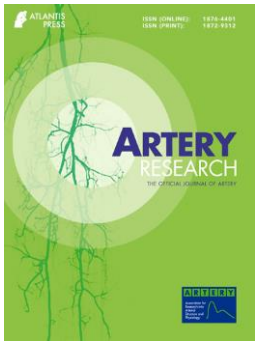

Artery Research

ISSN (Online): 1876-4401 ISSN (Print): 1872-9312
Journal Home Page: https://www.atlantis-press.com/journals/artres

05.02: HERITABILITY AND INTRAFAMILIAL AGGREGATION OF ARTERIAL CHARACTERISTICS

J.S. Seidlerova, J.A.S. Staessen, M.B. Bochud, M.C. Cwynar, M.D. Dolejsova, T.K. Kuznetsova, T.N. Nawrot, A.O. Olszanecka, K.S. Stolarz, L.T. Thijs, W.W. Wojciechowska, HAS.-B. Struijker-Boudier, KK.-J. Kawecka-Jaszcz, R.C.E. Elston, R.F. Fagard, J.F. Filipovsky

To cite this article: J.S. Seidlerova, J.A.S. Staessen, M.B. Bochud, M.C. Cwynar, M.D. Dolejsova, T.K. Kuznetsova, T.N. Nawrot, A.O. Olszanecka, K.S. Stolarz, L.T. Thijs, W.W. Wojciechowska, HAS.-B. Struijker-Boudier, KK.-J. Kawecka-Jaszcz, R.C.E. Elston, R.F. Fagard, J.F. Filipovsky (2007) 05.02: HERITABILITY AND INTRAFAMILIAL AGGREGATION OF ARTERIAL CHARACTERISTICS, Artery Research 1:2, 48–49, DOI: https://doi.org/10.1016/j.artres.2007.07.043

To link to this article: https://doi.org/10.1016/j.artres.2007.07.043

Published online: 21 December 2019

01.04

NON INVASIVE EVALUATION OF ARTERIAL REMODELING IN PATIENTS WITH FABRY DISEASE AFTER ENZYME REPLACEMENT THERAPY

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Context: Fabry disease (FD) is a deficiency of lysosomal enzyme α-galactosidase A leading to accumulation of glycosphyngolipids in vascular and renal tissues. Affected patients exhibit neuropathic pain and premature mortality because of renal failure and cardiovascular diseases. We have already described an accelerated hypertrophy of the arterial wall. Although enzyme replacement therapy (ERT) decreases glycosphyngolipids accumulation in tissues, there is no evidence of ERT efficacy on vascular hypertrophy.
Objective: To evaluate efficacy of intravenous ERT at usual dosage on large artery properties.
Design study: Longitudinal follow-up before (23 ± 11 Mo) and after ERT (47 ± 17 Mo). Four to 8 serial measurements of (a) carotid intima-media thickness (IMT) and diameter, obtained with high definition echotracking device, and (b) aortic stiffness, obtained through carotid to femoral pulse wave velocity (PWV).
Patients: 15 patients (12 males and 3 females with clinical manifestations), aged 33 ± 10 years.
Results: Carotid-femoral PWV significantly decreased during follow-up ($P<0.001$). The slope of PWV changes with time did not differ from zero (-0.16 ± 0.90 m/s/yr, NS) before ERT, but was significantly reduced after ERT (-0.50 ± 0.47 m/s/yr, $P<0.01$). IMT increased before ERT and kept increasing after ERT (ANOVA). However, individual slopes did not differ from zero (before ERT $+10 \pm 66$ μm/yr, after ERT: 4 ± 21 μm/yr ($P=0.745$)). Diameter, wall-to-lumen ratio and carotid distensibility did not change after ERT ($P=0.53$, 0.20, 0.44, respectively).
Conclusion: In addition to it's effectiveness on pain and glycosphingolipids storage in tissues, ERT with recombinant algasidase-beta proved to decrease aortic stiffness while carotid wall hypertrophy was still progressing.

