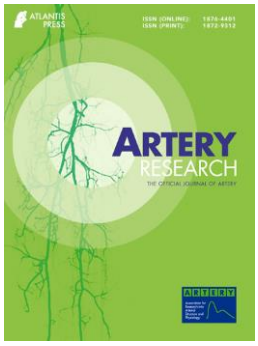

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P2.9: ASSESSMENT OF CENTRAL AORTIC PRESSURE AND ITS ASSOCIATION TO ALL CAUSE MORTALITY CRITICALLY DEPENDS ON WAVE FORM CALIBRATION

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Methods: We recruited 54 healthy volunteers and performed a complete echocardiographic exam. We included in the analysis a short axis view of the aortic arch, after the emergence of the brachiocephalic artery. The 2D-ST methodology was used to off-line calculate aortic arch mechanics (EchoPAQ, GE Healthcare®). The analysis was performed for circumferential aortic strain (CAS) and for early circumferential aortic strain rate (eCASR). We assessed the aortic pulse wave velocity (PVW) with the Complior®. Kolmogorov-Smirnov test was used for normality assessment.
Results: We included 50 controls with a gender balance and a mean age of 33±9 years. Of the total 300 aortic wall segments, 278 had adequate waveforms for analysis. Global CAS had a normal distribution ($p=0.20$); the mean and median CAS were 11.3±3.2% and 11.5% (8.4 - 13.7) respectively. Global eCASR also had a normal distribution ($p=0.10$); the mean and median eCASR were 1.5±0.4 s-1 and 1.6 s-1 (1.3 - 1.7), respectively. There was a significant negative correlation between CAS, age ($r=-0.46$, $p<0.01$), pulse pressure ($r=-0.40$, $p<0.01$), PWV ($r=-0.52$, $p=0.03$) and the vascular augmentation index ($r=-0.60$, $p=0.01$). A similar association was identified for eCARS.
Conclusion: 2D-ST is a feasible methodology for the analysis of the aortic arch mechanics; in this study, we obtained reference values and normal distributions.

P2.5

WITHDRAWN

P2.6
ARTERY DISTENSION MEASURED WITH STANDARD B-MODE IMAGE ECHO-TRACKING HAS SIMILAR ABSOLUTE VALUES AND PRECISION AS MEASURED WITH RADIO-FREQUENCY PHASE-TRACKING

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Objectives: Artery distension, the difference between diastolic and systolic diameter, is an important measure in stiffness evaluation. Distension can be extracted with high precision and accuracy from radio-frequency ultrasound (US) measurements at a high frame-rate using phase-tracking. However, in daily practice processed B-mode images are collected with a lower frame-rate, but higher line density, and distension may only be assessed using echo-tracking. Therefore, the aim of this study is to evaluate the accuracy and precision of echo-tracking distension as compared to that of phase-tracking distension.
Methods: Longitudinal B-mode (40mm, 37fps) US-measurements (video clips 3-6 heartbeats) of the left common carotid artery were performed with a Philips IU22 scanner on 21 patients (age 45-88y) with a recent cerebrovascular accident. In addition, unprocessed radio-frequency US-measurements were performed with a Mylab70 scanner operating in Fast B-mode (31 lines covering 29mm, 300fps, 3-6 heartbeats). To extract the diameter waveform, semi-automatic wall echo-tracking and phase-tracking methods were applied to B-mode and Fast B-mode measurements respectively.
Results: One patient was excluded due to large out of plane motion. Although phase-tracking diameter waveforms showed more detail, both methods exhibit similar intra-subject precision ($SD=34\mu m$ and $SD=33\mu m$, F-test: p-value=0.4). Echo-tracking and phase-tracking systolic-diastolic distension were similar (bias is 25±90μm, paired t-test: p-value=0.18).
Conclusion: Clinical scanners operating in B-mode can be used to measure distension with reasonable precision and accuracy in a relevant stroke population, although waveform details may be masked at lower frame-rates.
This research was supported by the Center for Translational Molecular Medicine and the Dutch Heart Foundation.

