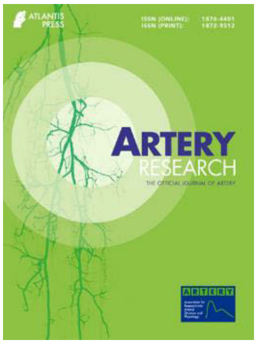

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3.3: ASSESSMENT OF AORTIC MORPHOLOGY IN A BICUSPID AORTIC VALVE POPULATION

Froso Sophocleous, Benedetta Biffi, Elena Giulia Milano, Cha Rajakaruna, Massimo Caputo, Costanza Emanueli, Chiara Bucciarelli-Ducci, Tom Gaunt, Silvia Schievano, Giovanni Biglino

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increased odds ratio (OR) for CV events (OR: 1.10; 95% confidence interval (CI): 0.27—4.44), but the risk has been significantly elevated in the two-point group (n = 29, OR: 4.59, CI: 1.39—15.22) and it increased further in the three-point group (n = 16, OR: 9.03, CI: 2.22—36.65), as well as in the four-point group (n = 9, OR: 11.84, CI: 2.52—55.64).
Conclusion: The ICPS score can help in the identification of chronic kidney disease patients with high CV risk.

3.2
ASCENDING AND DESCENDING AORTA PULSE WAVE VELOCITY AND DISTENSIBILITY IN BICUSPID AORTIC VALVE PATIENTS

Andrea Guala [1], Jose Rodriguez-Palomares [2], Lydia Dux-Santoy [2], Gisela Teixido-Tura [2], Giuliana Maldonado [2], Nicolas Villalva [2], Filipa Valente [2], Laura Galian [2], Marina Huguet [1], Laura Gutierrez [1], Teresa Gonzalez [1], Ruben Fernandez [1], Augusto Sao-Aviles [1], David Garcia-Dorado [1], Artur Evangelista [2]
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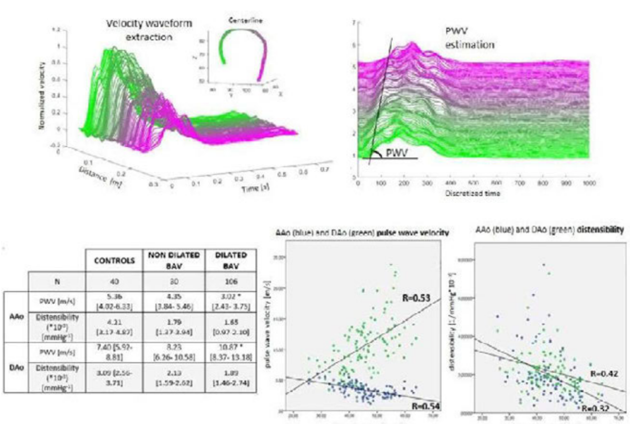
Purpose: Bicuspid aortic valve (BAV) is a cardiac congenital disease associated with ascending aorta (AAo) dilation. The study of the impact of aortic biomechanics in this population has been limited by technical difficulties. Contrasting results have been reported for distensibility while studies including regional pulse wave velocity (PWV) are still lacking. Using 4D-flow MRI, we assessed AAo and descending aortic (DAo) biomechanical properties and determined their association in BAV aortopathy.
Methods: One-hundred thirty-six BAV patients with no severe valvular disease and 40 healthy volunteers were recruited. The protocol included a 4D-flow acquisition and a set of 2D CINE PC-MRI at 1.5 T. Aortic 3D geometry was reconstructed from 4D-flow-derived angiography and at least 100 analysis planes were identified in the thoracic aorta. Transit time was calculated on the velocity upslope through wavelet analysis [1]. CINE PC-MRI were used to compute distensibility. Statistical significance is reported corrected for confounding factors.
Results: Non-dilated BAV and controls have similar AAo and DAo PWV and distensibility. Dilated patients presented lower AAo PWV and higher DAo PWV compared to non-dilated ($p < 0.001$ and $p = 0.017$, respectively). Distensibility did not differentiate dilated from non-dilated patients and presented lower association with dilation severity (see Figure).



		CONTROLS	NON DILATED BAV	DILATED BAV
	N	40	30	106
AAo	PWV [m/s]	5.36 [4.02-6.33]	4.35 [3.84- 5.46]	3.02 * [2.43- 3.75]
	Distensibility (*10⁻³) [mmHg⁻¹]	4.21 [3.17-4.87]	1.79 [1.37-3.94]	1.65 [0.97-2.10]
DAo	PWV [m/s]	7.40 [5.92- 8.81]	8.23 [6.26- 10.58]	10.87 * [8.37- 13.18]
	Distensibility (*10⁻³) [mmHg⁻¹]	3.09 [2.56- 3.71]	2.13 [1.59-2.62]	1.89 [1.46-2.74]

Conclusions: Confirming for the first time previous findings in abdominal aorta aneurysm and fluid-mechanics theory, AAo PWV is reduced in aneurysmatic BAV patients. BAV aortopathy is related to a stiffer DAo. Regional PWV outperforms distensibility as a marker of local aortic biomechanics. These data exclude congenital aortic wall pathology related to BAV

