



## Artery Research

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### **P1.15: ASSOCIATION BETWEEN CAROTID AND FEMORAL ATHEROSCLEROTIC BURDEN AND VASCULOGENIC ERECTILE DYSFUNCTION**

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What aspect contributed the most to these results (diet, exercise or possession of a personal vascular image) needs further larger early detection study.

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#### P1.11

##### DIURNAL AND GENDER VARIATION OF ARTERIAL STIFFNESS IN YOUNG HEALTHY VOLUNTEERS

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**Objective:** The augmentation index (Alx) is a measure of arterial stiffness, and is an autonomous determinant independent of other cardiovascular risk factors.

**Methods:** We examined whether the peripheral and central blood pressure (BP), pulse rate, Alx of healthy volunteers, measured at three different times of the day (8 AM, 12 PM, 5 PM), would show any difference. The measurements were carried out using SphygmoCor device.

**Results:** 52 healthy volunteers were included into the study. The average age and BMI of the 23 males were 24.4±2.5 years and 24.0±2.9 kg/m<sup>2</sup>, while it was 23.0±1.4 years and 20.5±3.6 kg/m<sup>2</sup> at the 29 females, respectively. During the three different times of measurement, the actual peripheral and central systolic and diastolic BP and pulse rate did not show any significant difference either for males, or females. In contrast, the Alx of the males was significantly reduced over the course of the day: 8 AM: 13.1±10.2%; 12 PM: 5.3±9.8%; 5PM: 3.4±8.2% (p<0,01). We observed a similar trend in the case of the females as well: 8 AM: 17.0±9.1%; 12 PM: 13.3±10.2%; 5 PM: 11.3±7.5% (p<0,01). The females Alx were higher than that of males (p<0,01).

**Conclusion:** We conclude that augmentation index shows a considerable diurnal variation and gender difference. There is a gradual decrease from morning values over the course of the day along. Our data suggest to take period of the day at which the measurement was taken and gender into account, while determining physiological and pathological values or interpreting test results.

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#### P1.12

##### COMPARISON OF ARTERIAL RELAXATION TIME IN NORMOTENSIVE AND HYPERTENSIVE SUBJECTS

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Arterial stiffening is emerging as an important determinant of increased systolic blood pressure (SBP) and pulse pressure in the aging population. The relation of the brachial artery was studied in both normotensive and hypertensive volunteers. The test subjects include six healthy, normotensive (SBP/DBP < 120/80 mm Hg) subjects (control group, four in the age range 19 to 23 years, and two in the older subjects, 57 and 60 years) and four subjects (48 to 58 years) with elevated SBP (ranging from 130-168 mm Hg) and who are currently on hypertensive medications (hypertensive group). Temporal measurements of the pressure and volume waveforms were recorded in both hands with one arm at heart level and the other initially at heart level and then raised a distance of 35 cm above heart level. Upon raising the arm, a delay is observed in the pulse measurement of the raised arm relative to the hand at heart level. The delay has previously been shown to decay exponentially with time. For the normotensive subjects, the average values of the pressure and volume relaxation times  $\tau_p$  and  $\tau_v$  were 75 s and 41 s for the younger-age group and 86 s and 68 s for the older-age group. The delay times for subjects in the hypertensive group were assumed to approach the baseline asymptotically. The validity of this assumption has been demonstrated in the control group. The average value of  $\tau_p$  in the hypertensive group was found to be 581 s, significantly larger than the control group.

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#### P1.13

##### ENHANCED VASCULAR REACTIVITY TO COLD PRESSOR TEST IN AFRICAN NORMOTENSIVE SUBJECTS

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**Background:** Cold exposure increases arterial wave reflection to the aorta mainly through adrenergic vasoconstriction. Normotensive blacks exhibit

heightened sympathetic response to cold as compared to Whites controls. We therefore decided to test the hypothesis that cold exposure would elicit a greater increase in arterial wave reflection in normotensive Africans when compared to normotensive Caucasian subjects. In addition we sought to investigate whether this would be accompanied by a higher increase in aortic pulse wave velocity (PWV) and by a more pronounced vasoconstriction of the skin microcirculation.

