P2.19: VALIDATION OF A NEW SYSTEM FOR THE ASSESSMENT OF FLOW MEDIATED DILATION: COMPARISON WITH A REFERENCE METHOD

F. Faita, S. Loukogeorgakis, V. Gemignani, M. Okorie, E. Bianchini, L. Ghiadoni, J.E. Deanfield, M. Demi


To link to this article: https://doi.org/10.1016/j.artres.2008.08.385

Published online: 21 December 2019
Results: The overall mean (±SD) difference between CSBP and SBP2 calibrated using the Omron 750T was 1.4±11.8 mmHg. When SBP2 was calibrated from aortic MAP and DBP the difference between CSBP and SBP2 was -1.1±5.6 mmHg. Conclusion: These results suggest non-invasive calibration does not produce a major systematic error in estimation of CSBP from SBP2, but does introduce greater variability when compared to invasive calibration.

doi:10.1016/j.artres.2008.08.380

P2.15 A COMPARISON OF SHEAR STRESS ESTIMATES IN THE COMMON CAROTID ARTERY IN HYPERTENSIVES

B. Ariff 1, F. Gior 2, Y. Xu 3, S. Thom 1, A. Hughes 1
1 Clinical Pharmacology, NHLI, Imperial College, London, United Kingdom
2 Dept Chemical Engineering, Imperial College, London, United Kingdom

Shear stress (SS) is associated with the formation of localised atherosclerosis. Due to the complexities of flow accurate determination of shear stress is difficult. Whilst 2D methods of deriving SS are widely used, computational fluid dynamic (CFD) modelling allows modelling of flow within complex geometry of the carotid bifurcation (CB). This study compared mean SS using ultrasound based Womersley’s solution and MRI based CFD.

This study compared mean SS using ultrasound based Womersley’s solution and MRI based CFD. 9 untreated hypertensive subjects [median age 42 (range 35-52) yrs] in a double-blind, placebo controlled, randomised, 3 way crossover trial using amlopidine or lisinopril underwent ultrasound examination of the right common carotid (CC) using a 7.5 MHz ultrasound transducer (L12-5 scan-head, HDI 5000, ATL, Bothell, Washington). Pulse wave Doppler was performed using a 1.5mm sample volume placed in the centre of CC 2cm proximal from the carotid bulb. Mean Womersley shear stress was calculated from these data using custom written software.

MRI of the CB was performed (Siemens Magnetom Sonata 1.5 T scanner) using a 2D TOF protocol and 3D PC sequence for flow measurements. These data were combined with custom refined CFD codes (CFX4.4, AEA Technology, Didcot, Oxfordshire UK).

Mean difference was -0.242 Pa (SD 0.314; 95% limits of agreement -0.856, 0.373); Lin’s concordance correlation coefficient (rho_c 0.16; SE 0.13; p = 0.21); Pearson’s r = 0.244; p = 0.219.

Overall the data indicate poor agreement between WSS measured by ultrasound-based and MRI-based CFD models. However, early detection is challenging and costly. The aim of this in-vitro study was to assess the value of a new detection method based on pressure profile analysis at the hemodialysis needle.

A silicon model of a radiocephalic arteriovenous fistula was built (4mm artery connected by an end-to-side anastomosis with a 7mm vein). A water-glycerine mixture was used as blood mimicking fluid. Pressure profiles were measured at the arterial hemodialysis needle (4cm downstream the anastomosis) and in the feeding artery 20cm upstream the anastomosis. Stenoses (50% diameter reduction) were created 10cm upstream the anastomosis (proximal artery (PA)) and 3.5cm and 8cm downstream the arterial needle (distant vein (DV) and proximal vein (PV) respectively). The pulse pressure (maximum minus minimum) at the needle was divided by the pulse pressure at the feeding artery to obtain a dimensionless ratio, $\delta_{PP}$. Experiments were conducted at different blood flow (500 to 1200 ml/min) and heart rates (60 to 90 beats/minute) to test this new index over a wide range of hemodynamic conditions.

In the control model (no stenosis), $\delta_{PP}$ was 20.26±4.55%. PA stenosis significantly decreased $\delta_{PP}$ to 7.69±2.08% (P<0.001), while presence of stenosis in the distal (36.20±2.12%) and proximal (32.38±2.17%) vein lead to significantly higher values of $\delta_{PP}$ (P<0.001).

In this in vitro study shows that the analysis of the pressure profile at the dialysis needle is useful for early detection and localization of hemodialysis vascular access stenosis, independent of heart rate and flow level.

doi:10.1016/j.artres.2008.08.382

P2.17 ASSESSMENT OF THE BRACHIAL ARTERY FLOW-MEDIATED DILATION WITHOUT ECG GATING

V. Gemignani 1, E. Bianchini 1, F. Faita 1, C. Gianarelli 2, L. Ghidoni 2, M. Demi 1
1 Institute of Clinical Physiology, CNR, Pisa, Italy
2 Department of Internal Medicine, Univ of Pisa, Pisa, Italy

The methods commonly used for non-invasive ultrasound assessment of endothelium-dependent Flow-Mediated Dilation (FMD) require an ECG signal in order to synchronize the measurement with the cardiac cycle. In this study, we present a method for assessing FMD which does not require ECG gating. The approach is based on filtering of the diameter-time curve, which is obtained by means of a B-mode image processing system. Since diameter changes due to vasodilation/vasoconstriction mechanisms and diameter changes induced by the cardiac cycle happen at different frequencies (fractions of Hz for the former; more than 1 Hz for the latter), frequency filtering was used to separate the two components and obtain the desired information.

