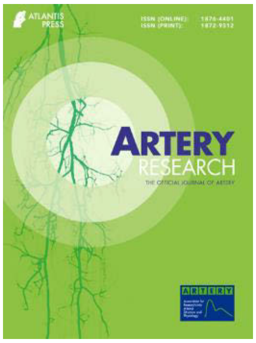

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P168: FEASIBILITY STUDY OF LOCAL PULSE WAVE VELOCITY ESTIMATION IN THE CAROTID ARTERY WITH MULTI-BEAM LASER DOPPLER VIBROMETER

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P166

AORTIC PULSATILITY, AND NOT MEAN ARTERIAL PRESSURE, IS AN INDEPENDENT DETERMINANT OF LEFT MAIN CORONARY ARTERY DISEASE

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Introduction: Left Main Coronary Artery (LMCA) disease is prognostically the most important coronary lesion. LMCA differs from the other coronaries in having high elastin content. Aortic Pulsatility (AP) is an independent predictor of cardiovascular events in CAD. We hypothesized that pulsatile stress may be an independent determinant of disease in the LMCA.
Methods: This was a prospective cohort study in patients undergoing coronary angiography between the years 2011 and 2016 ($n = 4633$, 25% female) at King Abdul Aziz Cardiac Center, Riyadh, Saudi Arabia. We excluded patients with acute myocardial infarction, cardiogenic shock and significant valvular disease. Aortic systolic and diastolic blood pressures (BP) were measured in the ascending aorta. Mean Arterial Pressure (MAP) by direct integration of the BP curve and Pulse pressure (PP) as difference between systolic and diastolic BP. AP was calculated as PP/MAP. CAD was defined as $>$ 50% stenosis in any major vessel.
Results: Six percent of the population had LMCA disease (mean age 60 ± 11 years, 25% female). LMCA disease was associated with higher PP (69 ± 22 vs. 58 ± 18, $p < 0.0001$) despite similar MAP (94 ± 16 vs. 94.5 ± 14, $p = 0.92$) compared with non-LMCA disease. AP was significantly higher (0.72 ± 0.30) in LMCA disease compared with; 3-vd (0.63 ± 0.32); 2-vd (0.61 ± 0.28), 1-vd (0.58 ± 0.31) and non-obstructive CAD (0.52 ± 0.26) ($p < 0.0001$). In a stepwise regression model, AP was an independent predictor of LMCA disease ($R^2=0.68$, $P < 0.0001$) even when adjusted for potential confounders, including MAP, age and gender.
Conclusions: LMCA disease is independently associated with high AP. Considering aortic pulsatile stress to be an independent cardiovascular prognosticator, stiffness of the LMCA may play an important role in plaque formation, hitherto ignored.

P167

ACUTE EXERCISE EFFECTS ON VASCULAR AND AUTONOMIC FUNCTION IN PATIENTS WITH STABLE CORONARY ARTERY DISEASE

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Purpose: To examine the acute effect of maximal exercise effort on pulse wave velocity (PWV) and heart rate variability (HRV) in patients with CAD with a range of functional capacity levels, and the association between these parameters 1,2,3.
Methods: Thirty-six patients with CAD (62 ± 10 y) ranging in very-poor (5.22 ± 0.83METs; $n = 18$; VPFIT-CAD) to poor (6.50 ± 1.35METs; $n = 18$; PFIT-CAD) functional capacity, and 18 age-sex-matched healthy controls (8.53 ± 1.84METs; FFIT-CON) had their aortic- and peripheral-PWV, and HRV assessed prior to, and at 10 min and 30 min following a maximal cycle-ergometer test.
Results: Aortic- and peripheral-PWV did not differ between groups ($p > 0.05$) at baseline. Aortic-PWV was significantly increased at 10 min (0.63–0.98 $m.s^{-1}$) following exercise in all groups, but only remained so at 30 min in PFIT-CAD. Lower limb-PWV decreased in VPFIT-CAD and FFIT-CON at 10min (0.48; 0.51 $m.s^{-1}$) and remained so at 30 min (0.51; 0.45 $m.s^{-1}$), but not in PFIT-CAD. Still, no interaction effects were observed ($p = 0.864$). RMSSD was lower in PFIT-CAD compared to FFIT-CON (6.55, $p = 0.009$). RMSSD decreased at 10min following exercise in PFIT-CAD (5.26, $p=0.005$) and FFIT-CON (8.86, $p < 0.001$) but only remained so at 30min in PFIT-CAD (3.27, $p = 0.47$; p-interaction $= 0.001$). A significant correlation between changes in aortic-PWV and RMSSD assessed from prior to 10min recovery was observed in VPFIT-CAD ($r = 0.44$, $p = 0.034$).
Conclusion: Patients with CAD have similar arterial response to maximal exercise compared to their higher fit healthy peers. However, HRV following exercise is apparently compromised in CAD patients. The reduction in aortic PWV is parallel to the changes in HRV in patients with CAD with very-poor functional levels.