P2.7
VALIDATION OF THE COMPLIOR® ANALYSE IN THE ASSESSMENT OF CENTRAL ARTERY PRESSURE CURVES AND AORTIC PULSE WAVE VELOCITY

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Introduction: The purpose of this study was to evaluate the accuracy of carotid pulse wave analysis (PWA) and aortic pulse wave velocity (PWV) with the new version of the Complior device - the Complior Analyse.

Methods: Two cross-sectional studies were implemented to address the reproducibility of the device (87 participants, 60% men, with a mean age of 34.26±16.58 years), and its accuracy comparing it with invasive hemodynamic parameters (15 patients, 7 female gender, mean age 62.07±10.59 years, referenced for cardiac catheterization).
Results: The analysis of concordance revealed a very good agreement for paired PWA and PWV values, regarding both the intra- and inter-observer variability. The intra-observer's intra-class correlation coefficients (ICC) were 0.99 (IC:0.95-1.00, $p<0.0001$), 0.97 (IC:0.96-0.98, $p<0.0001$), 0.98 (IC:0.97-0.99, $p<0.0001$) and 0.86 (IC:0.77-0.90, $p<0.0001$), respectively for PWV, central systolic (cSBP), pulse pressure (cPP) and augmentation index (AiX). For inter-observer analysis, the ICCs were 0.98 (IC:0.93-0.99, $p<0.0001$), 0.98 (IC:0.97-0.99, $p<0.0001$), 0.98 (IC:0.97-0.99, $p<0.0001$) and 0.85 (IC:0.77-0.89, $p<0.0001$).
A good concordance between Complior and invasive hemodynamic data was also obtained for all the measured parameters, with intraclass correlation (ICC) coefficients above 0.9. Bland-Altman's analysis also denoted a good accuracy profile of the Complior device, with small mean differences observed for all parameters and most values confined within 2 standard deviations of the mean difference.
Conclusion: The presented results and available research clearly indicate that the Complior Analyse device measures accurately carotid pressure waves, and has an excellent reproducibility when used in ideal conditions and by experienced observers.

P2.8
IS THE GOLD-STANDARD FOOT-TO-FOOT PULSE WAVE VELOCITY A GOOD ESTIMATE FOR AORTIC STIFFNESS? A NUMERICAL ASSESSMENT

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Arterial stiffness is an important predictor of cardiovascular events. In clinical practice, it is commonly evaluated non-invasively by central (carotid-femoral) or peripheral (femoral-ankle or brachial-ankle) foot-to-foot pulse wave velocities (PWV). Though, the efficiency of these indices as predictors of aortic stiffness in normal and pathological conditions has not been theoretically validated.
This study investigates the relation between aortic stiffness and central and peripheral PWV in normal and pathological conditions using a validated one-dimensional model of blood flow in the arterial network. The model allows us to (i) calculate the theoretical value of aortic stiffness from model parameters and (ii) investigate the effect of specific pathological changes in parameters on PWV estimates.
Our results show that in normal conditions, the central PWV over-estimates aortic stiffness by 8%. This error (e) tends to decrease with increased aortic ($e=-0.5\%$) and global ($e=2,3\%$) arterial stiffening (200% increase from baseline). However, in the presence of isolated lower-limb arterial stiffening, the central PWV over-estimates the aortic stiffness by up to 20%.
In normal conditions, peripheral PWV largely over-estimate aortic stiffness ($42\%< e<67\%$). Though, these errors drop to less than 3% with aortic stiffening.
Increased global arterial stiffening induces significant increases in all PWV. However, progressive increases in aortic stiffness are only detected by central PWV. Interestingly, increased peripheral vascular resistance and compliance only induce small changes in all PWV.
Our study suggests that central PWV is a good estimate of aortic stiffness, and that peripheral PWV can augment diagnosis by detecting the origin of vascular stiffening.

P2.9
ASSESSMENT OF CENTRAL AORTIC PRESSURE AND ITS ASSOCIATION TO ALL CAUSE MORTALITY CRITICALLY DEPENDS ON WAVE FORM CALIBRATION

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Background: The impact of different calibration methods on the prognostic power of aortic systolic pressure (aSBP) is only rarely reported in literature.
Objective: The aim of this work was therefore the prospective investigation of the association of brachial (bSBP) and aortic systolic blood pressures to all cause mortality with special emphasis on different calibration methods for central pressure estimates, in particular brachial systolic and diastolic as well as brachial mean and diastolic pressures.