01.05

RESPONSE OF BLOOD FLOW AND VASCULAR RESISTANCE IN COMMON CAROTID ARTERY TO HYPERCAPNIA

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Background: Although the brachial artery is appreciated as a representative of the arterial tree for endothelial function tests, it would be favourable to estimate flow mediated dilation (FMD) at clinically relevant locations e.g. the common carotid artery (CCA). Hypercapnia strongly stimulates cerebral blood volume flow, with steady state achieved after 2 mins, inducing FMD in the CCA.
Objective: To develop a complete stimulus-response profile (baseline, peak, steady state) of flow velocity, diameter and heart rate during and after hypercapnia, also to evaluate their interrelationships.
Methods: The CCA was visualised with an ultrasound beam at 60° in Doppler-mode with a P350 ultrasound system. Hypercapnia was induced with a 6.8% CO2 inhalation for a period of 2 mins. Processing of received signals from baseline, during hypercapnia and return to baseline (total 10 mins) clearly revealed in beat-to-beat changes in systolic and end diastolic diameters, blood flow velocity (BFV), blood flow rates, and carotid peripheral resistance.
Results: Continuous long-term measurements indicate a peak at 3 mins, with a steady decay over the remaining follow up time. The BFV (+25%), carotid diameter (+12%), distension and heart rate increase significantly during and post hypercapnia. No significant changes are seen in blood pressure.
Conclusions: Inhalation of CO2 for 2mins increases blood flow and induces carotid artery dilatation. CCA FMD exposes the dynamic interrelationship between blood flow and CCA diameter and is a good tool to test directly endothelial function in atherosclerotic prone arteries.

01.06

BIOMECHANICAL ANALYSIS OF HUMAN COMMON CAROTID ARTERIES BY SEGMENTED APPROACH ON NON-INVASIVE ECHOTRACKING SYSTEMS

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Background: In addition to measurement of diameter, intima-media thickness (IMT) and stiffness, the high resolution of non-invasive echotracking systems (Wall Track System® ArtLab®) permits to have insights in new parameters. First we can study longitudinal segmental inhomogeneities of strain defining gradients of strain and layer-by-layer changes in strain within the arterial wall, defining inhomogeneities in compressibility. The aim of the present report is to present feasibility data and first results for these two parameters.
Methods and results: Multidirectional segmentations of radio-frequency matrix recordings were applied to different diseases. First, longitudinal gradient of strain were measured in 92 patients with plaques, either hypertensive or not. Second, strain gradient within the wall (hence estimated compressibility), was tested in 46 patients with vascular Ehlers-Danlos Syndrome (vEDS) and 72 controls. Different conceptual and operational tools were developed under Matlab® software for these purposes. We observed that remodeling at the level of the plaque deeply influenced the segmental behavior of strain, inward remodeling being associated with exaggerated strain, and outward remodeling with reduced strain. We showed that both vEDS and control subjects exhibited marked excess of compressibility within IMT, and that this highly compressible zone was closer to the lumen and accentuated in vEDS than in controls.
Conclusion: It is possible to make segmental analysis of segmental properties of remodelling and bending stress. In addition, apparently homogeneous arterial walls exhibited mechanical interfaces which exaggerated compressibility and local stresses between different sub-layers within the wall.

05.01

CAN WAVE INTENSITY HELP EXPLAIN THE DIFFERENT VELOCITY FLOW PROFILES IN THE CORONARY ARTERIES?

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Background: In the left coronary arteries, coronary flow is said to occur mainly in diastole, but this is not the case in the right coronary artery (RCA). Since the pressure being applied at the aortic end is identical for both arteries, we hypothesised that differences from the microcirculatory end account for the differences in the flow velocity waveform. We apply a new technique, wave intensity analysis, to explain the differences in these velocity waveforms.
Methods: In 10 subjects sensor-tipped intra-arterial wires were used to measure simultaneous pressure and Doppler velocity in the proximal left main stem (LMS), the left anterior descending (LAD), the left circumflex arteries (LCX) and RCA. Wave intensity analysis was applied to derive proximal- and distal-originating waves.
Results: In all three left coronary artery positions, the systolic-diastolic ratio of peak velocity was significantly lower than the corresponding ratio in the RCA (LMS 0.58 ± 0.13, LAD 0.47 ± 0.12, LCX 0.57 ± 0.15 versus RCA1.09 ± 0.48, $p<0.03$ for each). The cause was a lower diastolic flow velocity in the RCA than the left coronary arteries (RCA 0.37 ± 0.28m/s versus LMS 0.58 ± 0.30m/s, LAD 0.58 ± 0.44m/s $p<0.05$ for each, LCX 0.46 ± 0.33m/s $p=$NS), which is explicable by the lower distal-originating suction wave (RCA $16.6 \pm 5.4\%$ versus LMS $27.6 \pm 7.6\%$, LAD $28.8 \pm 6.3\%$, LCX $26.0 \pm 6.6\%$, $p<0.02$).
Conclusion: The RCA has a flow velocity waveform which is evenly distributed between systole and diastole, in contrast to the diastolic dominant waveform seen in the left coronary arteries. The reason for this difference is the lower diastolic velocity of the RCA which is due to a smaller distally-originating diastolic ''suck'' from its microcirculation.

