Research Article

The cardiovascular health score and the volume of carotid body in computed tomography angiography in patients with arterial hypertension

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Abstract

The cardiovascular health (CVH) score constitutes a reliable and measurable indicator of CVH proposed by the American Heart Association (AHA) calculated based on seven fundamental parameters, that is, smoking, body mass index, physical activity, healthy diet score, blood pressure, blood cholesterol, and fasting plasma glucose. The size and activity of carotid body (CB) play an important role in the pathogenesis of the cardiovascular system. The objective of this study was to define the relationship between the AHA CVH score and the volume of CB ($V_{rCB+lCB}$) estimated based on computed tomography angiography (CTA) in patients with arterial hypertension. Studies were conducted on a group of 57 patients with arterial hypertension (age: 70.74 ± 8.21 years). The CVH score was calculated, and CTA of carotid arteries was carried out for all patients. The CB analysis was performed based on delayed phase imaging obtained from CTA of carotid arteries. Based on the CVH score value, CVH was determined as optimal (CVH score between 10 and 14 points), average (5 and 9 points), or inadequate (0 and 4 points). CVH score in the studied group of patients was 6.53 ± 1.81, whereas $V_{rCB+lCB}$ value was 38.58 ± 18.43 mm^3. Patients with an inadequate CVH score (0–4 points) have statistically significantly higher $V_{rCB+lCB}$, and they are fraught with $V_{rCB+lCB} \geq$ median much more often than patients with an optimal CVH score (10–14 points). The receiver operating characteristic curve indicated a CVH score value of 6 as an optimal cutoff point to predict $V_{rCB+lCB} \geq$ median. The CVH score ≤ 6 criterion indicates $V_{rCB+lCB} \geq$ median with sensitivity of 58.6% and specificity of 71.4%. In the regression analysis, it was indicated that lower partial scores for physical activity, healthy diet score, and blood pressure in the AHA CVH evaluation constitute independent risk factors for higher $V_{rCB+lCB}$. In the studied group of patients with arterial hypertension, an inversely proportional dependence between the CVH score and the size of CB is observed in CTA of carotid arteries. J Am Soc Hypertens 2018;∎(∎):1–10. © 2018 American Heart Association. All rights reserved.

Key words: Cardiovascular health score; volume of the carotid body; computed tomography angiography; arterial hypertension.

Introduction

Cardiovascular diseases (CVDs) still constitute the main cause of general mortality. According to the World Health Organization report ''Global Health Estimates 2015'' in general population, CVDs constituted a cause of 31.3% of deaths; among them, the largest mortality rates characterize ischemic heart disease (15.5% of deaths), stroke

(11.1%), diabetes (2.8%), and hypertensive heart disease (1.7%).[1]

In the cardiovascular health (CVH) promotional strategy for 2010–2020, the American Heart Association (AHA) determined the target reduction of the number of deaths resulting from CVDs and stroke in American society by 20%, with a simultaneous improvement of CVH by 20%. AHA's Cardiovascular Health metrics (AHA Life's Simple 7), allowing calculation of the CVH score based on seven fundamental CVH parameters (smoking, body mass index, physical activity, healthy diet score, blood pressure, blood cholesterol concentration, and fasting plasma glucose concentration), was developed.[2] Studies conducted in subsequent years concerning predictive usefulness of the AHA CVH score indicated its strong inversely proportional relationship with the incidence of atherosclerosis, ischemic heart disease, myocardial infarction, stroke, hypertension, chronic kidney disease, and other cardiovascular outcomes.[3,4]

Carotid body (CB) situated bilaterally in the area of the common carotid artery division is responsible for reflexive, chemical control of the regulation of respiratory activities of the body. Apart from that, CB plays an important role in the regulation of activities of the circulatory system.[5] In recent years, dependencies between an abnormal activity and size of CB and frequent incidence of heart failure, hypertension, insulin resistance, and obstructive sleep apnea were documented.[6–9] Furthermore, efforts were made to implement methods based on attempts to reduce activity of CB through their surgical resection or ablation[10–12] into therapeutic schemes for CVDs.

In the concept of "health fields" developed in the 70s of the 20th century, four superior categories of health determinants with their significance expressed in percentages were determined: lifestyle (55%), environmental factors (20%), biological and genetic factors (15%), and organization of health care (10%).[13] Previous scientific research on CB concerned mainly their significance in the pathogenesis of CVDs. According to the authors, the relationship between various health determinants and the size of CB may be interesting. In the previous studies, it has been indicated that there could be genetic conditions for CB enlargement. In patients with hypertension, it was observed that particular genotypes of the renin-angiotensin-aldosterone system may influence the volume of CB.[14] No scientific studies dedicated to the dependency between lifestyle, environmental factors, or organization of health care and the volume of CB in imaging studies were found in available scientific literature.

The objective of this elaboration was to determine the relationship between the CVH score assessed based on AHA's CVH metrics and the volume of CB ($V_{rCB+lCB}$) estimated based on their imaging using computed tomography angiography (CTA) in patients with arterial hypertension.

Material and Methods

The study was carried out on a group of 81 patients fulfilling the following criteria: age ≥ 20 years, diagnosis of arterial hypertension, at least 5-year history of pharmacological treatment of hypertension with antihypertensive drugs, and clinical premises justifying the need for CTA of carotid arteries, that is, chronic headache and dizziness with a probable vascular origin (58 patients), episodes of transient ischemic attack (18), history of ischemic stroke (seven), and ambiguous USG results concerning carotid arteries (nine). Then, a group of 14 patients fulfilling the following disqualification criteria was excluded from the study: secondary hypertension diagnosis (two patients), ischemic heart disease (8), renal failure (three), and hyperthyroidism or hypothyroidism (six). Other 10 patients were excluded from the study because of the lack of sufficient visualization of CB in CTA of carotid arteries. Therefore, the final studied group consisted of 57 patients with arterial hypertension (age: 70.74 $\pm$ 8.21 years). Clinical characteristics with the characteristics of hypertension treatment in the studied group of patients are included in Table 1.

The written informed consent was obtained from all persons taking part in the study. The study was approved by the local ethics committee (No. 429/2013). In all patients, the CVH score was assessed and the CTA of carotid arteries was conducted.

The evaluation of CVH score was performed based on AHA's CVH metrics (AHA Life's Simple 7). Seven CVH parameters were assessed, among others four indicators of health behavior (lifestyle) and three cardiovascular disease risk factors. Indicators of health behavior included smoking, body mass index, physical activity, and healthy diet score, whereas the assessed cardiovascular disease risk factors included total cholesterol in blood, blood pressure, and fasting plasma glucose. Indicators of health behavior for the purposes of the AHA Life's Simple 7 evaluation were evaluated based on a survey study. Total cholesterol in blood and fasting plasma glucose were determined based on the standard commercial tests used in clinical practice. Blood pressure was measured using the Korotkoff method. In case of each assessed CVH parameter, a three-step scoring was used—two points for fulfilling the CVH ideal criteria, 1 point: intermediate CVH and 0 point: poor CVH. The complete scoring criteria for particular CVH in the AHA Life's Simple 7 analysis are included in Table 2, together with the distribution of the obtained scoring in the studied group of patients. The possible maximum CVH score was 14. Based on the CVH score value, CVH was determined as optimal (CVH score between 10 and 14 points), average (5 and 9 points), or inadequate (0 and 4 points).

All CTAs of carotid arteries were carried out using one computed tomography (CT) device: SOMATOM Definition Dual-Source CT (Siemens Healthcare, Germany). A unified protocol to assess carotid arteries, including