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3.3
ASSESSMENT OF AORTIC MORPHOLOGY IN A BICUSPID AORTIC VALVE POPULATION

Froso Sophocleous [1], Benedetta Biffi [2], Elena Giulia Milano [3,4], Cha Rajakaruna [3,4], Massimo Caputo [3,4], Costanza Emanueli [1,5], Chiara Bucciarelli-Ducci [3,4], Tom Gaunt [1], Silvia Schievano [2], Giovanni Biglino [1]
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Background: Bicuspid aortic valve (BAV) is a congenital heart disease associated with aortic wall abnormalities and co-existing with other congenital defects (e.g. aortic coarctation). This study aimed to explore aortic shape features in a BAV population, identifying sub-groups with different aortic morphologies.
Methods: Single-centre retrospective study. Patients with an MRI scan and native BAV diagnosis between 2011 and 16 were studied (n = 525); those with a 3D MRI dataset were included for shape analysis (n = 108, 64% males, 38 ± 16.5 years). MRI-derived 3D aortic reconstructions were analysed using a statistical shape modelling framework [1]. A mean aortic shape ('template') was computed and shape deformations were correlated with demographic, volumetric and functional data.
Results: Aortic coarctation (n = 71) was significantly associated with a more gothic arch ($p = 0.02$), more tubular ascending aorta and descending aorta dilation ($p < 0.001$). Also, smaller aortic size in patients with coarctation was associated with the younger age of this group (33 ± 13 vs. 47 ± 19, $p < 0.001$), given the overall relationship between aortic size and age ($p < 0.001$). Aortic stenosis

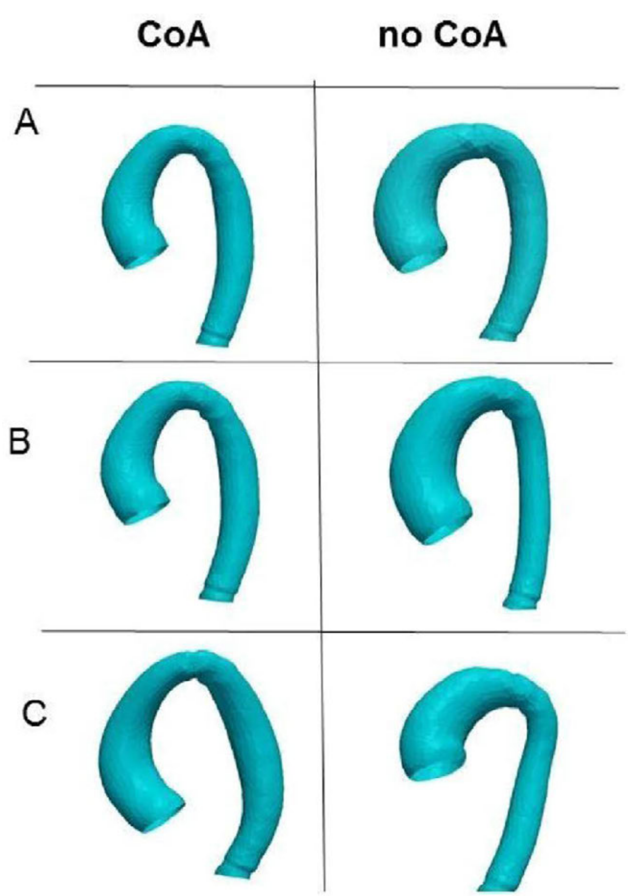

Figure 1 Shape features of coarctation (CoA) vs no CoA in BAY population. A) The 'template' (or average shape) for patients with CoA on the left, and patients without CoA on the right. B) Patients with CoA have tubular ascending aortas (left), while patients without CoA tend to have increased ascending aortic dilation (right). C) Patients with CoA have more a gothic arch (left), whereas patients without CoA have a rounder arch (right).

(n = 30) was also associated with gothic arch (p = 0.01), and dilated ascending aorta but with no aortic root dilation (p = 0.02).

On multivariate regression analysis, gothic arch was indeed associated with coarctation and stenosis, and also with non-coronary valve fusion pattern (p = 0.03). Patients with aortic regurgitation tended to have larger aortas (p = 0.005).

Conclusion: The presence of aortic coarctation and stenosis may influence the amount of dilation and the overall arch architecture in BAV patients. Patients with BAV present profoundly different morphological phenotypes depending on the presence/absence of aortic coarctation (Fig. 1).

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3.4
RESERVOIR PRESSURE SEPARATION AT BRACHIAL, CAROTID AND RADIAL ARTERIES: A QUANTITATIVE COMPARISON AND EVALUATION

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Background: At present, reservoir pressure parameters are derived from arterial pressure waveforms regardless of the location of measurement. However, a comparison between sites has not been made, and site-related differences may affect interpretation. In this study, we computed reservoir pressure waveform separations on hypertensive individuals where brachial, carotid and radial pressure measurements were available and quantitatively assessed their results.

