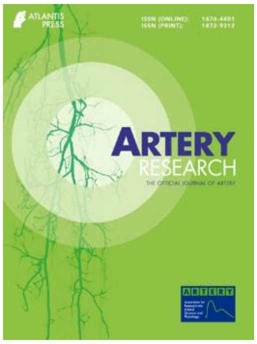


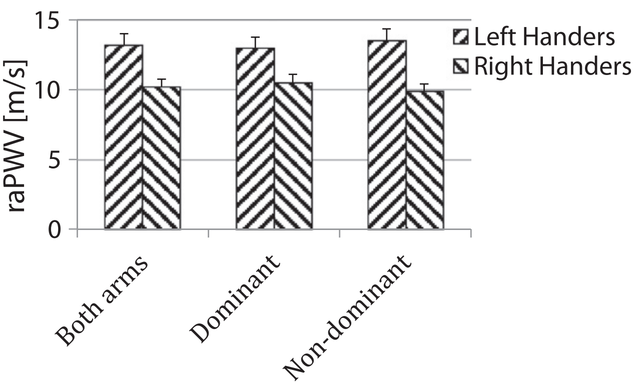
Artery Research

ISSN (Online): 1876-4401 ISSN (Print): 1872-9312
Journal Home Page: https://www.atlantis-press.com/journals/artres

P2.28: OPTICAL AND MECHANICAL MEASUREMENT OF THE ARTERIAL ELASTICITY

M.J. Huotari, J. Röning, A. Vehkaoja, K. Määttä, J. Kostamovaara

There was no statistically significant correlation between raPWV and arm musculature. 3)Left handed individuals had higher raPWV than right handers, figure below. (unpaired t-test; both limbs PWV $p<0.0001$, dominant only $p<0.015$, non-dominant $p<0.001$).
Summary and Conclusions: Results failed to support hypotheses 1 and 2, although differences in muscularity between the two arms were small. Intriguingly, for reasons unknown, left handers had stiffer arms than right handers. In future we will measure PWV at other sites and include racquet sport players with greater muscular disparity between each arm.



P2.26

PRESSURE AT THE LAST SYSTOLIC SHOULDER OF THE ARTERIAL WAVEFORM EQUALS CENTRAL AORTIC SYSTOLIC PRESSURE AND IS CONSTANT ALONG THE UPPER LIMB

A. Guilcher, B. Jiang, D. Hou, P. Chowienczyk
King's College London, British Heart Foundation Centre, London, United Kingdom

Objective: Previous studies have shown that the pressure at the late systolic shoulder (SBP_2) of the radial or digital pressure waveform is a good estimate of central systolic pressure (cSBP) when waveforms are calibrated from invasive measurements. These results suggest SBP_2 may remain constant along the upper limb. The aim of this study was to examine the agreement between SBP_2 at the carotid, brachial and radial arteries.
Methods: We compared measurements of SBP_2 obtained by applanation tonometry using the SphygmoCor system (Atcor Medical, Australia) at the radial (RA), brachial (BA) and carotid (CA) arteries on 45 subjects (24 men, aged 23-84 years). Waveforms were calibrated using the same mean (MAP) and diastolic blood pressure (DBP).
Results: There was a close agreement between SBP_2 values measured at the different sites with a mean difference (SD) of 0.88 (5.29) mmHg for RA-BA, -2.30 (4.60) mmHg for BA-CA and -1.42 (4.34) mmHg for RA-CA.
Conclusion: These results suggest that SBP_2 can be considered as constant along the arm.