05.02

HERITABILITY AND INTRAFAMILIAL AGGREGATION OF ARTERIAL CHARACTERISTICS

J.S. Seidlerova [1], J.A.S. Staessen [1], M.B. Bochud [2], M.C. Cwynar [3], M.D. Dolejsova [4], T.K. Kuznetsova [1], T.N. Nawrot [1], A.O. Olszanecka [3], K.S. Stolarz [3], L.T. Thijs [1], W.W. Wojciechowska [3], HAS.-B. Struijker-Boudier [5], KK.-J. Kawecka-Jaszcz [3], R.C.E. Elston [6], R.F. Fagard [1], J.F. Filipovsky [4]. [1]*Studies Coordinating Centre, Division of Hypertension and Cardiovascular Rehabilitation, Department of Cardiovascular Diseases, University of Leuven, Leuven, Belgium,* [2]*Institute of Social and Preventive Medicine, Centre Hospitalier Universitaire Vaudois and University of Lausanne, Lausanne, Switzerland,* [3]*The First Department of Cardiology and Hypertension, Jagiellonian University Medical College, Cracow, Poland,* [4]*The Faculty of Medicine in Pilsen, Charles University, Pilsen, Czech*

Republic, [5]The Department of Pharmacology and Toxicology, Cardiovascular Research Institute, Maastricht, Netherlands, [6]Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, USA

Background: We investigated in the same subjects, heritability and familial aggregation of various indexes of arterial stiffness and we partitioned the phenotypic correlation between these traits into shared genetic and environmental components.
Methods: Using a family-based random sampling frame, we recruited 204 parents (mean age, 51.7 years) and 290 offspring (29.4 years) from the population in Cracow, Poland (62 families), Hechtel-Eksel, Belgium (36), and Pilsen, the Czech Republic (50). We measured peripheral pulse pressure (PPp) sphygmomanometrically at the brachial artery; central pulse pressure (PPc), the peripheral (PAIx) and central (CAIx) augmentation indexes by tonometry at the radial artery; and aortic pulse wave velocity (PWV) by tonometry or ultrasound. In multivariate-adjusted analyses, we used the ASSOC and PROC GENMOD procedures as implemented in S.A.G.E. and SAS, respectively.
Results: All traits, with the exception of PPc ($P=0.79$) and PWV ($P=0.08$), showed significant heritability ($P\leq0.0001$), ranging from 0.37 for PPp to 0.41 for CAIx. The genetic correlation between PWV and the other arterial indexes were significant ($\rho_G\geq0.29$; $P<0.0001$). The corresponding environmental correlations were only significantly positive for PPp ($\rho_E=0.10$, $P=0.03$). Intrafamilial concordance was significant for all arterial indexes ($r\geq0.12$; $P\leq0.02$), with the exception of PPc ($r=-0.007$; $P=0.90$) in parent-offspring pairs. The sib-sib correlations were also significant for CAIx ($r=0.22$; $P=0.001$).
Conclusion: The observation in the same group of subjects of significant intrafamilial concordance and heritability of various indexes of arterial stiffness as well as the genetic correlations among arterial phenotypes strongly support the search for shared genetic determinants underlying these traits.

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05.03
OSTEOPROTEGERIN IS RELATED TO CAROTID-FEMORAL PULSE WAVE VELOCITY AND SURVIVAL IN HEMODIALYSIS PATIENTS

J. Nemcsik [1], B.C.S. Fekete [2], G. Speer [2], G. Bakonyi [3], J. Egresits [1], E. Fodor [3], T.E.H. Othmane [2], A. Szabo [3], I. Kiss [1], A. Tisler [2]. *[1]Division of Angiology and Nephrology, Department of Medicine, St. Imre Teaching Hospital, Budapest, Hungary, [2]1st Department of Medicine, Semmelweis University, Budapest, Hungary, [3]B Braun Avitum Nephrological Network, Budapest, Hungary*

Osteoprotegerin (OPG) is a marker and regulator of arterial calcification, and it is related to survival in hemodialysis patients. The link between OPG and aortic stiffening - a consequence of arterial calcification - has not previously been evaluated in this population, and it is not known whether OPG related mortality risk is mediated by arterial stiffening.

At baseline OPG and aortic pulse wave velocity (PWV) was measured in 98 hemodialysis patients who were then followed for a median of 18 months. The relationship between OPG and PWV was assessed by multivariate linear regression. The role of PWV in mediating OPG related mortality risk was evaluated by including both OPG and PWV in the same survival model.

At baseline mean (SD) PWV was 11.2 (3,3) m/s and median OPG (interquartile range) was 11.1 (7.5-15.9) nmol/L. There was a strong positive linear relationship between PWV and lnOPG (beta=1.48, p=0.009), independent of other covariates. During follow-up 28 patients died (mortality rate 18.4/100 patient years). In separate survival models both PWV and lnOPG were related to all cause mortality (hazard ratios 1.21[1.07-1.38] and 5.39 [2.16-13.43], respectively). When both PWV and lnOPG were entered into the same model, only OPG remained significantly associated with mortality (hazard ratios 1.12 [0.97-1.28] and 4.37 [1.62-11.80], respectively).

