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1.2: ASSESSMENT OF DIASTOLIC FUNCTION IN PAEDIATRIC PATIENTS BY MEANS OF WAVE INTENSITY ANALYSIS DERIVED FROM CARDIOVASCULAR MAGNETIC RESONANCE IMAGING

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Oral Presentation Abstracts

Oral Session 1

Young Investigator Oral Presentations

In association with the ESC Working Group on Peripheral Circulation

1.1

COMPARISON OF VARIOUS METHODS FOR THE ESTIMATION FOR AORTIC CHARACTERISTIC IMPEDANCE IN TIME DOMAIN FROM VELOCITY-ENCODED MAGNETIC RESONANCE AND APPLANATION TONOMETRY DATA

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Objectives. To combine cardiovascular magnetic resonance (CMR), which provides accurate and non-invasive evaluation of flow, with applanation tonometry to assess aortic characteristic impedance (Zc) in time domain while comparing six different methods.

Methods. We studied 72 healthy volunteers (31 women, age: 42.1 ± 15.3 years) who underwent aortic velocity-encoded CMR and carotid applanation tonometry. We developed a method for the superimposition of flow and pressure waveforms as well as semi-automated estimation of temporal Zc based either on magnitude, derivative peaks and early systolic up-slopes ratios or pressure-flow loop. All Zc indices were used to calculate reflection magnitude (RM) as the ratio between backward and forward pressures.

Results. For all methods, Zc was in good agreement with the reference Zc provided in frequency domain and with the theoretical water-hammer Zc, which combines aortic pulse wave velocity and area, and with carotid pulse pressure (table) with a slight superiority for methods based on derivatives peaks and early systolic up-slopes. In addition, only these latter two methods were significantly related to arterial stiffness indices such as tonometric carotid-femoral pulse wave velocity ($r = 0.27$ and $r = 0.25$; $p < 0.03$) and CMR ascending aorta distensibility ($r = -0.30$ and $r = -0.25$; $p < 0.03$). Again these two methods were slightly superior when comparing the derived RM against age ($r = 0.68$, $r = 0.65$; $p < 0.0001$).

Conclusions. The time derivative and up-slopes straightforward computation methods that can be easily integrated in a clinical workflow provides

reliable characteristic impedance and reflection magnitude that might enhance CMR usefulness in evaluating aortic left ventricular (LV) pulsatile load and help for further understanding in LV-aortic coupling.

1.2

ASSESSMENT OF DIASTOLIC FUNCTION IN PAEDIATRIC PATIENTS BY MEANS OF WAVE INTENSITY ANALYSIS DERIVED FROM CARDIOVASCULAR MAGNETIC RESONANCE IMAGING

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Evaluating diastolic function in children remains a topic of clinical discussion and a gold standard measurement technique is still lacking. Wave intensity analysis can provide insight into ventricular filling mechanisms and ventriculo-vascular coupling, and it can be derived directly from cardiovascular magnetic resonance (CMR) imaging data, specifically from routine phase-contrast flow acquisitions, by defining wave intensity in terms of simultaneous changes of velocity and fractional changes of area. This method was applied to a group of 53 cases (12 healthy controls, 12 congenital aortic stenosis, 11 hypertrophic cardiomyopathy, 8 restrictive cardiomyopathy, 10 dilated cardiomyopathy). All patients also had full CMR and echocardiographic examinations. A new wave intensity parameter FCW/FEW was defined (=ratio of peak forward compression wave in early systole, typically associated with ventricular dP/dt , and peak forward expansion wave at end systole, associated with diastolic time constant τ) and compared with accepted indicators of diastolic dysfunction, i.e. left atrium area from CMR, E/A ratio, E/E' ratio and E-wave deceleration time (DT) from echo. Differences between cohorts were firstly appreciated in terms of ejection fraction and aortic distensibility. Receiver operating characteristic (ROC) curves then revealed that FCW/FEW, LA area and E/E' ratio were overall good, statistically significant discriminators between controls and patients with presumed compromised diastolic function, while E/A and DT failed to differentiate (Fig. 1, Table 1). This study proposes CMR-derived wave intensity analysis as an additional medium to non-invasively investigate diastolic function in children, contributing to a point of on-going clinical debate.