**Methods:** 17 young normotensive Africans and 17 age and weight matched Caucasians were recruited for the study. All underwent assessment of PWV and Augmentation Index corrected for heart rate (Alx) at rest, during and after hand immersion in ice water (cold pressor test, [CPT]). Concomitantly, skin microvascular blood flow response to cold was continuously monitored by laser Doppler flowmetry method.

**Results:** At rest, Africans exhibited higher values of PWV than Caucasians (7.3±0.3 vs 6.4±0.2 m/sec respectively, p=0.04). During CPT the magnitudes of increases in SBP and PWV were greater in Africans than Caucasians (26±3 mmHg vs 15±3 mmHg and 0.8±0.2 m/sec vs 0.4±0.2 m/sec respectively, p<0.05 for all). Additionally, CPT induced a more pronounced skin microvascular vasoconstriction in Africans as compared to Caucasians (-45±7 % vs -25±7 %, p=0.01). Finally, Africans exhibited higher Alx values during CPT (12.6±2.4 vs 5.5±2.4 %, p=0.04) when compared to Caucasian subjects.

**Conclusions:** Normotensive Africans exhibit intensified wave reflection to the aorta as response to CPT when compared to Caucasians. This is accompanied by a greater increase in PWV and a more pronounced vasoconstriction of the microcirculation.

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#### P1.14

##### CORRELATION BETWEEN AORTIC PULSE WAVE VELOCITY AND ASYMPTOMATIC CAROTID ATHEROSCLEROSIS

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**Background:** It seems that traditional risk factors are not sufficient predictors of the atherosclerosis and cardiovascular disease (CVD). Although the carotid ultrasonography is a gold standard of the detection of asymptomatic atherosclerosis, the correlation between aortic pulse wave velocity (PWVao) and the presence of preclinical carotid plaques was poorly investigated. The aim of this study was to examine this correlation and determine the most sensitive cut-off value of the aortic PWV for carotid atherosclerosis by using ROC (Receiving Operating Characteristic) analysis.

**Methods:** 557 asymptomatic subjects were included without known CVD. Arterial stiffness parameters (PWVao) were measured with non-invasive oscillometric device (Arteriograph) and carotid scan was performed with carotid ultrasonography in both side by a "blinded" investigator who was unaware of the stiffness-parameters in all subjects as well.

**Results:** We have found 283 carotid negative subjects and 274 carotid positive subjects. The carotid ultrasonography was positive when the IMT > 1.3mm or calcificated plaque ≥ 1mm was detected. The mean values were: age 57, BP 134/82 mmHg, HR 72/min, Aix -8,7%, PWVao 9,9 m/s. In data analysis the SPSS software and the ROC curve were used. The most sensitive PWVao was 9.62m/s. The sensitivity of increased PWVao was 77.7%, the specificity 65.4%, the positive predictive value (PPV) 68,5%, the negative predictive value (NPV) 75,2%. The significance between these values was very good.

**Conclusion:** The increased (>9,62 m/s) PWVao shows a strong association with the asymptomatic carotid plaques and seems to be a suitable method to detect preclinical atherosclerosis.

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#### P1.15

##### ASSOCIATION BETWEEN CAROTID AND FEMORAL ATHEROSCLEROTIC BURDEN AND VASCULOGENIC ERECTILE DYSFUNCTION

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**Background:** Vasculogenic erectile dysfunction (ED) may be considered a clinical manifestation of a generalized arterial disease. We attempted to evaluate the association between penile vascular dysfunction and extent of

generalized arterial disease proposing a score that incorporates intima-media thickness (IMT) from the carotid and femoral arteries.