P2.27

LOCAL RADIAL STRAIN OF THE COMMON CAROTID ARTERY WALL

E. Hermeling [1,4], F. H. Schreuder [2], W. H. Mess [2], M. E. Kooi [1,4], A. P. G. Hoeks [3,4]
[1]*Department of Radiology, Maastricht University Medical Centre, Maastricht, Netherlands*
[2]*Department of Clinical Neurophysiology, Maastricht University Medical Centre, Maastricht, Netherlands*
[3]*Department of Biomedical Engineering, Maastricht University, Maastricht, Netherlands*
[4]*Cardiovascular Research Institute Maastricht, Maastricht, Netherlands*

Background: Rupture of atherosclerotic plaques occurs when mechanical stress exceeds material strength. Increased radial strain (ε, measured in the wall tissue) may be indicative for both locally increased mechanical stress as well as locally decreased material strength. The aim of our feasibility study was to analyse the precision and accuracy of ε, within the common carotid artery (CCA) wall of patients with and without recent cerebrovascular accident (CVA,<6weeks).
Methods: The left and right CCA of 21 patients (15 with CVA) were measured twice with multiple M-mode ultrasound. ε was determined for the intima-media layer (ε_m) and adventitia layer (ε_a), separately, using an RF-based algorithm. Intima-to-intima ($(\Delta D/D)_{in}$) and adventitia-to-adventitia relative distension ($(\Delta D/D)_{out}$) were also obtained, which are strongly related to strain ($\varepsilon \approx -\Delta D/D$) when wall-inhomogeneities are negligible.
Results: Intra-subject precision was 1.8% for ε_m and 1.0% for ε_a. Averaged over all patients, $\varepsilon_m=-7.4\pm2.7\%$ (mean±sd) was higher than $\varepsilon_a=-3.9\pm1.7\%$ ($p<0.0001$). ε_m was significantly correlated with $(\Delta D/D)_{in}$ ($r^2=0.48$, $p<0.0001$), but higher than $-(\Delta D/D)_{in}$ ($\Delta=0.8\pm2.1\%$, $p=0.02$). For the adventitial layer, the correlation between ε_a and $(\Delta D/D)_{out}$ was weaker ($r^2=0.10$, $p=0.05$; $\Delta=0.7\pm2.0\%$, $p=0.02$). Despite similar blood pressures and stenosis degrees, ε_m, $(\Delta D/D)_{out}$, $(\Delta D/D)_{in}$, but not ε_a, were higher at the ipsilateral side for patients with than for patients without CVA, ($p=0.002$, $p=0.05$ and $p=0.06$, respectively).
Conclusion: Strain can be measured directly within wall tissue with reasonable accuracy and precision and allows discrimination between arterial layers and patient groups. As $\Delta D/D$ is not applicable to inhomogeneous walls, strain is a promising tool to evaluate vulnerability of plaques.

Table Radial strain and relative distension between patients with and without CVA

	N#	SBP (mmHg)	DBP (mmHg)	stenosis degree(%)	ε_m (%)	ε_a (%)	$(\Delta D/D)_{in}$ (%)	$(\Delta D/D)_{out}$ (%)
ipsilateral	14	136±22	77±12	38±36	−8.5±2.5*	−4.3±1.3	7.2±2.9	5.1±2.0*
contralat.	15			28±33	−7.8±2.6*	−3.8±1.2	7.1±2.7	4.9±1.6
w/o CVA	10	145±18	85±10	27±29	−5.3±1.8	−3.5±2.5	5.1±2.1	3.6±1.4

*significant different from patient without (w/o) CVA using Student t-test; number of CCAs (N); systolic blood pressure (SBP); diastolic blood pressure (DBP); contralat, contralateral. #1 ipsilateral CCA of patients with CVA and 2 CCAs in patients without CVA were excluded due to poor image quality.