Table Comparison of aortic characteristic impedance using the 6 time domain methods against the frequency and theoretical references as well as carotid pulse pressure.

r (p)	Frequency Zc	Water-hammer Zc	Carotid pulse pressure
Peak Zc	0.59 ($p < 0.001$)	0.52 ($p < 0.001$)	0.46 ($p < 0.001$)
95% peak Zc	0.79 ($p < 0.001$)	0.54 ($p < 0.001$)	0.32 ($p = 0.01$)
Inflection point Zc	0.54 ($p < 0.001$)	0.53 ($p < 0.001$)	0.47 ($p < 0.001$)
Derivative peaks Zc	0.84 ($p < 0.001$)	0.55 ($p < 0.001$)	0.56 ($p < 0.001$)
Early systolic up-slopes Zc	0.91 ($p < 0.001$)	0.51 ($p < 0.001$)	0.57 ($p < 0.001$)
Pressure-flow loop Zc	0.76 ($p < 0.001$)	0.38 ($p = 0.001$)	0.39 ($p < 0.001$)

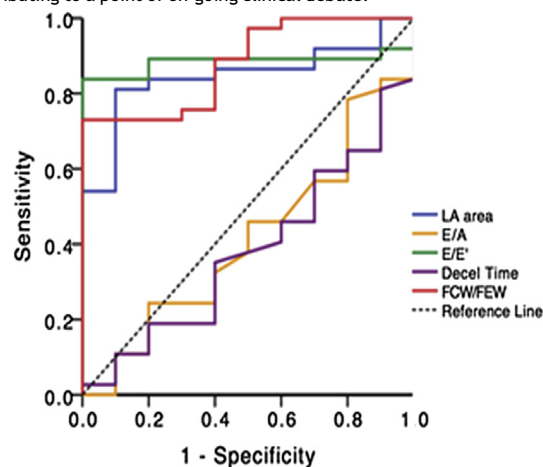


Table 1 (AUC = area under the curve)

Parameter	AUC	p Value
FCW/FEW	0.881	<0.001*
LA area	0.846	0.001*
E/A	0.412	0.398
E/E'	0.884	<0.001*
Dec time	0.380	0.247

1.3

SPATIAL INHOMOGENEITIES IN INTIMA-MEDIA THICKNESS OF THE COMMON CAROTID ARTERY ARE ASSOCIATED WITH THE DEGREE OF STENOSIS IN THE INTERNAL CAROTID ARTERYJ. Steinbuch^{1,4}, M. T. B. Truijman^{2,3}, A. P. G. Hoeks^{1,4}, W. H. Mess³¹Department of Biomedical Engineering, Maastricht University, Maastricht, Netherlands²Department of Radiology, Maastricht University Medical Center, Maastricht, Netherlands³Department of Clinical Neurophysiology, Maastricht University Medical Center, Maastricht, Netherlands⁴Cardiovascular Research Institute Maastricht (CARIM), Maastricht University, Maastricht, Netherlands

Objectives. Inhomogeneities of wall characteristics may relate to plaques in a nearby vessel. The aim of the present study is to investigate the association between spatial inhomogeneities of intima-media thickness (IMT) of the common carotid artery (CCA) and plaques in the internal carotid artery. **Methods.** Longitudinal B-mode ultrasound examinations of CCA were performed bilaterally on 48 patients with a recent cerebrovascular accident. IMT of CCA and its IMT inhomogeneity, defined as IMT standard deviation along the artery segment, were extracted from the ultrasound images by use of semi-automated B-mode vessel wall tracking program. Degree of stenosis was categorised in three groups: less than 30%, 30–50% and 50–70% stenosis in the internal carotid artery.

Results. In total 88 arteries were examined (Table 1). Three patients and two arteries were excluded (incomplete data, extreme moving artery). Mean values and standard deviations of IMT and IMT inhomogeneity are shown in Table 1. There was no significant difference within groups in IMT and IMT inhomogeneity between both sides (Student *t*-test, *p*-value >0.05). However, a significant difference was found in the IMT inhomogeneity between the group with less than 30% stenosis and the group with 50–70% stenosis (ANOVA Bonferroni adjusted, *p*-value 0.016), whereas no significant difference was found in IMT between those groups.

Conclusion. Spatial IMT inhomogeneity of the CCA, but not mean IMT, is associated with the degree of stenosis in the ipsilateral internal carotid artery. This research was supported by the Center for Translational Molecular Medicine and the Dutch Heart Foundation (PARISK).

Table 1 Mean values ± standard deviations of IMT and IMT inhomogeneity.

Degree of stenosis	N	Age	IMT [μm]	Inhomogeneity IMT [μm]
<30%	26	67 ± 9	967 ± 177	135 ± 64
30–50%	39	68 ± 8	1003 ± 188	166 ± 100
50–70%	23	71 ± 8	1127 ± 399	235 ± 189

1.4

BLOOD PRESSURE LEVELS ARE THE SOLE DETERMINANT OF DIFFUSE MYOCARDIAL FIBROSIS IN HYPERTENSIVE PATIENTSD. Rosenbaum^{1,2}, N. Kachenoura², A. Redheuil², A. Decesare², F. Villeneuve¹, X. Girerd¹, P. Cluzel^{2,3}¹Cardiovascular Prevention Unit, Pitié Salpêtrière Hospital, Paris, France²Laboratoire d'imagerie Fonctionnelle, UPMC INSERM U 678, Paris, France³Département d'imagerie Cardiovasculaire, Pitié Salpêtrière Hospital, Paris, France

Objectives. Myocardial fibrosis occurs early in hypertension and plays a major role in CV disease. Our goal was to assess the mutual influence of blood pressure (BP) and cardiovascular (CV) risk factors on diffuse myocardial

fibrosis, as assessed non-invasively from Cardiovascular Magnetic Resonance (CMR) T1 mapping images in a population of non-diabetic hypertensive patients in primary prevention.

