2.5: DOES WAVE REFLECTION PROTECT THE MICROVASCULATURE FROM HIGH PULSE PRESSURE?

Avinash Kondiboyina, Joe Smolich, Michael Cheung, Berend Westerhof, Nico Westerhof, Jonathan Mynard


To link to this article: https://doi.org/10.1016/j.artres.2018.10.028

Published online: 7 December 2019
SD greater dBPV was associated with lower IPS (beta [SD difference]; 95% CI: -0.10; -0.20 to -0.00) and EF (-0.12; -0.22 to -0.01), and borderline associated with lower MF (-0.09; -0.20 to 0.01). A 1-SD greater sBPV, however, was not associated with IPS (-0.04); -0.14 to 0.06), or EF (-0.09; -0.20 to 0.02), but was borderline associated with lower MF (-0.11; -0.21 to 0.00). This effect of greater dBPV on cognitive performance is equivalent to ±3 additional years of ageing. The stronger association of dBPV than sBPV with cognitive performance may be explained by the fact that DBP is the main determinant of MAP. Excessive dBPV may then lead to inadequate cerebral perfusion. In conclusion, greater very short-to mid-term dBPV and, to a lesser extent, sBPV could be a modifiable risk factor for cognitive impairment.

2.3 OCCUPATIONAL, SPORT AND LEISURE RELATED PHYSICAL ACTIVITY HAVE CONTRASTING EFFECTS ON NEURAL BAROREFLEX SENSITIVITY. THE PARIS PROSPECTIVE STUDY III

Rachid Climing 1, Pierre Boutouyrie 1, Marie-Cecile Perier 1, Edouard Chaussade 2, Matthieu Pitchart 2, Lucile Offredo 2, Catherine Guibout 1, Thomas van Sloten 2, Frederique Thomas 3, Bruno Pannier 1, James Sharm 4, Stephane Laurent 4, Xavier Jouven 5, Jean-Philippe Empapa 1

1INSERM U970, France
2APHP, Paris Descartes university, Paris, France
3Investigations Prévontiennes et cliniques (IPIC), Paris, France
4Menizes Institute for Medical Research, France
5INSERM 970, France
6INSERM, France
7INSERM U970, France
8INS, France

Background: Physical activity (PA) is beneficial for baroreflex sensitivity (BRS), but it is unclear whether the type of PA has similar effects on the neural (nBRS) or vascular (carotid stiffness) components of BRS. We sought to determine this in healthy adults from a community-based study via assessment of occupational (OPA), sport (SPA), leisure (LPA) and total PA (TPA).

Methods: In 8649 adults aged 50 to 75 years, resting nBRS (estimated by low frequency gain, from carotid distension rate and heart rate) and carotid stiffness were measured using high-precision carotid echotracington. PA was self-reported using the Baecke questionnaire, which distinguishes OPA, SPA, LPA and TPA. The associations between PA and nBRS and carotid stiffness were quantified using multivariable linear regression analysis. Analyses were conducted separately in the working and non-working populations.

Results: In working adults (n = 5039), OPA was associated with lower nBRS function (p = 0.026) and borderline higher carotid stiffness (p = 0.08). When stratified by education, this association remained only in those with less than tertiary education. SPA was associated with higher nBRS (p = 0.0005) and borderline lower carotid stiffness (p = 0.052). Neither LPA nor TPA was associated with nBRS or carotid stiffness. In non-working adults (n = 3610), SPA and TPA were both associated with lower carotid stiffness (p = 0.012 and p = 0.020), but not nBRS. LPA was not associated with either parameter.

Conclusion: Occupation-related PA is associated with lower nBRS function and higher carotid stiffness, especially in those with lower education. Higher amounts of sport-related PA are associated with higher nBRS and lower carotid stiffness.

2.4 CENTRAL SYSTOLIC BLOOD PRESSURE PROVIDES ADDITIONAL INFORMATION IN RISK PREDICTION IN HEMODIALYSIS PATIENTS

Christopher C. Mayer 1, Julia Matschik 2, Pantelis A. Sarafidis 3, Stefan Hugmair 1, Georg Lorenz 1, Susanne Angermann 5, Matthias C. Braunisch 7, Marcus Baumann 2, Uwe Heemann 2, Christoph Schmaderer 1, Siegfried Wastertheurer 1

1A1T Austrian Institute of Technology, Center for Health & Bioresources, Vienna, Austria
2Department of Nephrology, Technical University of Munich, Klinikum rechts der Isar, Munich, Germany
3Department of Nephrology, Hippokration Hospital, Aristotele University of Thessaloniki, Thessaloniki, Greece
4Murdoch Children’s Research Institute, Parkville, VIC, Australia
5University of Melbourne, Parkville, VIC, Australia
6Murdoch Childrens Research Institute, Parkville, VIC, Australia
7Royal Children’s Hospital, Parkville, VIC, Australia
8VU University Medical Center, Amsterdam, the Netherlands
9Royal Children’s Hospital, Parkville, VIC, Australia

Background: Association of Ambulatory Blood Pressure Monitoring (ABPM) with mortality depends on cardiac function in hemodialysis patients. Evidence for the predictive power of central Systolic Pressure (cSBP) is inconclusive. Thus, this study aimed to investigate the additional information of ambulatory cSBP in risk prediction in a cohort of hemodialysis patients.

