



Artery Research

ISSN (Online): 1876-4401

ISSN (Print): 1872-9312

Journal Home Page: <https://www.atlantis-press.com/journals/artres>

8.3: QUANTIFYING HEART AND ARTERIAL CONTRIBUTIONS TO CENTRAL BLOOD PRESSURE IN SYSTOLE

Samuel Vennin, Ye Li, Marie Willemet, Henry Fok, Brian Clapp, Jordi Alastruey, Phil Chowienczyk

To cite this article: Samuel Vennin, Ye Li, Marie Willemet, Henry Fok, Brian Clapp, Jordi Alastruey, Phil Chowienczyk (2016) 8.3: QUANTIFYING HEART AND ARTERIAL CONTRIBUTIONS TO CENTRAL BLOOD PRESSURE IN SYSTOLE, Artery Research 16:C, 65–65, DOI: <https://doi.org/10.1016/j.artres.2016.10.059>

To link to this article: <https://doi.org/10.1016/j.artres.2016.10.059>

Published online: 7 December 2019

References

1. Landbo, et al. Prognostic value of nutritional status in chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1999; 160:1856-61.
2. Mannino, et al. Prevalence and outcomes of diabetes, hypertension and cardiovascular disease in COPD. *Eur Respir J*. 2008; 32(4):962-969.

8.1

ARTERIAL STIFFNESS, BLOOD PRESSURE AND CARDIAC OUTPUT STUDY

Suzanne Holewijn, Erik Groot Jebbink, Wim Aengevaeren, Jasper Martens, Marcel Hovens, Michel Reijnen
Rijnstate Hospital, Arnhem, Netherlands

We are planning a prospective study in 200 patients with an abdominal artery aneurysm (AAA). Non-invasive measurements will be performed including tonometry-based pulse wave analysis (PWA) and pulse wave velocity (PWV), echocardiography, and 24-hour blood pressure measurements.

This study will provide insight in how PWV/PWA-parameters can help identify characteristics of prostheses used to treat AAA that best match native aortic characteristics and will lead to the best long-term outcome after aneurysm repair. Also the interaction between blood pressure (and control) and cardiac output will be evaluated. These results will form the basis for evidence-based practice for stent choice and lead to better outcomes after AAA treatment. First we will validate non-invasive against invasive central pressure in 20 patients treated with endovascular aneurysm repair (EVAR).

This study will provide insight if arterial stiffness parameters change over time after treatment of AAA and the possible role of PWV/PWA for the surveillance after treatment. We expect to provide insight in the various determinants of the PWV/PWA-parameters pre- and post-repair of AAA evaluation also includes graft material, intraluminal thrombus, and inflammation. We will study whether the different PWV/PWA parameters predict outcome after AAA repair for different prostheses.

Finally, this study will reveal whether parameters of cardiac output obtained by tonometry correspond with parameters obtained by echocardiography in AAA patients. If so, the PWV/PWA measurement can detect cardiologic problems at an early stage during follow-up. By early treatment, the development of heart failure can be delayed or even prevented. We look forward to input on our study-plan.

8.3

QUANTIFYING HEART AND ARTERIAL CONTRIBUTIONS TO CENTRAL BLOOD PRESSURE IN SYSTOLE

Samuel Vennin, Ye Li, Marie Willemet, Henry Fok, Brian Clapp, Jordi Alastruey, Phil Chowienczyk
King's College London, UK

Background: A recent study has shown that the central pressure waveform could be determined by a very small set of parameters accounting for the physical properties of the heart and the arteries [1]. Particularly, main pressure features like first systolic shoulder (P1) and systolic (P2) pressures were estimated accurately.

Methods: By combining a numerical virtual population ($n=3,325$) similar to [2] and experimental data acquired from a pressure/Doppler flow velocity transducer placed in the ascending aorta in 18 patients (meanSD: age 63 ± 11 yr, aortic BP $136\pm 23/73\pm 13$ mmHg) at the time of cardiac catheterization, we assessed the accuracy of those predictions for magP1 (P1-DBP) and P2 using respectively a water hammer [3] and a 3-element Windkessel models [4]. Contributions of the heart and arterial properties to these estimates through respectively blood velocity, volume and pulse wave velocity, compliance, resistance were then derived from the theoretical models used.

Results: P1 and P2 estimates agreed well with theoretical pressure both in the numerical dataset (mean+/-SD difference, 1.1 ± 3.2 mmHg and -1.6 ± 3.1 mmHg respectively) and the clinical cohort (mean+/-SD difference, -2.4 ± 5.5 mmHg and 1.9 ± 6.5 mmHg respectively). The ratio arterial-to-heart contribution has been shown to be fairly constant as magP1 was increasing.