In hemodialysis patients OPG is strongly related to PWV and OPG related mortality risk may, in part, mediated by increased PWV.

05.04
ACUTE EFFECTS OF PASSIVE SMOKING ON PERIPHERAL VASCULAR FUNCTION

D. Adamopoulos [1], J.F. Argacha [1], M. Gujic [1], N. Amai [1], D. Fontaine [2], G. Berkenboom [1], P. van de Borne [1]. *[1]Department of Cardiology, Erasme Hospital, Brussels, Belgium, [2]Laboratory of Pharmacology and Physiology, Erasme Hospital, Brussels, Belgium*

Background: Environmental tobacco smoke (ETS) acutely affects vascular function through many pathophysiological mechanisms including nicotine sympathoexcitatory effects and oxidative stress. However, a secondary vascular reflex following smoke sensory stimulation cannot be excluded, since the vascular effects of ETS exposure have never been compared to these of a non-tobacco smoke. We therefore tested the hypothesis that acute ETS exposure, when compared to non-tobacco smoke, is responsible for a specific increase in aortic wave reflection and that this is accompanied by an alteration of endothelium dependent microvascular function.
Materials and methods: We examined the vascular effects of one hour ETS exposure, compared to a non-tobacco smoke and a normal-air exposure, in 11 healthy non-smokers men, using a randomized, single blind cross over study design. Augmentation index (AIx), and wave transit time (Tr) have been used to assess aortic wave reflection, while skin microvascular response to a local heating stimulation has been measured with a laser doppler flowmeter to assess endothelial function.
Results: Air particle densities did not differ during the ETS and non-tobacco smoke sessions. We observed no effect of ETS or non-tobacco smoke on central and peripheral blood pressures. However, AIx increased both during ($p=0.01$) and after ($p<0.01$) the ETS session, but remained unchanged in the non tobacco smoke session as compared to normal air. A strong correlation between serum nicotine levels ($n=10$) after ETS exposure and Aix change ($r=0.84$, $p<0.01$) was also noted. Tr decreased both during ($p=0.02$) and after ($p<0.01$) ETS, but remained unchanged in the non tobacco smoke session as compared to normal air. ETS exposure reduced the skin blood flow response to heating ($p=0.03$), which was not seen during the non tobacco smoke and the normal air sessions.
Conclusions: Passive exposure to tobacco smoke increases aortic wave reflection and impairs endothelium dependent microvascular function as compared to passive inhalation of non tobacco smoke. The increase in wave reflection after ETS exposure is strongly related to the rise in serum nicotine levels.

Free Communications

06.01
THE INFLUENCE OF CARDIOVASCULAR DISEASE AND RISK FACTORS ON AGE-RELATED CHANGES IN AORTIC PULSE WAVE VELOCITY

C.M. McEniery [1], Y. Yasmin [1], M. Munnery [2], S.M.L. Wallace [1], B. McDonnell [2], K.M. Maki-Petaja [1], S. Hickson [1], J.R. Cockcroft [2], I.B. Wilkinson [1]. *[1]University of Cambridge, Cambridge, United Kingdom, [2]Wales Heart Research Institute, Cardiff, United Kingdom*

We have demonstrated previously that age-related changes in aortic pulse wave velocity (PWV) are more prominent in individuals over the age of 50 years, suggesting that aortic PWV might provide a sensitive marker of risk in older subjects. Therefore, the aim of this investigation was to assess the impact of cardiovascular disease and risk factors on age-related changes in aortic PWV.

Data from 4219 participants in the ACCT Study[†] cohort were analysed (aged 18-92 years). In all subjects, seated and supine brachial BP was measured following at least 10 minutes of rest. Central (aortic) BP was derived by pulse wave analysis, and aortic (carotid-femoral) and brachial PWV were recorded (SphygmoCor). Subjects were then divided into groups based on the presence of cardiovascular disease ($n=445$) or risk factors: diabetes ($n=311$), hypertension ($n=952$), hypercholesterolaemia ($n=196$) and smoking ($n=318$), leaving 1997 control subjects, all of whom were free of cardiovascular risk factors and medication. Peripheral and central blood pressure and aortic PWV all increased significantly with age ($P<0.001$). However, compared with healthy controls, there was a steeper age-related rise in aortic PWV after the age of 50 years in subjects with cardiovascular disease or risk factors ($P<0.001$, Figure), even after adjusting for differences in mean