The method was tested on 22 healthy volunteers without cardiovascular risk factors and the measurements obtained with the proposed approach were compared with those obtained with ECG gating. Diameter values computed with the new method were very similar to those obtained with ECG gating (3.90±0.75mm and 3.88±0.75mm respectively). FMD values obtained with the two methods were compared with Bland Altman plot: the bias was negligible (0.02%) and the SD of the difference was 0.24%, a value which is largely acceptable for this measurement.

In conclusion, the new method showed a good agreement with ECG gated measurements. Moreover, since it is based on a larger number of measurements, it provided a higher precision. Further advantages were also found both in terms of reliability of the measure and simplification of the instrumentation.


P2.18 NON INVASIVE MEASUREMENT OF ENDOTHELIAL DYSFUNCTION BY DIGITAL VOLUME PULSE ANALYSIS TECHNIQUE: APPLICATION & UTILITY IN CLINICAL PRACTICE

University Department of Medicine, City Hospital, Birmingham, United Kingdom

Background: The assessment of endothelial function has been accepted as an independent surrogate marker of cardiovascular disease (CVD), having both positive prognostic and diagnostic implications. The Digital Volume Pulse (DVP) analysis technique is a non–invasive approach to derive endothelial function. However, the utility and clinical application of this analysis technique has not been established.

Methods: we determined the discriminatory performance of the DVP analysis technique in identifying the people with established risk indices compared to a healthy population (West Midlands of the UK). Endothelial dependent and independent vessel function (D RI) was calculated by analyzing the change in digital pulse wave forms obtained by DVP photoplethysmography technique(Micro Medical).

Results: Of our cohort of (n=225) (60.1% male; mean age 53.7 (SE 1.5) years), 155 had established CVD risk factors and had significantly (P<0.001) impaired endothelial function ( ΔRII (SE) [Diasstes : 4.6±0.3], Hypertension: 6.9(0.6), hypercholesteremia 6.4(0.6)] compared to healthy controls [10.5(0.5)]. On univariate analysis, endothelial function was strongly associated with glycaemic status (R=-0.38, P =<0.001) in multivariate analysis, after adjusting for age and other risk factors, glycaemic status independently predicted endothelial function (Beta: -2.32(95% CI: -4.36--0.30), P = 0.04) In ROC analysis Δ RI was a better discriminator (AUC(SE): 0.7(0.06) compared to individual CVD risk factors such as mean blood pressure, wait hip ratio and total serum cholesterol level.

Conclusion: Measurement of endothelial function by DVP analysis technique provides a non- invasive method of measuring endothelial function in clinical practice for the discrimination of people with established risk factors and may aid more precise cardiovascular risk stratification.

doi:10.1016/j.artres.2008.08.384
VALIDATION OF A NEW SYSTEM FOR THE ASSESSMENT OF FLOW MEDIATED DILATION: COMPARISON WITH A REFERENCE METHOD

F. Faita 1, S. Loukogeorgakis 1, V. Gemignani 1, M. Okorie 1, E. Bianchini 1, L. Ghiaidini 2, J.E. Deanfield 2, M. Demi 3.

1 Institute of Clinical Physiology, Pisa, Italy
2 Department of Clinical Medicine, University of Pisa, Pisa, Italy
3 Vascular Physiology Unit, Institute of Child Health, London, United Kingdom
4 Esaote Spa, Firenze, Italy

Endothelial function is linked to cardiovascular risk factors, provides prognostic information when studied non-invasively by measurement of flow-mediated dilation (FMD). Despite the large effort to standardize the methodology, the FMD examination is still characterized by problems of reproducibility and reliability that can be overcome with the use of automatic systems. In our lab, we developed a system for the assessment of brachial FMD from ultrasound images which is able to automatically evaluate the brachial artery diameter in real-time. In order to validate our system, we carried out a comparison with another automatic method, available at the Vascular Physiology Unit of the Institute of Child Health (London), that is considered as a reference method in FMD assessment.

Two protocols have been followed in order to evaluate the agreement between the systems.

Protocol 1: 47 VCR recorded FMD sequences have been analyzed. Mean baseline (Basal), maximal (Max) brachial artery diameter and FMD, as maximal percentage diameter increase (%FMD) have been evaluated for each sequence.

Protocol 2: brachial artery diameter (Diam) has been evaluated in 618 frames from 12 sequences. Diam value and %FMD have been considered for each frame. Bland-Altman analysis has been used. As shown in the table, the bias is negligible and the SD of the differences is satisfactory. In conclusion, the compared systems show a optimal grade of agreement and they can be used interchangeably. Thus, the use of a system characterized by real-time functionalities would represent a referral method for assessing endothelial function in clinical trial.

<table>
<thead>
<tr>
<th>PROTOCOL 1</th>
<th>PROTOCOL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td>Diam</td>
</tr>
<tr>
<td>Mean of Diff</td>
<td>-0.044 mm</td>
</tr>
<tr>
<td>SD of Diff</td>
<td>0.028 mm</td>
</tr>
</tbody>
</table>

Discussion: Currently used ultrasound imaging modalities have important limitations to assess complex flow in the carotid artery. This complicates the use of these images to extract quantitative data related to flow such as wall shear stress. This virtual ultrasound environment is a powerful tool to assess limitations of currently used ultrasound imaging modalities and to develop new algorithms of upcoming techniques such as 3D ultrasound.

doi:10.1016/j.artres.2008.08.385