Methods: 95 participants in the Anglo-Scandinavian Cardiac Outcomes Trial (ASCOT) had sequential measurements of pressure and flow velocity waveforms from carotid, brachial and radial arteries [1]. Pre-processing was performed to impose identical diastolic and mean blood pressures at all three arterial locations. Using pressure information only, reservoir pressure separation was performed [2, 3]. Systolic durations were estimated based on minimum pressure waveform derivatives.

Reservoir curves characterized by physiologically implausible parameters, i.e. a rate constant $b < 0$ or an asymptotic pressure $P_\infty < 0$, were discarded, leaving 74 subjects with valid reservoir pressure waveforms at all three arterial locations.

Results: Estimated reservoir parameters are shown in Table 1. We observed significant differences between arteries in almost all parameters. A high correlation was observed between reservoir pulse pressure and reservoir pressure area at all locations, and the correlation between brachial and radial arteries was stronger for all parameter.

Table 1 Quantification of reservoir pressures at three arterial locations in the format of mean ± standard deviation based on 74 subjects whereby PP denotes the reservoir pulse pressure, A_p the area of reservoir pressure above diastolic blood pressure, P_∞ the asymptotic blood pressure and a, $b = 1/\tau$ the rate constants with the time constant τ describing the diastolic pressure decay. The correlation coefficient r is computer between relevant arterial locations. The statistical significance of the differences between locations was based on a paired t-test with * indicating $p < 0.05$.

Reservoir	Brachial Artery(B)	Carotid Artery(C)	Radial Artery(R)	*r*(B,C)	*r*(B,R)	*r*(C,R)
PP [mmHg]	37.1 ± 8.6	41.6 ± 9.0	36.1 ± 8.4	0.84*	0.95*	0.84*
A_p [mmHg s]	16.7 ± 5.0	19.0 ± 4.4	16.0 ± 4.3	0.91*	0.96*	0.91*
P_∞ [mmHg]	61.6 ± 14.2	66.6 ± 12.8	66.2 ± 11.2	0.50*	0.51*	0.46*
A [1/s]	8.3 ± 3.7	11.4 ± 2.7	7.0 ± 2.7	0.11*	0.91*	0.18*
B [1/s]	1.8 ± 0.6	2.2 ± 0.9	2.1 ± z0.7	0.30*	0.62*	0.40*

Conclusions: The results of this study indicate differences in parameters derived from reservoir pressure separation at different arterial locations. This suggests that interpretations cannot be made agnostic to the location of measurement.

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3.5
HEART RATE DEPENDENCE OF REGIONAL AND LOCAL AORTIC PULSE WAVE VELOCITY IN RATS AS A FUNCTION OF BLOOD PRESSURE

Bart Spronck [1], Isabella Tan [2], Koen Reesink [1], Dana Georgevsky [2], Tammo Delhaas [1], Alberto Avolio [2], Mark Butlin [2]

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Background: Pulse wave velocity (PWV) is quantified by time difference of arrival of the blood pressure (BP) wave at two sites along the arterial bed (transit time; TT-PWV), or by combining measured arterial pressure and diameter using the Bramwell-Hill equation (BH-PWV). Besides the dependence of PWV on BP, TT-PWV also depends on heart rate (HR). The present study aimed to also quantify the dependence of BH-PWV's on HR, as a function of diastolic BP (DBP).

Methods: Adult anaesthetised rats (n = 24) were randomly paced at 300—500 bpm, at 50-bpm steps. At each step, aortic TT-PWV (two pressure-tip catheters) and BH-PWV (pressure-tip catheter and ultrasound wall-tracking; abdominal aorta) were measured simultaneously, across a pharmacologically induced DBP range of 60—110 mmHg.

Data from 9142 heart beats was analysed using mixed-effects modelling.

Results: HR dependence of TT-PWV increased from 0.03 m/s/100 bpm at DBP = 60 mmHg to 0.06 m/s/100 bpm at DBP = 110 mmHg (both $p \leq 0.023$). HR dependence of BH-PWV was 0.11 m/s/100 bpm at DBP = 60 and 85 mmHg, but paradoxically decreased to 0 at DBP = 110 mmHg (p = 0.686). This decrease in dependence is explicable in that standard BH-PWV uses an approximate derivative of pressure to diameter, which overestimates PWV with increasing pulse pressure (PP). PP decreases as HR increases, potentially causing a BH-PWV decrease with HR. This effect can be overcome by estimating the full pressure-diameter curve for each HR, and calculating the true derivative at DBP, yielding a BH-PWV that no longer shows significant HR dependence ($p \geq 0.076$ at all DBPs).

Conclusions: BH-PWV and TT-PWV show a different HR dependence, affected by DBP.

3.6
NON-INVASIVE, MRI-BASED ESTIMATION OF PATIENT-SPECIFIC AORTIC BLOOD PRESSURE USING ONE-DIMENSIONAL BLOOD FLOW MODELLING

Jorge Mariscal Harana [1], Arna van Engelen [1], Torben Schneider [2], Mateusz Florkow [1,2], Peter Charlton [1], Bram Ruijsink [1], Hubrecht De Bliek [3], Israel Valverde [1], Marietta Carakida [1], Kuberan Pushparajah [1],