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P168

FEASIBILITY STUDY OF LOCAL PULSE WAVE VELOCITY ESTIMATION IN THE CAROTID ARTERY WITH MULTI-BEAM LASER DOPPLER VIBROMETER

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Background: An innovative device using Laser Doppler Vibrometry (LDV) has been designed [1] to measure the transit time of the pulse wave between two locations along the course of the carotid artery (CA) from skin surface vibrations for assessment of local pulse wave velocity (PWV) [2].Aim: Tests were conducted on in-vitro models to assess the feasibility of the LDV to estimate the local PWV; preliminary in-vivo measurements were also performed.
Methods: Two CA geometries embedded within a soft-tissue-mimicking hydrogel were considered: i) a straight latex tube and ii) a patient-specific CA silicone-rubber model including the bifurcation. Models were pressurised in a water-filled loop and pulsatile flow was generated with a pump and/or high frequency impulses induced externally. For all measurements, two sets of six beams were used to measure surface displacement perpendicular to the external surface. PWV was calculated from the distance between selected beams and the delay between corresponding signals, using the time of the maximum of first and second derivatives of pressure (P-PWV) and displacement (LDV-PWV) as fiducial points [3]. A windowed cross correlation method [4] was also used for the in-vivo data analysis.
Results: PWV values for the in-vitro models are summarized in Table 1, while preliminary in-vivo LDV-PWV results are shown in Fig 1.
Conclusions: Good agreement between P-PWV and LDV-PWV in the tubular model was found under impulse loading, while complex waveforms measured under pulsatile flow and in-vivo conditions lead to more disparate effects when using different analysis methods. Further signal analysis is warranted.

	Straight tube model		Carotid model	
	Pulsatile flow	Induced impulse	Pulsatile flow	Induced impulse
P-PWV (m/s)	14.1	5.7	13.6	4.1
LDV-PWV (m/s)	3.2	6.2	5.1	15.7

Table 1. P-PWV and LDV-PWV mean values under pulsatile flow and Induced impulse conditions.

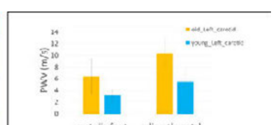

Fig 1 a) PWV mean values and standard deviation for a young (24 years) and old (72 years) subject, systolic foot and dicortic notch were used as reference points. Note the higher PWV in the older subject, as expected.

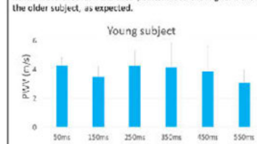

Fig 1 b) PWV mean values and standard deviation from windowed cross correlation analysis around the dicrotic notch region.

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P169

RELATIONSHIP BETWEEN COMMON CAROTID DISTENSIBILITY/AORTIC STIFFNESS AND LEFT VENTRICULAR MORPHOLOGY AND FUNCTION IN RHEUMATOLOGIC PATIENTS