**Methods:** 56 consecutive non diabetic patients (mean age:  $58 \pm 12$  yrs) affected by non-psychogenic and non-hormonal ED were evaluated for penile vascular disease severity by penile Doppler ultrasound. The mean systolic velocity (PSV) shows the greatest flow velocity detectable in an artery throughout the systole. Ultrasonographic assessments of IMT, lumen diameter and plaques in the carotid and femoral arteries were evaluated and a score was developed.

**Results:** Patients with high score ( $n=26$ ) compared with subjects with low score were older ( $59$  vs  $54$  yrs,  $P=0.06$ ), had decreased mean PSV ( $25.3$  vs  $33.1$  cm/s, figure) and longer duration of ED ( $3.8$  vs  $2$  yrs,  $P<0.05$ ), whereas these two groups did not differ regarding systolic pressure, metabolic profile and smoking status. Analysis of covariance revealed that PSV values of penile arteries were significantly different between the two groups after adjustment for confounders ( $P<0.05$ ). Moreover, in the entire population, mean PSV exhibited a negative correlation with femoral ( $r=-0.34$ ,  $P<0.05$ ) and carotid IMT ( $r=-0.29$ ,  $P<0.05$ ).

**Conclusions:** Ultrasound findings of penile vasculature and duration of ED correlate significantly with increasing severity of carotid and femoral artery wall thickness and atherosclerotic lesions. These data suggest a close interrelationship between progression of vasculogenic ED and early atherosclerosis.

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#### P1.16

##### HIGHER ORDER NON-LINEARITY IN ARTERIAL WALL DISTENSIBILITY IS PRESENT IN ONE-THIRD OF PATIENTS WITH CARDIOVASCULAR DISEASE

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**Background:** It is generally accepted that arterial cross-section is an exponential function of pressure. We hypothesized that the order of non-linearity varies substantially between individuals.

**Methods:** We obtained simultaneously intra-arterial pressure waveforms and common carotid artery (CCA) diameter waveforms by ultrasound in 10 patients (age  $70 \pm 8$  yrs) undergoing coronary catheterisation. We extracted beat-to-beat diastolic (D), systolic (S), and diastolic notch (N) values from both pressure and diameter waveforms by an automated algorithm. We reconstructed pressure-cross-section curves of each patient by fitting the  $p = p_d \cdot \exp(a(A - A_d)/A_d)$  model to D, S, and N; with: pressure (p), diastolic pressure ( $p_d$ ), artery cross-section (A), and diastolic cross-section ( $A_d$ ). Based on a we recalculated systolic blood pressure ( $p_s$ ).

**Results:** Eight patients had systolic hypertension and two were normotensive.  $P_s$  was  $144 \pm 25$  (mean $\pm$ SD),  $p_d$  was  $75 \pm 12$ , and pulse pressure was  $69 \pm 25$  mmHg. In 7/10 the exponential model ( $a=9.4 \pm 3.9$ ) fitted the three point data well ( $r^2 > 0.99$ , difference in  $p_s = 0 \pm 1$  mmHg), but in 3/10 (one normotensive) the fit was less good because the non-linearity was of a higher order than contained in the model. In those particular patients, the model underestimated real  $p_s$  by 4 to 10 mmHg.

**Conclusions:** Non-invasive methods to estimate local pulse pressure or characterize arterial stiffness based on the above exponential model are less suitable in 30% of patients with cardiovascular disease due to the presence of a higher order non-linearity in arterial wall distensibility.

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#### P1.17

##### ARTERIAL STIFFNESS IS RELATED TO LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN DILATED CARDIOMYOPATHY

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**Aim:** . To evaluate the relationship between left ventricular (LV) diastolic and systolic function, arterial stiffness and endothelial function in patients with dilated cardiomyopathy (DCM)

**Methods:** In 54 patients with DCM (age  $63 \pm 13$  years, 10 females) and LV ejection fraction (EF) $<45\%$ , applanation tonometry (Sphygmocor®) was evaluated for determining augmentation index (AIx) and pulse pressure (PP) amplification (brachial PP / central PP%) by pulse wave analysis and carotid to femoral pulse wave velocity (PWV). Endothelium-dependent (flow-mediated dilation, FMD, after 5-minute of forearm ischemia) and independent (sublingual glycerol trinitrate, GTN, 25  $\mu$ g) vasodilation were

assessed by ultrasounds and computerized analysis of brachial artery diameter changes. A Doppler and echocardiographic study was also performed, for measurements of E/A ratio and E wave deceleration time (ETD).

