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Research Article

The relation of digital vascular function to cardiovascular risk factors in African-Americans using digital tonometry: the Jackson Heart Study

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Abstract

Digital vascular tone and function, as measured by peripheral arterial tonometry (PAT), are associated with cardiovascular risk and events in non-Hispanic whites. There are limited data on relations between PAT and cardiovascular risk in African-Americans. PAT was performed on a subset of Jackson Heart Study participants using a fingertip tonometry device. Resting digital vascular tone was assessed as baseline pulse amplitude. Hyperemic vascular response to 5 minutes of ischemia was expressed as the PAT ratio (hyperemic/baseline amplitude ratio). Peripheral augmentation index (AI), a measure of relative wave reflection, also was estimated. The association of baseline pulse amplitude (PA), PAT ratio, and AI to risk factors was assessed using stepwise multivariable models. The study sample consisted of 837 participants from the Jackson Heart Study (mean age, 54 ± 11 years; 61% women). In stepwise multivariable regression models, baseline pulse amplitude was related to male sex, body mass index, and diastolic blood pressure (BP), accounting for 16% of the total variability of the baseline pulse amplitude. Age, male sex, systolic BP, diastolic BP, antihypertensive medication, and prevalent cardiovascular disease contributed to 11% of the total variability of the PAT ratio. Risk factors (primarily age, sex, and heart rate) explained 47% of the total variability of the AI. We confirmed in our cohort of African-Americans, a significant relation between digital vascular tone and function measured by PAT and multiple traditional cardiovascular risk

Supplemental Material can be found at www.ashjournal.com.

Conflict of interest: K.S. with Itamar Medical Ltd. provided equipment and analyses at no charge to the Jackson Heart Study. G.F.M. is owner of Cardiovascular Engineering, Inc, a company that designs and manufactures devices that measure vascular stiffness. The company uses these devices in studies that evaluate the effects of diseases and interventions on vascular stiffness.

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factors. Further studies are warranted to investigate the utility of these measurements in predicting clinical outcomes in African-Americans. J Am Soc Hypertens 2017;11(6):325–333.

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Introduction

The vast majority of studies of noninvasive measures of vascular function have been conducted in predominantly non-Hispanic whites.[1–4] Published data on vascular function and stiffness typically have included limited numbers (generally less than 400) of African-Americans.[5,6] African-Americans experience excess morbidity and mortality from cardiovascular disease (CVD). Because impaired vascular function predicts increased CVD and mortality, it is important to understand the clinical factors associated with vascular function in African-Americans.[7,8]

Peripheral arterial tonometry (PAT) is a relatively novel technique using a digital tonometry device that noninvasively measures vasodilator response in the microcirculation of the finger. Investigations are needed to determine if racial differences in digital artery measures are comparable to the differences that have been observed with other measures of vascular function such as flow-mediated dilation of the brachial artery. This is of particular importance given recent data showing that PAT has prognostic value in predicting CVD events.[7,8] We noninvasively characterized vascular endothelial tone and function in 837 African-Americans by examining digital PAT waveforms. We examined cross-sectional relations between CVD risk factors and vascular measures. We hypothesized that there is a strong relation between PAT vascular function and traditional risk factors of CVD in African-Americans.

Methods

The Jackson Heart Study (JHS) is a community-based cohort study that was initiated in 2000 to prospectively investigate the epidemiology of CVD in African-Americans.[9] Participants include former participants of the Atherosclerosis Risk in Communities study, a component recruited by random selection, a component acquired from a constrained volunteer sample,[10] and a cohort as part of the Jackson Heart Family Study, as described previously.[11] The JHS was approved by the University of Mississippi Medical Center Institutional Review Board, and the participants gave written informed consent.

Clinical Covariates

All clinical covariates were classified at the nearest examination (second examination). The mean (±standard deviation) time between the examination and PAT measure was 1.2 ± 1.5 year(s). Self-reported smoking status was determined as those who were current smokers at the time of the baseline visit. Hypertensive medications were coded if participants reported use in the 2 weeks before the visit. Body mass index (BMI) was determined as fasting weight (in kilograms) divided by height (in meters) squared. Systolic and diastolic blood pressures (BPs) were taken in the sitting position by trained technicians using a random-zero sphygmomanometer after 5-minute rest; an average of the second and third readings was used.[12] Pulse pressure was defined as the difference between systolic and diastolic BP. Diabetes mellitus was defined as fasting serum glucose ≥126 mg/dL, the use of diabetic medications within 2 weeks of the clinic visit, or a history of physician-diagnosed diabetes.[13] Insulin resistance was estimated using homeostasis model assessment of insulin resistance[14] using the following formula:

$$HOMA-IR = (fasting\ plasma\ insulin\ [\mu U/ml]) \times (fasting\ plasma\ glu\cos e[mmol/L]) \times /22.5$$

Insulin resistance was defined as a homeostasis model assessment score >4.6 for those without diabetes.

Fasting serum total cholesterol and high-density lipoprotein (HDL) cholesterol and triglyceride concentrations were assessed with Roche enzymatic methods using a Cobras centrifuge analyzer (Hoffman-La Roche, Inc, Nutley, NJ, USA), with the laboratory certified by the Lipid Standardization Program of the Centers for Disease Control and Prevention and the National Heart, Lung, and Blood Institute.

Prevalent CVD was coded as the occurrence of angina, myocardial infarction, fatal coronary heart disease, heart failure and stroke, or intermittent claudication at or prior to examination 2.

Measurement of Arterial Tonometry

The technique of obtaining PAT waveforms has been described previously.[15] Briefly, waveforms generated from small vessel diameter pulsations were obtained from fingertips of participants using a PAT device (endo-PAT2000, Itamar Medical). Participants had been fasting overnight. The sensor of the PAT device was placed on the forefinger of each hand, and waveforms were acquired at baseline to assess vascular tone and microvascular compliance and rarefaction. A BP cuff was placed on the right forearm and inflated to occlusive pressure (defined as either 220 mm Hg or 50 mm Hg above the systolic BP). After 5 minutes at occlusive pressure, the BP cuff