Methods. CMR MOLLI T1 mapping sequence was acquired on a median LV slice pre-contrast and then at 5, 10 and 15 minutes after a bolus injection of Gadolinium (0.2 mml/kg). After T1 estimation in myocardium and LV cavity, myocardial ECV was calculated as $(1 - \text{hematocrit}) \times (1/T1_{\text{post}} - 1/T1_{\text{pre}}) / (1/T1_{\text{post}} - 1/T1_{\text{pre}})_{\text{blood}}$. Patients also underwent routine clinical and biological assessments and BP levels were determined using 3 days home measurements (hBP).

Results. 37 patients (median age 57, range 31 to 71, 54% males) were included. Population characteristics are summarized in table 1. Mean ECV remained unchanged at 5, 10 and 15 minutes (0.21 ± 0.04). In univariate analysis, ECV was significantly associated with systolic hBP ($r = 0.48$, $p = 0.017$) but not with other risk factors (LDL-C, Hba1c, smoking status). This association remained significant after adjustment for age and hBP remained the only significant determinant of changes in ECV.

Conclusion. In hypertensive patients, home BP levels were found to be the sole significant and independent determinant of myocardial fibrosis.

1.5

EFFECTS OF ACUTE BOUTS OF ENDURANCE EXERCISE ON RETINAL VESSEL DIAMETERS

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Objectives. Retinal vessel diameters are a valid tissue biomarker for cardiovascular risk assessment. We aimed to assess the acute effects of different exercise intensities on retinal vessel diameters, and whether these effects differ between seniors and young adults.

Methods. In this cross-over study, 17 seniors (mean (SD) age 67 (5) years) and 15 young adults (mean (SD) age 26 (4) years) first performed a maximal treadmill test (MTT) followed by a submaximal 2-km treadmill test (SMTT) and a control condition in randomised order. We measured central retinal arteriolar (CRAE, μm) and venular (CRVE, μm) equivalent before as well as 5 (*t*₅) and 40 (*t*₄₀) minutes after exercise cessation using a Static Retinal Vessel Analyser.

Results. Relative to the control condition, both MTT and SMTT led to a statistically significant dilatation in CRAE and CRVE. At *t*₄₀, the dilatation was greater for MTT compared to SMTT (CRAE: 1.7 (95% CI -0.1, 3.6; $P = 0.061$); CRVE: 2.2 (95% CI 0.4, 4.1; $P = 0.019$)). In seniors, average CRAE and CRVE at *t*₅ were higher for MTT compared to SMTT. In young adults, both parameters were lower for MTT compared to SMTT. The estimated difference between seniors and young adults in the cross-over difference comparing MTT and SMTT was 5.3 (95% CI 2.0, 8.5; $P = 0.002$) for CRAE and 4.1 (95% CI -0.4, 8.6; $P = 0.076$) for CRVE.

Conclusions. Acute bouts of endurance exercise lead to an increase in retinal vessel diameters. The regulatory mechanisms following acute bouts of exercise may differ according to age.

Oral Session 2**Free Communication Oral Presentations***In association with the North American Artery Society*

2.1

ETHNIC DIFFERENCES IN ASSOCIATIONS BETWEEN CAROTID IMT, CORONARY ARTERY CALCIFICATION AND CEREBROVASCULAR DISEASE. A POPULATION-BASED STUDY OF EUROPEANS, SOUTH ASIANS AND AFRICAN CARIBBEANST. Tillin¹, K. March¹, J. Heasman¹, C. Park¹, N. Beauchamp², D. Shibata², A. Wright¹, A. Hughes¹, N. Chaturvedi¹¹Imperial College, London, United Kingdom²University of Washington, Seattle, United States

Aims. We compared associations between common carotid intima-media thickness (IMT) and coronary artery calcification (CAC) and measures of cerebrovascular disease (CVD) in 3 ethnic groups.

Methods. A community-based sample of 1331 men and women (47% White European (WE), 36% South Asian (SA) and 16% African Caribbean (AfC)) living in west London (1988-91). At 20 year follow-up (mean age 69.7 ± 6.2), CAC was quantified using CT, carotid IMT was quantified using ultrasound. Cerebral infarcts and white matter hyperintensities (WMH) were identified using