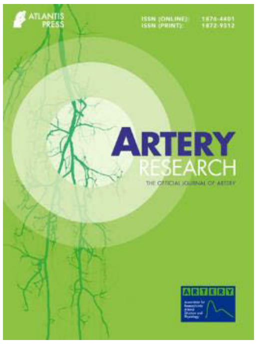

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P125: USE OF VASCULAR ADAPTATION IN RESPONSE TO MECHANICAL LOADING FACILITATES PERSONALISATION OF A ONE-DIMENSIONAL PULSE WAVE PROPAGATION MODEL

Maarten Heusinkveld, Koen Reesink, Theo Arts, Wouter Huberts, Tammo Delhaas

Conclusions: The discrepancies between (F) and (P1), (P2) raise concerns about the validity of the implicit assumptions in pressure-only reservoir pressure separation at the radial artery. Differences in (P1) and (P2) indicate some sensitivity of derived parameters to the algorithm employed.

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RESERVOIR PRESSURE IS INDEPENDENTLY ASSOCIATED WITH 11—12 YEAR OLD'S KIDNEY FUNCTION: POPULATION-DERIVED STUDY

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Introduction: Reservoir pressure (RP) and excess pressure (XSP) independently predict cardiovascular events in adults, but have never been investigated as markers of cardiovascular risk among children. This study aimed to determine the association of RP and XSP with end-organ makers of cardiovascular risk related to kidney function and large artery pre-atherosclerosis.

Methods: Participants were 1874 11—12 year-old children (50% male) from the Longitudinal Study of Australian Children's Child Health CheckPoint study. Brachial blood pressure was measured by cuff oscillometric device (SphygmoCor XCEL, AtCor, Sydney). The same device was used to derive reservoir pressure (RP) and excess pressure (XSP) from the brachial pressure waveform. Kidney function was determined from estimated glomerular filtration rate (eGFR, $n = 926$) and large artery pre-atherosclerosis was determined from carotid intima media thickness (cIMT, $n = 1131$) using ultrasound.

Results: The eGFR was significantly correlated with RP peak ($r = -0.109$, $p = 0.001$), RP integral ($r = -0.136$, $p < 0.001$), XSP peak ($r = 0.096$, $p = 0.004$) and XSP integral ($r = 0.102$, $p = 0.002$). The RP (whether expressed as peak or integral) was significantly associated with eGFR after adjusting for sex, waist-to-hip ratio, heart rate and brachial BP indices (RP peak $\beta = -0.079$, $p = 0.02$, partial $R^2 = 0.006$ and RP integral $\beta = -0.079$, $p = 0.02$, partial $R^2 = 0.007$). XSP was not independently associated with eGFR after adjusting for the above variables. Neither RP nor XSP were significantly associated with cIMT.

Conclusion: Independent of conventional risk factors, RP was significantly associated with kidney function among a large population of Australian children. The non-invasive method to derive RP using an oscillometric cuff device could provide useful clinical information in children.

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VALIDITY AND RELIABILITY OF PULSE WAVE ANALYSIS ESTIMATED BY A NOVEL WRIST-WORN TONOMETER

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Objective: To analyze the reliability and validity of Pulse Wave Analysis determined with the new wrist-worn tonometry.

Methods: Cross sectional study including 254 subjects. Aged 51.9 ± 13.4, being women 53%. Main measurements: Peripheral AIx (PAIx) and Central AIx (CAIx) by wrist-worn tonometry and Sphygmocor. Carotid femoral (cf) pulse wave velocity (PWV) by Sphygmocor, Cardio Anckle Vascular index (CAVI), anckle brachial index (ABI) and brachial anckle (ba) PWV by Vasera device. Carotid intima media thickness (IMT) by ultrasonography.

Results: Intra-class correlation coefficient (ICC) intraobserver for the PAIx was 0.886 (95% CI 0.803 to 0.934) and for the CAIx 0.943 (0.901 to 0.968) with a Bland Almant agreement limit of −0.75 (−23.8 to 21.8) and 0.08 (−15.7 to 15.9) respectively. ICC interobserver for PAIx was 0.952 (95% CI 0.915 to 0.972) and CAIx 0.893 (0.811 to 0.939) with an agreement limit of −0.45 (−13.7 to 12.8) and 0.43 (−17.7 to 1835) respectively. We found, compared with Sphygmocor, an ICC of 0.849 (0.798 to 0.887) for PAIx, and 0.783 (0.711 to 0.838) for CAIx. The agreement limit for PAIx was −1.03 (−22.73 to 20.67) and CAIx 2.14 (−20.50 to 24.79). We found positive correlation with PAIx, CAIx and CAIx HR75 by Aurora with age, CAVI, ABI, baPWV, cfPWV, IMT and cardiovascular risk and negative with glomerular filtration rate.