**Results:** . Mean LV EF was  $32 \pm 10\%$ . AIx was related to E/A ratio ( $r=-0.51$ ;  $p<0.01$ ) and EDT ( $r=0.36$ ;  $p<0.05$ ). PP amplification correlated with E/A ratio ( $r=0.61$ ;  $p<0.0001$ ) and EDT ( $r=-0.36$ ;  $p<0.05$ ). PWV was associated with EDT ( $r=0.36$ ;  $p<0.05$ ). A significant correlation was found between PP amplification and LV EF ( $r=-0.33$ ;  $p<0.05$ ). No significant correlations were apparent between FMD, response to GTN and FMD/GTN ratio with respect to indexes of LV systolic and diastolic function.

**Conclusions:** In DCM patients, arterial stiffness is related to LV diastolic dysfunction, indicating that increased arterial stiffness is associated with either restrictive or pseudo-normal LV filling. Pulse wave amplification is directly related to diastolic parameters and inversely to systolic function, suggesting lesser central pressure augmentation rather than increased peripheral amplification.

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#### P1.18

##### AN HEMODYNAMIC STUDY OF THE LOWER LIMB ARTERIAL NETWORK AND ITS APPLICATION IN A MODEL FOR PREDICTIVE BYPASS SURGERY

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Vascular bypass surgery is commonly performed in the lower limb network in symptomatic patients presenting arterial occlusions. These bypasses can be performed with prosthetic material (PTFE/ polyester) of different diameters, or with autologous veins. Venous grafts have shown a better long-term patency (persisting graft function) than prosthetic ones (70% versus 40% at 4 years)(1). One hypothesis is an abnormal hemodynamic into the bypass leading to thrombosis or intimal hyperplasia. Nowadays, no objective tool is available to help the surgeon to predict the patient-specific hemodynamic performance of a bypass and choose its most adequate characteristics (material, diameter).

In order to analyse the hemodynamic parameters of the lower limb pathological arterial network before surgery, non-invasive measurement techniques are used: area, velocity and flow rate are recorded by doppler ultrasound; pressure and pulse wave velocity by SphygmoCor®. These measurements allow the evaluation of the outflow conditions of the leg (resistance and compliance) and their physiological behaviour related to the bypass. The hemodynamic modification due to the bypass is measured during surgery by invasive techniques: needle technique and Radi PressureWire® for the pressure waves and ultrasound flowprobes for the flow rate curves. These data are included in a numerical model which aim to predict the flow rate expected in the bypass depending on its characteristics of material and diameter. The results are compared to those of published studies describing velocity and flow rate data predictive of early graft failure (1).

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#### P1.20

##### ASSOCIATION BETWEEN LOW-GRADE ALBUMINURIA AND ARTERIAL STIFFNESS IN HYPERTENSIVE SUBJECTS

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**Background:** Microalbuminuria is an established risk factor for cardiovascular morbidity and mortality. Recently, the prognostic value of low-grade albuminuria for cardiovascular disease has been suggested. However, most studies were performed in heterogeneous population.

**Methods:** The association between urinary albumin excretion and arterial stiffness was evaluated in subjects with never treated hypertension and without diabetes and cardiovascular complications. Urinary albumin creatinine ratio (UACR) was measured with morning spot urine sample after overnight fasting. Arterial stiffness was measured with brachial-ankle pulse wave velocity (baPWV). Definition of low grade albuminuria was UACR  $<22$  for men or  $<31$  mg/g creatinine for women according to 2007 ESH/ESC