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Effects of cigarette smoke on Holter ECG recordings in patients with arterial hypertension. Part 1: Time domain parameters of heart rate variability

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A R T I C L E   I N F O

A B S T R A C T

This report was intended to evaluate the effect of cigarette smoke on heart rate variability (HRV) in patients with arterial hypertension (AH). 223 individuals were qalified to the studies. The following groups of patients not suffering from other disease which may affect HRV were delineated: 1 – patients with AH ($n = 145$); 2 – patients without AH ($n = 48$). In group 1 the following patient groups were studied: A – active smokers ($n = 42$), B – non-smokers exposed to cigarette smoke ($n = 30$), C – non-smokers not exposed to tobacco smoke ($n = 34$), D – former smokers ($n = 26$). A time domain HRV analysis was carried out. Group 1 versus group 2 manifested significantly lower mean values of most parameters in the HRV time domain analysis. Subgroups A, B and D versus subgroup C also exhibited significantly lower mean values of most parameters in the HRV time domain analysis. Active cigarette smoking and passive exposure to tobacco smoke represented independent risk factors for a decreased HRV. *Conclusions*: Active and passive exposure to cigarette smoke decreases HRV in hypertensive patients.

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1. Introduction

Cigarette smoking still represents a significant health problem and worldwide, around a quarter of adults (CDC, 2009) smoke. It is expected that half of all persons currently smoking cigarettes will die due to complications linked to smoking (WHO, 2011). The number of deaths linked to smoking in 2030 may reach 8 million per year, a significant part of which will take place in the least developed and developing countries (WHO, 2008). It has been proven that in the aspect of cardiovascular diseases, cigarette smoking initiates an accelerated atherosclerotic process (Ambrose and Barua, 2004; Armani et al., 2009). Smokers, as compared to non-smokers, manifest a twofold higher risk of cardiac ischemic disease, cerebral stroke and diseases of peripheral blood vessels and a three-fold higher risk of sudden death (Halawa, 2004). In the available

literature, there are only few studies which document dysregulation of the autonomic nervous system as a possible mechanism in which cigarette smoking affects the circulatory system (Dinas et al., 2013). However, this potential requires confirmation.

In the general population, passive exposure to cigarette smoke is even more common than the active cigarette smoking. According to NHANES III studies in the USA, the risk of passive exposure to cigarette smoke, evaluated on the basis of the cotinine concentration in serum, involves 87.9% of the population (Pirkle et al., 1996). The effect of passive cigarette smoking on the human body has not yet been sufficiently clarified and requires studies aimed at defining the involved mechanisms. Arterial hypertension represents a recognized risk factor of cardiovascular diseases (Sloand et al., 2007). In the available literature, there is no sufficient data on the significance of active or passive cigarette smoking for intensity

of cardiovascular complications of arterial hypertension. The role of cigarette smoke is of interest in the manifestation and intensity of the autonomic dysregulation.

A non-invasive and useful technique for evaluating the autonomic cardiac work regulation involves analysis of heart rate variability (HRV) (ESC, 1996). Decreased HRV has been documented in patients with various diseases of the cardiovascular system. Undoubtedly, low HRV characterizes patients with myocardial infarction, in addition representing an unfavorable prognostic factor of the acute coronary syndromes (Buccelletti et al., 2009; Chattipakorn et al., 2007). Moreover, a decreased HRV was recognized as one of the pathophysiological mechanisms characterizing heart failure, cardiomyopathies, diabetes, supraventricular and ventricular arrhythmias, sudden cardiac death and metabolic syndrome (Altuncu et al., 2012; Arsenos et al., 2012; Clariá et al., 2008; Eryonucu et al., 2000; Felber Dietrich et al., 2007; Karakurt et al., 2007; Oakley and Emond, 2011; Petelczyc et al., 2010; Reed et al., 2005; Schönauer et al., 2008; Terechtchenko et al., 2003).

The principal aim of this report was an evaluation of the effect of cigarette smoke on parameters of the time domain HRV analysis in patients with diagnosed arterial hypertension, who are actively or passively exposed to smoke.