Conclusions: Arteries and heart contribute as much to rise in P1. More clinical data are being collected to quantify the contributions of the heart and arteries to P2.

References

1. Vennin, S., Mayer, A., Li, Y., Fok, H., Clapp, B., Alastruey, J., & Chowienczyk, P. (2015). Noninvasive calculation of the aortic blood pressure

waveform from the flow velocity waveform: a proof of concept. *American Journal of Physiology-Heart and Circulatory Physiology*, 309(5), H969-H976.

2. Willemet, M., Chowienczyk, P., & Alastruey, J. (2015). A database of virtual healthy subjects to assess the accuracy of foot-to-foot pulse wave velocities for estimation of aortic stiffness. *American Journal of Physiology-Heart and Circulatory Physiology*, 309(4), H663-H675.

3. Parker, K. H., & Jones, C. J. H. (1990). Forward and backward running waves in the arteries: analysis using the method of characteristics. *Journal of biomechanical engineering*, 112(3), 322-326.

4. Westerhof, N., Lankhaar, J. W., & Westerhof, B. E. (2009). The arterial windkessel. *Medical & biological engineering & computing*, 47(2), 131-141.

8.4

DIURNAL CHANGES IN CENTRAL PRESSURE AND PULSE WAVE PARAMETERS IN HEALTHY SUBJECTS

Bernhard Hametner¹, Christopher Mayer¹, Jelena Köster², Johannes Weber¹, Michael Reppel⁴, Klaas Franzen⁵, Eugenijus Kaniasas³, Siegfried Wassertheurer¹, Kai Mortensen⁶

¹AIT Austrian Institute of Technology, Health & Environment Department, Vienna, Austria

²Medical University of Schleswig-Holstein, Medical Clinic II, Lübeck, Germany

³Vienna University of Technology, Institute of Electrodynamics, Microwave and Circuit Engineering, Vienna, Austria

⁴Cardiology Landsberg, Landsberg, Germany

⁵Medical University of Schleswig-Holstein, Medical Clinic III, Lübeck, Germany

⁶Cardiology Practice, Kiel, Germany

Purpose: The feasibility of pulse wave analysis (PWA) over 24 hours with oscillometric devices has already been shown and first studies indicate additional information compared to single measurements. Nevertheless, diurnal patterns of PWA parameters in healthy subjects, which can potentially serve as a reference, are currently missing. Therefore, the aim of this study was to perform 24h-PWA measurements in healthy subjects over a wide age range and to analyse day/night differences.

Methods: 91 well defined healthy subjects underwent 24h PWA measurements using the Mobil-O-Graph device (IEM, Germany). The subjects were categorized in three age groups (20-29 years, 30-49 years, 50-69 years). Day-time (9-21h) and nighttime (0-6h) averages were calculated.

Results: A significant dipping behaviour in all age groups could be found for diastolic blood pressure (> 14 mmHg in all age groups, $p<0.05$), peripheral systolic blood pressure (> 15 mmHg, $p<0.05$) and central systolic blood pressure (> 9 mmHg, $p<0.05$). A significant rising effect in all age groups was found for the reflection magnitude ($> 8\%$). In contrast, the day/night difference in augmentation index was age dependent and this dependency remained also for Alx75, see table.

Conclusions: Prominent pressure dipping and a rise in reflection magnitude were present in all age groups during nighttime, while diurnal changes in augmentation index showed an age-dependency. This differing behaviour of PWA parameters should be investigated in further studies. Furthermore, the observed effects of diurnal changes in healthy subjects may provide a basis for reference profiles for future patient evaluation.

Table: Mean day and night values for peripheral systolic blood pressure (pSBP), peripheral diastolic blood pressure (pDBP), central systolic blood pressure (cSBP), central diastolic blood pressure (cDBP), heart rate (HR), augmentation index (Alx, Alx75) and reflection magnitude (RM) * marks a significant difference between day and night (t-test, $p<0.05$).

	20–29 years		30–49 years		50–69 years	
	Day	Night	Day	Night	Day	Night
pSBP (mmHg)	118.8 *	103.4	124.8 *	109.0	123.0 *	105.8
pDBP (mmHg)	75.7 *	59.5	81.4 *	64.2	79.6 *	64.8
cSBP (mmHg)	106.3 *	97.1	114.8 *	103.3	114.5 *	100.7
cDBP (mmHg)	77.4 *	60.6	83.1 *	65.3	81.1 *	65.6
HR (bpm)	76.0 *	59.6	77.5 *	64.4	70.4 *	59.8
Alx	18.2	19.0	19.7	22.7	25.9 *	35.0
Alx75	19.3 *	10.4	20.6	15.7	23.4	26.4
RM	55.2 *	63.2	59.7 *	68.8	62.3 *	71.5