Conclusions: The wrist-worn tonometry shows an adequate reliability intra and interobserver, and interdevice when compared to Sphygmocor, and an adequate validity when compared with other measures that evaluate arterial stiffness, target organ damage and cardiovascular risk.

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USE OF VASCULAR ADAPTATION IN RESPONSE TO MECHANICAL LOADING FACILITATES PERSONALISATION OF A ONE-DIMENSIONAL PULSE WAVE PROPAGATION MODEL

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Background: Mathematical modelling of pressure and flow waveforms in blood vessels using pulse wave propagation (PWP) models could support clinical decision-making. For a personalised model outcome, measurements of all modelled vessel radii and wall thicknesses are required. In clinical practice, however, datasets are often incomplete. To overcome this problem, we hypothesised that the adaptive capacity of blood vessels in response to mechanical load can be utilised to fill in the gaps of incomplete patient-specific datasets.

Methods: We implemented homeostatic feedback loops in a validated PWP model [1] to allow adaptation of vessel geometry to maintain wall stress and wall shear stress. To evaluate our approach, we utilised complete datasets of 10 patients scheduled for vascular access surgery. Datasets comprised of wall thicknesses and radii of 7 central and 11 arm arterial segments. We simulated reference models (RefModel, $n = 10$) using complete data and adapted models (AdaptModel, $n = 10$) using data of one brachial artery segment only. The remaining AdaptModel geometries were estimated using adaptation. In both models, mean brachial pressure, brachial artery distensibility, heart rate and aortic inflow were prescribed. We evaluated agreement between RefModel and AdaptModel geometries, as well as between pressure and flow waveforms of both models.

Results: Limits of agreement (bias ± 1.96SD) between AdaptModel and RefModel radii and wall thicknesses were 0.029 ± 1.3mm and 28 ± 230μm, respectively. AdaptModel pressure and flow waveform characteristics across the proximal-to-distal arterial domain were within the uncertainty bounds of the RefModel (Fig. 1).

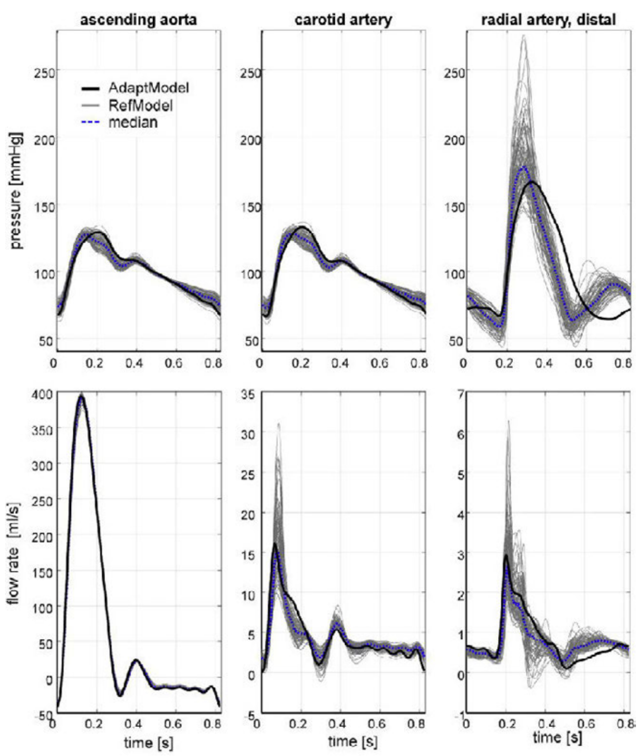

Figure 1 AdaptModel and RefModel pressure and flow waveforms at three arterial locations. For adequate comparison between the AdaptModel and the RefModel a total of 100 RefModel realisations were generated within the measurement uncertainty. The median RefModel is indicated by the blue dotted curves.

Conclusions: Our adaptation-based PWP model enables personalisation even when not all required data is available.