Method: The ISAR-study cohort, 344 hemodialysis patients underwent 24 h ABPM on the dialysis day. All-cause and cardiac mortality was defined as endpoints. Risk prediction was performed using Cox regression in patients with or without atrial fibrillation (AF) or heart failure (HF) for peripheral (pSBP) and central systolic pressure calibrated with peripheral systolic and diastolic pressure (cSBP1) or peripheral mean and diastolic pressure (cSBP2).

Results: During a mean follow-up of 37.6 (17.5 SD) months, 115 patients died, of whom 47 due to cardiovascular reasons. In patients with AF or HF, a negative association to mortality could be observed, independent of pressure location and calibration (see Table). In patients without AF or HF, those associations were to the opposite directions and cSBP2 was superior to pSBP and cSBP1 for all-cause (pSBP: HR = 1.01, p = 0.30; cSBP1: HR = 1.00, p = 0.77; cSBP2: HR = 1.01, p = 0.06) and cardiovascular (pSBP: HR = 1.03, p = 0.02; cSBP1: HR = 1.02, p = 0.06; cSBP2: HR = 1.03, p = 0.003) mortality. This circumstance was confirmed in multivariable analysis combining pSBP and differences between pSBP and cSBP (see Table).

Conclusion: This study provides evidence for the additional information of central systolic blood pressure and its dependency on calibration in risk prediction in hemodialysis patients. Further studies are needed to confirm these findings.

2.5 DOES WAVE REFLECTION PROTECT THE MICROVASCULARITY FROM HIGH PULSE PRESSURE?

Avinash Kondiboyina 1, 2, Joe Smolich 3, 4, Michael Cheung 1, 4, Berend Westerhof 1, 4, Nico Westerhof 1, 4, Jonathan Mynard 1, 2, 4

1Murdoch Children’s Research Institute, Parkville, VIC, Australia
2University of Melbourne, Parkville, VIC, Australia
3Murdoch Childrens Research Institute, Parkville, VIC, Australia
4Royal Children’s Hospital, Parkville, VIC, Australia
5VU University Medical Center, Amsterdam, the Netherlands
6Royal Children’s Hospital, Parkville, VIC, Australia

Background: Wave reflection (caused by a stiffness increase from large to small arteries) has been considered to protect against high microvascular Pulse Pressures (mPP) (1). However, according to transmission line theory, Transmission (T) and Reflection (R) coefficients are proportional (T = 1+R), implying that reflection would not be protective. Proximal arterial stiffening with aging is associated with reduced Total Arterial Compliance (TAC) and increased forward Pressure (Pfw). We hypothesized that a high TAC and low Pfw, rather than high R, are responsible for protection from mPP.

Methods: We constructed a fractal arterial tree containing 5008 vessels across 14 generations (fractal exponent 2.76, asymmetry ratio 0.8). Wave speed in each vessel was prescribed to achieve a uniform reflection coefficient (R = -0.025, 0, 0.025 or 0.05) at every junction, achieved by progressively stiffening distal vessels while keeping aortic wave speed constant (“distal-stiffening”) or by progressively stiffening proximal vessels while
keeping average wave speed in all terminal vessels constant ("proximal-stiffening", see Figure). An elastance heart model was applied at the inlet and simulations were performed with a one-dimensional flow solver (2).

Results: Proximal-stiffening and distal-stiffening had opposing effects on R but the same effects on mPP, whereas mPP increased monotonically with decreasing TAC and increasing Pfw in both settings (Figure).

Conclusion: Wave reflection per se does not provide protection from high mPP since greater reflection also entails greater transmitted pressure. Although a decreased R may accompany proximal arterial stiffening, the likely mechanism of increased mPP with aging is decreased TAC and greater Pfw.