P2.28

OPTICAL AND MECHANICAL MEASUREMENT OF THE ARTERIAL ELASTICITY

M. J. Huotari [1], J. Röning [1], A. Vehkaoja [2], K. Määttä [1], J. Kostamovaara [1]
[1]*University of OULU, OULU, Finland*
[2]*Tampere University of Technology, TAMPERE, Finland*

The photoplethysmography (PPG) derives from the change of attenuation of the light either transmitted or reflected through the tissues over which the LED light has been applied. Variation in light intensity received by the photodetector depends on the amount of blood in arteries, but the accurate waveform is also caused by arterial wall properties, e.g., arterial elasticity. Also eletromechanical film (EMFi) is an excellent sensor material for long-term applications for arterial pulse wave recordings to find out wall elasticity. The EMFi sensor measures extremely small displacements of the arterial wall and the tissue around the artery caused by the blood pressure wave signal. Comparison between the EMFi and PPG sensor shows a very close correlation inside of the pulsatile component of blood flow mechanically in the wrist and the change in light absorption on the fingertip. It is possible to separate mathematically five distinct components of the PPG and EMFi waveforms. Potentially from these non-invasively measured information about cardiac function and arterial elasticity can be calculated. When the PPG probe is attached to the fingertip or the second toe, the pulsations detected are from the cutaneous vascular bed. The factors that regulate that blood flow will have a profound effect on the photoplethysmogram, which depend on many factors of microcirculation. These components are not shown in the EMFi pulse wave. Analysis of these factors shows that the information contained in the PPG and EMFi is of great importance. In this paper we will combine arterial optical and mechanical elasticity measurements.

P2.29
COMPARISON OF ARTERIAL AUGMENTATION INDICES OBTAINED BY ULTRASOUND WALL TRACKING AND ARTERIAL TONOMETRY

B. Jiang [1], A. Guilcher [1], P. Chowienczyk [1], D. Hou [2]
[1]*Thomas Hospital, London, United Kingdom*
[2]*Capital Institute of Pediatrics, Beijing, China*

Arterial augmentation indices (AI, the ratios of differences in the components of arterial pressure during systole to pulse pressure) provide measures of pressure wave reflection and are usually estimated from arterial tonometry. High resolution ultrasound tracking of the arterial wall provides an alternative method for obtaining AI. The objective of the present study was to compare AI measured by tonometry and wall tracking at the carotid, brachial and radial arteries. Forty seven asymptomatic subjects (24 men), aged 23-84 years were studied. At each site, tonometry (SphymoCor system, Atcor medical, Australia) and wall tracking (Aloka α10 ultrasound system with a 10MHz linear vascular transducer, Aloka, Japan) were performed in triplicate in random order. At the carotid artery, there was reasonably good agreement between AI obtained by wall tracking and tonometry ($R=0.82$, $P<0.0001$, mean difference$\pm$SD, 3.0$\pm$13.7%) but at brachial and radial sites agreement was poor ($R=0.33$, mean difference$\pm$SD, 17.7$\pm$24.2% at brachial, $R=0.48$, mean difference, 18.1$\pm$23.5% at radial). Wall tracking may be a reasonable surrogate for tonometry when measuring AI at the carotid artery but there is poor agreement between AI obtained by tonometry and wall tracking in smaller arteries.

P2.30
DOES OCCLUSION OF THE BRACHIAL ARTERY CAUSE LOCAL OSCILLATION OF ARTERIAL PRESSURE?

O. Korolkova [1], K. H. Parker [1], J. E. Davies [2], A. D. Hughes [2], J. H. Siggers [1]
[1]*Departement of Bioengineering, Imperial College London, London, United Kingdom*
[2]*National Heart and Lung Institute, Imperial College London, London, United Kingdom*

One-dimensional (1D) models are useful to study pressure and flow waves in large arteries in cases where clinical measurements are not available. Using a simplified 1D model (1) we have modelled the pressure waveform in the brachial artery with and without occlusion, which is relevant to non-invasive measurement of blood pressure with cuff-based devices. The results show that occlusion of the brachial artery leads to superposed high frequency oscillations in local brachial blood pressure of up to 10mmHg (Fig.). A modelling study of brachial occlusion done independently by a group from Swansea University (2) has also shown similar results.
Preliminary data made with a fluid-filled catheter by collaborators in New Zealand (unpublished data) show much smaller pressure fluctuations during cuff occlusion, but the use of a fluid-filled catheter may have damped out the relatively high frequency waves that are predicted. Therefore, measurements of blood pressure using a high-fidelity catheter are being made in patients undergoing routine cardiac catheterization. Pressure waveforms recorded in the brachial, subclavian arteries and the ascending aorta with and without brachial artery occlusion are compared to the predictions of the 1D models.