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P126

COMPARISON OF PULSE WAVE ANALYSIS ASSESSMENT METHODOLOGY IN ELDERLY MEN

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Background: Both the Sphygmocor (S) and Vicorder (V) devices can be used for pulse wave analysis (PWA). However, large studies comparing data from both devices are lacking.

Methods: 1,722 men (78.5 ± 4.7yrs) from the British Regional Heart Study underwent PWA with S and V devices. Brachial blood pressure (BP) was assessed by V and by Omron- HEM907 (S). Measures of central Augmentation Pressure (cAP) Augmentation Index (cAIx) and central (c) BP were compared.

Results: Data were successfully obtained in 1,380 (80%) with S and 1,706 (99%) with V. 1,373 men had both S and V data. cAP and cAIx were higher in S than V (17 ± 9 vs 13 ± 5 mmHg and 29 ± 10 vs 21±6% respectively, both $p < 0.001$), and were significantly correlated (cAP $r = 0.65$ cAIx $r = 0.48$ $p < 0.001$), but with greater differences at higher values. Brachial BP readings were greater with V vs Omron (mean difference 1.1 ± 9.7/3.7 ± 6.3 mmHg). Mean cBP was higher in V than S (139 ± 17 vs 131 ± 19 mmHg) and despite strong correlation between measures (0.87 $p < 0.001$), cBP was more likely to be greater with S than V cBP at higher cBPs.

These differences between V + S remained directionally consistent even after adjustment for risk factors (with multiple regression analysis) and when S PWA results were recalculated using V BP in a subsample ($n = 58$).

Conclusion: PWA evaluations were more frequently successful with using V than S in elderly men. Differences in cAP, cAIx and cBP found between devices were not due to differences in BP calibration values. Further research is needed to understand the causes and clinical implications of these differences

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FLOW DYNAMICS AND ITS RELATION TO BICUSPID AORTOPATHY ASSESSED BY 4D FLOW CMR

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Purpose: Different altered flow dynamics may influence ascending aorta (AAo) dilation morphotypes in bicuspid aortic valve (BAV) (1). Using 4D-flow CMR, we aimed to identify flow variables related to root or ascending dilation in BAV.

Methods: One-hundred and one BAV patients (no severe valvular disease, aortic diameters <45 mm) underwent 4D-flow on GE 1.5 T Signa scanner (GE Healthcare, Waukesha, USA). Peak velocity, jet angle, normalized flow displacement, in-plane rotational flow (IRF), systolic flow reversal ratio (SFRR) and wall shear stress (WSS) were evaluated at proximal, mid and distal AAo. Dilation morphotypes were classified as non-dilated, ascending and root (2), using z-score > 2. Univariate and multivariate linear regression were used to identify factors related to dilation. ROC curves were performed to assess the relationship between variables obtained in the multivariate analysis and dilation morphotypes.

Results: Fusion phenotype was right-left (RL) in 78 patients, and right-non coronary (RN) in 23. Dilation morphotype was non-dilated in 24 patients, root in 11 and ascending in 66. On univariate analysis, BAV phenotype (RN), displacement and circumferential WSS presented the highest odds ratios (Table). On multivariate analysis, sex (male), proximal velocity and axial WSS were related to root morphotype (AUC 0.91, $P < 0.001$), while RN-BAV, distal IRF, and mid-AAo SFRR and circumferential WSS were related to ascending morphotype (AUC 0.81, $P < 0.001$) (Table and Figure).

Table. Univariate and multivariate factors related to of aortic dilation and dilation morphotypes.

		Univariate analysis of aortic dilation		Multivariate analysis of aortic dilation			
				Root morphotype		Ascending morphotype	
		Odds Ratio	P-value	Odds Ratio	P-value	Odds Ratio	P-value
	BAV phenotype (RL/RN)	3.23	0.02			1.33	0.008
	Sex (Male)	1.10	0.02	4.67	0.005		
Prox	Peak velocity	1.02	0.028	1.10	0.043		
	Jet angle	1.05	0.037				
	Displacement	3.56	0.001	1.11	0.021		
	IRF	1.01	0.002				
	WSS_{axial}	1.20	0.003	7.64	0.008		
	$WSS_{Circumf}$	1.65	0.05				
Mid	Jet angle	1.07	0.006				

(*continued on next page*)