Artery Research (2018) 21, 29–37

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/artres

Flow-mediated slowing of brachial-radial pulse wave velocity: Methodological aspects and clinical determinants

Nicholas Cauwenberghs, Yenthel Heyrman, Lutgarde Thijs, Wen-Yi Yang, Fang-Fei Wei, Zhen-Yu Zhang, Jan A. Staessen, Tatiana Kuznetsova*

Research Unit Hypertension and Cardiovascular Epidemiology, KU Leuven Department of Cardiovascular Sciences, University of Leuven, Belgium

Received 17 November 2017; accepted 7 December 2017
Available online 9 January 2018

KEYWORDS
General population;
Endothelial function;
Flow-mediated slowing;
Pulse wave velocity

Abstract *Background:* Recent studies proposed that deceleration in pulse wave velocity (PWV) following reactive hyperaemia might reflect arterial distensibility and endothelial function. We therefore investigated methodological aspects and clinical determinants of new indexes of flow-mediated slowing (FMS) of PWV in a community-based sample.
Methods: In 71 subjects (mean age, 60.3 years; 50.7% women), we continuously assessed brachial-radial PWV using Vicorder® at baseline and after 3-min or 5-min suprasystolic upper-arm cuff occlusion. We calculated the relative change (Δ) in PWV per each 30 s intervals during 4 min of post-occlusion. We performed stepwise regression analyses to assess determinants of the PWV response.
Results: The peak FMS was detected at the first PWV recording obtained after occlusion. Overall, the decline in PWV during hyperaemia was significantly greater after 5-min of occlusion as compared to 3-min (effect sizes for 0–240 s intervals: −1.83% to −9.63%; $P \leq 0.037$). PWV declined significantly less with higher age during the 0–60 s post-occlusion intervals ($P \leq 0.0053$). On the other hand, after 120 s of post-occlusion, ΔPWV remained significantly lower in subjects with high diastolic blood pressure and oxidized LDL, and in smokers ($P \leq 0.028$). Consequently, as compared to healthy reference group, participants with cardiovascular risk factors exhibited a delay in age-adjusted recovery of PWV after 5-min of occlusion ($P \leq 0.039$).
Conclusions: Our findings confirm the use of a 5-min occlusion time for the assessment of vasomotor function by FMS. Whereas the early FMS response might deteriorate with ageing,

* Corresponding author. Research Unit of Hypertension and Cardiovascular Epidemiology, KU Leuven Department of Cardiovascular Sciences, University of Leuven, Campus Sint Rafaël, Kapucijnenvoer 35, Block D, Box 7001, B-3000 Leuven, Belgium.
E-mail address: tatiana.kouznetsova@med.kuleuven.be (T. Kuznetsova).

https://doi.org/10.1016/j.artres.2017.12.001

cardiovascular risk factors such as smoking, oxidative stress and hypertension might affect recovery of PWV after reactive hyperaemia.

Introduction

The vascular endothelium regulates key processes involving platelet function, inflammation, smooth muscle cell proliferation and vascular tone.[1] Endothelial dysfunction, characterized by reduced nitric oxide (NO) bioavailability, contributes to the progression of cardiovascular diseases such as atherosclerosis and hypertension.[2,3]

The vasodilatory response to increased shear stress during reactive hyperaemia following a brief period of ischaemia is partly triggered by endothelium-dependent release of NO.[4] This adaptation in vascular tone could be non-invasively assessed by the flow-mediated dilation (FMD) of large arteries,[5,6] or by the changes in digital pulse wave amplitude.[4,7–10]

Another novel approach to assess the conduit artery vasomotor function is based on changes in brachial-radial pulse wave velocity (PWV) during reactive hyperaemia.[11,12] The observed decline in PWV during the vasodilation after ischaemia might be used as a marker of arterial distensibility and endothelial function.[11,12] Indeed, PWV is inversely related to arterial distensibility[13,14] and reflects in some degree dynamic changes in vascular tone.[15] Moreover, the assessment of such flow-mediated slowing (FMS) of PWV has emerged as a user-friendly and reproducible alternative to measurement of FMD.[12] The automated FMS measurement protocol requires little training and logistics, favouring its use in large-scale population studies and screening programs.