2.   Materials and methods

2.1.   *Study population*

The 223 individuals recruited for this study were divided into two groups: I – patients with arterial hypertension treated pharmacologically, and II – normal subjects without arterial hypertension. Inclusion criteria in group I involved: 18–65 years of age and diagnosed arterial hypertension treated with hypotensive agents. Inclusion criteria in group II were: 18–65 years of age, normal values of arterial blood pressure (<140/90 mm/Hg) in anamnesis and optimum values of arterial blood pressure (<120/80 mm/Hg) in measurements performed upon enrolling to the studies. On the basis of the accepted criteria, the group I included 158 and 54 subjects were qualified to the group II. Finally, 11 persons were excluded from the studies: 4 persons who did not meet the accepted age criterion, 5 persons who did not suffer from the arterial hypertension but did not exhaust the criteria of optimum arterial blood pressure value (<120/80 mm/Hg) in the measurements performed upon the qualification to the studies, and 2 individuals suffering from the arterial hypertension but without effective treatment.

At the next stage, individuals manifesting coexistence of diseases that could affect HRV were excluded. Such defined potential criteria of exclusion were: secondary arterial hypertension (1 person from group I), diabetes mellitus (9 persons from group I, 2 persons from group II), hyperthyroidism (2 persons from group I and 2 persons from group II), renal insufficiency (1 person from group I), neurological diseases (2 persons from group II), electrolyte disturbances (3 persons from group I and 2 persons from group II), atrial fibrillation (3 persons from group I) and disturbances in heart rhythm exceeding 10% of evolutions on the Holter ECG recordings (6 persons in group I and 2 persons in group II). Eventually,

13 persons from group I and 6 persons from group II were excluded from the study. 11 patients excluded from the study as they met more than a single criterion of exclusion.

Finally, the following groups were enrolled to the study: group 1 consisting of 145 persons with arterial hypertension treated pharmacologically and not suffering from other disease which may affect HRV; group 2 – not suffering from arterial hypertension, and not suffering from other diseases that may affect HRV. The basic clinical parameters in both groups and characteristics of hypotensive treatment in group 1 are shown in Table 1. Characteristics of exposure to cigarette smoke in groups 1 and 2 are displayed in Table 2.

Initially, in group 1, the following subgroups were distinguished: subgroup A of patients with arterial hypertension treated pharmacologically who actively smoked cigarettes; subgroup B of patients with arterial hypertension treated pharmacologically who were passively exposed to cigarette smoke; subgroup C of pharmacologically treated patients with arterial hypertension who never smoked cigarettes and were not exposed to smoke; group D – individuals with pharmacologically treated arterial hypertension who gave up a habit of smoking cigarettes.

Criteria for active smoking qualifying the individuals from group I to subgroup A included smoking of at least one cigarette per day for at least one year. In turn, criteria of passive exposure to smoke permitting to qualify patient from group I to subgroup B included not smoking cigarettes (neither now nor in the past) or staying for at least 1 h per day in rooms, in which cigarettes were smoked, or staying for at least 30 min per day in direct vicinity of persons smoking cigarettes, or living with a person/persons who smoked cigarettes in the household. Subgroup C included persons of group I who fulfilled the following criteria: not smoking cigarettes (neither now nor in the past) and failing to exhaust the criteria of inclusion to group B. Persons who broke the habit of cigarette smoking included those who smoked in the past at least one cigarette per day for at least one year but at the time of the study were not smoking cigarettes for at least five years. Individuals in group I fulfilling the above criterion of breaking the habit of cigarette smoking were included in subgroup D.

On the basis of the above criteria, the population of 145 persons in group I was divided in the following way: 42 persons were enrolled to subgroup A, 30 persons were recruited to subgroup B, 34 persons were included in subgroup C, 26 persons were included in subgroup D and 13 persons were excluded from the studies. Causes of exclusion of those 13 persons included absence of the criterion involving regularity of smoking among active smokers, inability to determine a duration of exposure to smoke in passive smokers, failing to fulfill the criterion of five year non-smoking period in persons who broke the habit of smoking or imprecise responses to the questions listed in the questionnaire on cigarette smoking. Principal clinical parameters and characteristics of hypotensive treatment in subgroups A, B, C and D are shown in Table 3.

2.2.   *Questionnaire analyses and basic measurements*

Among all persons included in the study, questionnaire analyses were performed. The questionnaire included questions related to present health condition (with particular