References

2.6 FEASIBILITY OF AORTIC WAVE INTENSITY ANALYSIS FROM SEQUENTIALLY ACQUIRED CARDIAC MRI AND NON-INVASIVE CENTRAL BLOOD PRESSURE

Anish Bhuva 1,2, Niro Nadarajan 3, Andrew D'Silva 4, Camilla Torlasco 5, Redha Bouabatik 6, Siana Jones 7, Paul Scully 8, Rachel Bastiaenen 9, Guy Lloyd 10, Sanjay Sharma 11, James Moon 12, Kim Parker 13, Charlotte Manisty 14, Alun Hughes 15, 1University College London, UK
2Barts Heart Centre, London, UK
3Institute of Cardiovascular Science, University College London, UK
4Cardiovascular Sciences Research Centre, St. George’s, University of London, London, United Kingdom
5IRCCS, Istituto Auxologico Italiano, Milan, Italy
6Department of Bioengineering, Imperial College London, UK
7MRC Unit for Lifelong Health and Ageing at UCL, London, UK

Background: Wave intensity analysis (WIA) in the aorta offers important clinical and mechanistic insights but is currently too invasive. We performed WIA by combining high temporal resolution cardiovascular magnetic resonance (CMR) flow velocity and non-invasive central blood pressure (BP) waveform data.

Method: 206 healthy volunteers (36 ± 11 years, 47% male) underwent sequential phase contrast CMR (Siemens Aera 1.5T, 1.97 x 1.77 mm², ≥9 ms temporal resolution) and supra-systolic oscillometric central BP waveform (Uscom Ltd BP+) measurement. Velocity (U) and central pressure (P) waveforms (200 Hz) were aligned using the wave foot, and local wave speed was calculated both from the P-U slope during early systole (c) and the sum of squares method (cSS) (Figure 1), and compared with CMR aortic arch pulse wave velocity (PWV) by transit time.

Results: The peak intensity of the initial compression wave (di+1), backwound compression wave (di) and protodiastolic decompression wave (di + 2) were 69.5 ± 28, -6.6 ± 4.2 and 6.2 ± 2.3 m/s² respectively. PWV correlated with c or cSS (r = 0.60, and 0.68 respectively; bias -1.3 [limits of agreement: -3.2 to 1.7] m/s), and bias -0.64 [limits of agreement: -3.0 to 1.7] m/s respectively). Figure 1.

Conclusion: Wave intensity patterns and values are similar to those measured using invasive methods. Local wave speed showed good agreement with PWV. CMR and central blood pressure provides a novel non-invasive technique for performing wave intensity analysis and is feasible for large scale studies.

2.7 FITNESS MODIFIES THE ASSOCIATION BETWEEN EXERCISE BLOOD PRESSURE AND LEFT-VENTRICULAR MASS IN ADOLESCENTS

Zhengzheng Huang 1, Ricardo Fonseca 2, James Sharan 2, Nish Chaturvedi 2, George Smith 2, Deborah Lawlor 2, Laura Howe 3, Chloe Park 2, Alun Hughes 4, 1Menzies Institute for Medical Research, Hobart, Australia
2Menzies Institute for Medical Research, University of Tasmania, Hobart, Australia
3Institute of Cardiovascular Science, University College London, London, UK
4MRC Integrative Epidemiology Unit, University of Bristol, Bristol, UK

Objective: Exaggerated exercise blood pressure (BP) is associated with higher left-ventricular mass index (LVMI). Paradoxically, exercise BP and LVMI may be higher with greater fitness, but underlying factors are poorly understood. This study aimed to determine the influence of fitness on exercise BP and its relationship with LVMI in adolescents.

Methods: 4835 adolescents from the Avon Longitudinal Study of Parents and Children, aged 15.4(0.3) years, 49% male completed a submaximal cycle test. Exercise BP was measured immediately on test cessation and fitness calculated as physical work capacity 170 adjusted for lean body-mass. LVMI (n = 1589), cardiac output (CO, n = 1628) and total peripheral resistance (TPR, n = 1628) were measured by echo-cardiography 2.4 (0.4) years later.

Results: Each unit of fitness was associated with a 6.46 mmHg increase (95% CI: 5.83, 7.09) in exercise systolic BP. Exercise systolic BP increased step-wise by third of fitness (difference 6.06 mmHg, 95% CI: 4.99, 7.13 first vs. middle, 11.13 mmHg, 10.05, 12.20 middle vs. highest). Each 5 mmHg increase in exercise systolic BP was associated with 0.25 g/m².7 (0.16,0.35) lower LVMI.

Conclusion: Exercise BP and LVMI increased step-wise by fitness, but the same effects on mPP, whereas mPP increased monotonically with decreasing TAC and increasing Pfw respectively (bias -3.0 to 1.7 m/s).

2.8 RELATIONSHIPS BETWEEN ADIPOSYSTOL AND LEFT VENTRICULAR FUNCTION IN ADOLESCENTS: MEDIATION BY BLOOD PRESSURE AND OTHER CARDIOVASCULAR MEASURES

Hannah Taylor 1, Alun D. Hughes 1, Abigail Fraser 1, Laura Howe 4, George Davey Smith 4, Debbie Lawlor 4, Nishi Chaturvedi 1, Chloe Park 2
1University College London, London, UK
2Department of Population Science & Experimental Medicine, Institute of Cardiovascular Science, University College London, UK