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Introduction: Arterial stiffness is known to be associated with atherosclerosis, cardiac remodelling and cardiovascular diseases. In recent studies, common carotid artery rigidity was seen to better predict cardiac morphology and function if compared to aortic parameters. The aim of the study was to determine the relation between carotid/aortic stiffness indices and the main echocardiographic measures in patients with rheumatological disease.
Methods: 208 participants were evaluated (57,4 $\pm$ 11,4 yr; males = 36,1%); 65,9% were previously diagnosed with rheumatoid arthritis, 20,2% with psoriatic arthritis and 13,9% with ankylosing spondylitis. In each subjects medical history, use of drugs and glico-metabolic status was assessed. Echocardiography, blood pressure (BP) measurement and carotid ultrasonography were performed. Carotid Distensibility (CD) and Aortic Stiffness (AoS) were measured as indices of arterial stiffness.
Results: Mean Left Ventricular Mass indexed by body surface area (LVM/BSA) and Relative Wall Thickness (RWT) were 98,8 $\pm$ 20,7 g/m^2 and 0,46 $\pm$ 0,06, respectively. In multiple regression analysis, DC was correlated with age (β = 0,325, p $<$ 0,0001) and mean BP (β = 0,502, p $<$ 0,0001) while AoS was not associated with any anthropometric, anamnestic and vascular parameters. DC has been seen to inversely correlate with LVM/BSA (r = $-$0,20, p = 0,005), Intraventricular Septum and Posterior Wall Thickenss; a direct correlation between AoS and left E/e' (a diastolic function indicator) has emerged (r = 0,191, p = 0,007).
Conclusion: Results are consistent with a possible predictive role of DC assessment in left cardiac hypertrophy and remodelling and a direct link between AoS and left ventricular diastolic function.

P170

A FOREHEAD AND NASAL BRIDGE PULSE OXIMETER COMPARISON MEASUREMENTS ON HEALTHY SUBJECTS

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Photoplethysmography (PPG) is a biophotonic technique which measures blood volume variations in vascular bed and it is well known for its utilization in pulse oximetry for the estimation of arterial blood oxygen saturation. Moving particles within the tissue bed generate rapidly changing absorption caused by the heart beats, while stationary components will cause a relatively constant absorption. The detected light in PPG is therefore composed of an alternating pulsatile component (A) and a constant direct component (B), the both components are utilized for calculating the oxygen saturation estimation. The two LEDs (660 nm & 940 nm) are typical for pulse oximetry. In pulse oximetry, good high-quality RED LED and IR LED generate raw PPG signals (A + B) in both wavelength which are acquired by a single photosensor. Arterial oxygen saturation (SpO2) is estimated from PPG signals acquired from the custom-made nasal bridge PPG sensor and a commercial forehead SpO2 sensor (Medtronic). The SpO2 is calculated based on an empirical formula, SpO2 = 110$-$R*25, where R = [(A/B)]RED/[(A/B)]IRThe arterial oxygen saturation were 98-100% in healthy young subjects measured from the forehead, whereas elderly people gave 95% - 97%. The use of pulse oximeters increases, and their needs for higher performance. We have measured with the nasal bridge PPG based pulse oximeter and analyzed the test results according to the empirical equations.
Results: Show a rhythmic fluctuation caused, e.g., respiratory activity. The comparison between the commercial device with the custom-made nasal bridge device results were compared because they have different measurement location.

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P171

CARDIOVASCULAR RISK EVALUATION IN BEHCET'S PATIENTS — THE ROLE OF CHRONIC INFLAMMATION IN ARTERIAL STIFFNESS

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Introduction: Behcet's disease (BD) is a chronic inflammatory syndrome with systemic manifestations. Systemic vasculitis contribute to vascular aging, increasing the arterial stiffness that can be inferred from the Pulse Wave Velocity (PWV) measurement. Carotid ultrasound evaluation allows vascular wall changes detection, as the increase of intima-media thickness (>IMT) and plaques. These alterations increase cardiovascular risk (CVR).
Methods: 49 patients were included. Anthropometric, sociodemographic, laboratorial, comorbidities, medication, peripheral and central blood pressure, Systematic Coronary Risk Evaluation, PWV and carotid ultrasound abnormalities data were evaluated. To understand the role of chronic inflammation in arterial stiffness, comparative analyzes were performed with a control group with CVR factors and with a group of healthy individuals.
Results: The sample consisted mainly of women (61.2%), characterized by 30.6% of arterial hypertension, 32.7% of dyslipidemia, 4.1% of diabetes and 14.3% of obesity. PWV median value was 8.32m/s, with 30.6% PWV > 90th percentile of the normal reference population and 16.3% with target organ lesion. >IMT in the common carotid artery (CCA) and plaques were observed in 10.4% and 41.7%, respectively. In the obtained linear regression model, the variables systolic central blood pressure and ›IMT in the ACC showed a statistically significant impact on PWV. In the established comparisons, PWV did not present statistically significant differences. Conclusion: The integrated analysis of the collected data made it possible to requalify the patients in the context of the CVR, allowing the early adoption of control measures. Chronic inflammation associated with BD did not lead to significant differences in arterial stiffness.

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