Methods: 135 Patients were enrolled in a longitudinal, prospective study of arterial stiffness and cardiovascular risk in a cohort suffering from chronic kidney disease stages 2 to 4. Office measurements of bSBP and aSBP were assessed by a validated oscillometric device. Prognostic factors of survival were identified by use of Cox proportional hazards regression models.
Results: After a mean follow up duration of 42 months (range: 30 to 50 months) 13 patients died. In univariate Cox analysis, bSBP did not significantly predict mortality, only aSBP assessed using measured mean and diastolic pressure calibration was significantly associated with mortality (HR=1.027, p=0.008). This remained significant in multivariate analysis after adjustment for age, sex and anthropometric measures. More important, adding bSBP to the multivariate model (HR=0.91, p=0.003), lead to a significantly increased prognostic and statistical power of aortic systolic pressure (HR=1.097, p<0.001) and indicated that differences between bSBP and aSBP are of potential interest.
Conclusion: Within our cohort, only aSBP assessed with measured mean and diastolic pressure predicted mortality and provided highly significant prognostic value.

P2.10
ASSESSMENT OF CAROTID PULSE WAVE VELOCITY BY ULTRASOUND: A WAVE INTENSITY ANALYSIS-BASED APPROACH

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Local carotid pulse wave velocity (cPWV) is a parameter increasingly investigated. The diameter-velocity loop (lnD-V loop) could represent a valid approach for cPWV evaluation, since it requires the use of the ultrasound (US) equipment only. Aim of this study was to develop a fully-automatic system for assessing cPWV which is based on the lnD-V loop and the use of the Wave Intensity Analysis (WIA).
US scans were obtained from 27 healthy subjects (44.1±17.8 years, 44.4% males, BMI 25.5±3.9 kg/m^2). Diameter and flow velocity instantaneous values were achieved from B-mode and PW-Doppler images using edge-detection and contour-tracking techniques. Single-beat mean diameter and velocity were calculated, time-aligned using an automatic technique and plotted together providing the lnD-V loop. The WIA, as introduced by Parker in 2009, was performed: the two local maxima (W1 and W2) were used to locate the two reflection-free linear parts of the loop. From the corresponding slopes, early-systolic (PWVes) and late-systolic PWV (PWVls) were calculated; moreover, a carotid stiffness (CS) value was obtained for each subject using Bramwell-Hill equation.
PWVes values (5.16±1.57 m/s) were lower than CS (5.86±1.50 m/s) and PWVls (6.65±3.28 m/s) assessments: the difference was significant for PWVes-PWVls comparison (p<0.05) but not for PWVes-CS and PWVls-CS comparisons. Both PWVes and PWVls values were significantly correlated with CS ones (R=0.90, p<0.001 and R=0.76, p<0.001, respectively).
The proposed approach, based on US images only and the WIA, allows an evaluation of the stiffness in two different phases of the cardiac cycle, reflecting the pressure-dependent changes in cPWV.