To date, however, no study assessed the correlates of the newly proposed FMS index. Therefore, we investigated in a random community-based sample to what extent methodological aspects of FMS measurement and clinical characteristics might affect the temporal decline in brachial-radial PWV following reactive hyperaemia.

Materials and methods

Study participants

From August 1985 until December 2005, we randomly recruited a family-based population sample stratified by sex and age from a geographically defined area in northern Belgium, as described previously.[10] The initial participation rate was 78.0%. The Flemish Study on Environment, Genes and Health Outcomes (FLEMENGHO) study is an ongoing population study, in which participants are repeatedly examined at a local examination centre.

From February 2016 until January 2017, a scheduled follow-up examination at the field centre included assessment of endothelial function using an automated FMS protocol.[12] From 93 invited participants, we obtained informed written consent from 82 subjects (response rate 88.2%). Of these, 6 subjects did not undergo the FMS protocol because of advanced age (>80 years). We also excluded 4 participants with frequent extrasystoles (n = 3) or a pacemaker (n = 1). Furthermore, we discarded one recording of insufficient quality to reliably assess the FMS index. In total, 71 participants were statistically analysed.

FMS protocol

The participants refrained from smoking, heavy exercise, and drinking alcohol or caffeine-containing beverages for at least 3 hours before the test. We studied FMS in an air-conditioned room at constant temperature around 22 °C. To attain a cardiovascular steady-state before starting the test, the subjects had rested for at least 20 min in the supine position.

We implemented an automated FMS protocol using the Vicorder® device (Skidmore Medical, Bristol, UK) (Fig. 1). Participants were lying with their left arm positioned 70–80° to their body. Two oscillometric cuffs connected to the Vicorder® were placed around the upper arm and wrist. We measured the brachial-radial distance (D) as the distance between the midst of both cuffs. Next, subjects underwent an FMS procedure that included a baseline period of 3 min, an occlusion period of 3 min or 5 min in which the brachial cuff was inflated to 200 mm Hg, and a 4 min post-

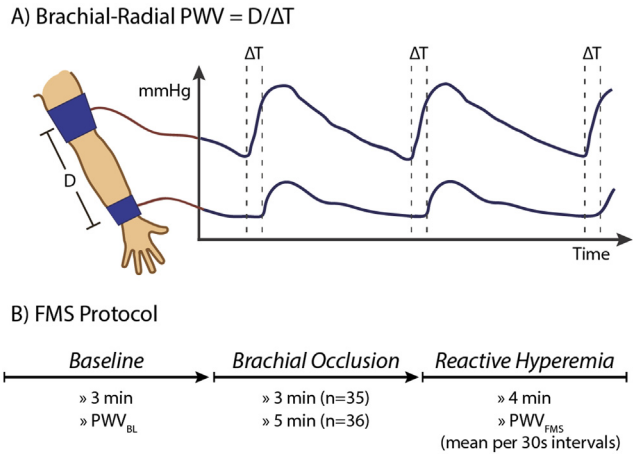

Figure 1 Automated assessment of flow-mediated slowing following reactive hyperaemia. (A) Mild inflation of brachial and radial cuff allow real-time recording of brachial-radial pulse wave velocity. (B) The FMS response equals the relative changes in pulse wave velocity following hyperaemia as induced by suprasystolic brachial occlusion. The FMS response was monitored for 4 min after 3-min or 5-min of occlusion. BL indicates baseline; D, brachial-radial distance; ΔT, time difference between brachial and radial pulse upstroke; FMS, flow-mediated slowing; PWV, pulse wave velocity.