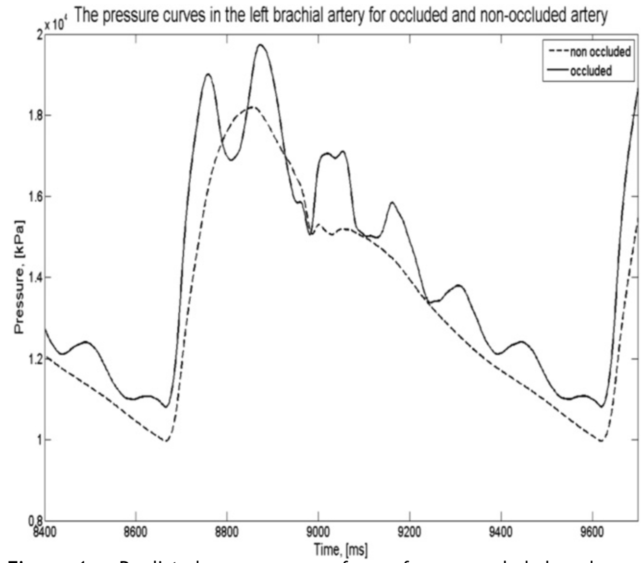


Figure 1 Predicted pressure waveforms for an occluded and non-occluded brachial artery.

(1) Alastuey, J., Parker, K.H., Peiro, J.& Sherwin, S.J. (2009). J Eng Math, 64:331—51
(2) Mynard, J.P. & Nithiarasu, P. (2008) Comm. Num. Meth. Engg, 24:367—417.

P2.31
COMPARISON OF TWO NONINVASIVE MEASUREMENTS FOR AORTIC PULSE WAVE VELOCITY: VASERA VERSUS SPHYGMOCOR

Y. Li, M. Cordes, H. Hanssen, A. Schmidt-Trucksäss
Institute of Exercise and Health Sciences, Basel, Switzerland

Backgroud: Aortic pulse wave velocity (aortic PWV) is the gold standard for evaluating arterial stiffness and can be measured using various noninvasive **Methods:** However, there has been few data comparing the repeatability and agreement of different methods within the same individuals. The objective of this study is to assess the intra-observer variation and the agreement of aortic PWV measurements using Vasera and SphygmoCor.
Methods: Aortic PWV measurements were performed in 22 healthy individuals (38.3$\pm$16.2 yr) using both Vasera VS-1500N and SphygmoCor. Double recordings with an interval of 5 minutes were undertaken by an experienced observer. The interclass correlation (ICC), coefficient of variation (CV) were calculated. Intra-observer differences between repeated measurements and the agreement of the two methods were also assessed using Bland-Altman plots.
Results: The ICC of the repeated aortic PWV measurements was 0.942 (0.866-0.976, 95%CI) for Vasera and 0.843 (0.644-0.931, 95%CI) for SphygmoCor. The mean difference of repeated aortic PWV measurements was 0.018$\pm$0.488m/s for Vasera and 0.177$\pm$0.670 m/s for SphygmoCor. The limit of agreement was -0.958 to 0.994 m/s and -1.163 to 1.517 m/s for Vasera and SphygmoCor, respectively. The CV was 3.3$\pm$3.9% for Vasera and 6.3$\pm$4.2% for SphygmoCor. The two methods showed good agreement (ICC$=$0.921, 0.821-0.967; 95%CI). The limit of agreement between the two methods was -1.066 to 0.998 m/s.
Conclusions: Aortic PWV measurement using Vasera had a better repeatability than using SphygmoCor. However, the two methods for assessing aortic PWV showed a good agreement.