P2.11
ASSESSMENT OF CAROTID DISTENTION WAVEFORM AND LOCAL PULSE WAVE VELOCITY DETERMINATION BY A NOVEL OPTICAL SYSTEM

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Measurement of structural and functional properties of the arterial tree produce important clinical indexes for the assessment of cardiovascular risk, vascular adaptation, and therapeutic efficacy. An optical system for non-contact measurement of skin surface vibrations with the distension in the carotid artery, that allows the determination the pulse wave velocity (PWV) and pulse waveform analysis (PWA), is promising nowadays.
A comparison between optical system and an invasive intra-arterial catheter were performed. The waveforms acquired by both systems show a strong correlation (mean value of 0.95805), the small differences emphasize the effect of the energy dissipation during the heart cycle that occurs due to the viscous properties of the arterial wall.
A comparative test between the optical system and a gold-standard method in PWV assessment (Complior®) was carried out. Lower values were expected for PWV in the carotid site than the PWV in a carotid-femoral measurement and the results proved that there are systematic lower values but with strong correlation (r = 0.819, p<0.001).
Trial tests were developed in a large group of healthy subjects for study the correlations between the population characteristics and their hemodynamic parameters measured by the optical system. The results confirmed an increase of PWV with age; the negative correlation between the Augmentation Index and the heart rate and lower values for the dP/dtmax.in female subjects.
The optical system proved to be able to measure the arterial pulse waveform in a reliable way and demonstrated a good consistency in the determination of clinical parameters using dedicated algorithms.

P2.12
ARTERIAL STIFFNESS MEASURED WITH POPMÈTRE® IN PRIMARY ANTI-PHOSPHOLIPIDS SYNDROME

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Arterial stiffness (AS) is an independent predictor of cardiovascular events. It can be estimated easily by a new technique: pOpmètre® (Axelife-SAS-France). Some data suggests an increase in AS in anti-phospholipids syndrome (APS) patients.
To study the relationship between AS indices, and blood anti-phospholipids antibody levels in patients with primary APS vs controls with an history of thrombosis.
Aortic impedance (Physioflow® Esaote-Italy) , Intima-media thickness (IMT) ultrasound, and foot to toe PWV, blood pressure, ABPI and the aPL antibody titers were measured in 20 APS patients and 20 controls with a distal deep vein thrombosis history.
The two groups were comparable for brachial blood pressure and ABPI (1.15 ± 0.04 vs 1.12 ± 0.03, ns), as well as the age. The APS group had a greater IMT (0.59 ± 0.02 versus 0.53 ± 0.01 mm, p <0.004). AS impedance (10.3 ± 0.6 versus 8.1 ± 0.6 m / s, p <0.02) and pOpmètre® ftPWV (13.2 ± 0.9 vs 10.5 ± 0.6 m/s; p <0.004) was increased in the APS group. Age correlated with systolic blood pressure (SBP) (r2 = 0.1; p = 0.002), AS (r2 = 0.11, p = 0.002), pOpmètre ® ftPWV (r2 = 0.23; p <10^{-4}), IMT (r2 = 0.16; p = 0.0003), not with the BAPI (r2 = 0.03; p = 0.06). No correlation was found between with age and aPL.
Conclusion: In the APS patients, arterial stiffness measured by pOpmètre® is increased compared to controls and correlated with AS indices and IMT.

P2.13
FOOT TO TOE PULSE WAVE VELOCITY WITH POPMETRE® INDEPENDENTLY CORRELATES WITH GLOMERULAR FILTRATION RATE IN RENAL TRANSPLANT PATIENTS

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Aim: To evaluate the relationship between glomerular filtration rate and arterial stiffness using Pulse Wave Velocity (PWV) as an independent cardiovascular risk factor in renal transplanted patients.
Patients and methods: We studied transplanted patients followed in our outpatient clinic. After a medical examination, we measured blood pressure (Comfort Cuff- Skil-Care, USA), PWV (pOpmètre® - Axelife sas - France) after 10 min supine resting. pOpmetre® measures the finger to toe transit time, and according to a height chart, calculates the PWV. Three measurements were performed to study the repeatability. Estimated glomerular filtration rate (eGFR) was calculated using MDRD equation.
Results: Forty-four (30 men, 14 women) renal transplant recipients were included. No significant difference between men and women were found in age (M±SEM: 53.2±2.2 years), systolic blood pressure (SBP: 138±2 mmHg), diastolic blood pressure (DBP: 81±2 mmHg), eGFR (45.9±2.4 ml/min/1.73 m2) and PWV (10.4±1 m/s) [range: 6.0-15.7]. Repeatability expressed as the SD/mean of 3 measurements was very good: 5.4%.
PWV correlated positively with age (r^2=0.16, p<0.009) and negatively with eGFR (r^2=0.15, p<0.009). Using a stepwise regression model (including gender, age, SBP, DBP, height, weight), only age and pOpmetre PWV remained significantly associated with eGFR.