International Journal of Psychophysiology 78 (2010) 158–162

Contents lists available at ScienceDirect

International Journal of Psychophysiology

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

Interoceptive awareness in essential hypertension

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ARTICLE INFO

Article history:
Received 26 September 2009
Received in revised form 2 July 2010
Accepted 6 July 2010
Available online 13 July 2010

Keywords:
Arterial hypertension
Ambulatory blood pressure monitoring
Interoceptive awareness
Cardiovascular reactivity
Sympathetic nervous system

ABSTRACT

Objective: Clinical practice and research provide evidence indicating the involvement of psychological factors in essential hypertension. Little is known about interoception (i.e. the ability of perceiving bodily signals) in essential hypertension. The present study focused on the assessment of interoceptive awareness in newly diagnosed-untreated hypertensives by means of ambulatory blood pressure monitoring (ABPM), a useful tool in the detection and evaluation of hypertension.
Methods: The study population consisted of 50 untreated newly diagnosed hypertensives (48.3 ± 9.7 years) and 31 normotensives (49.5 ± 14.2 years) matched regarding sex, BMI and prevalence of smoking. All participants underwent 24-hour ABPM (Spacelabs 90207). Cardiac interoceptive awareness was assessed by means of a heartbeat detection task.
Results: Hypertensives exhibited higher office blood pressure (BP) and heart rate (HR) levels (clinic systolic BP: 152 ± 20 vs 140 ± 17; $p = 0.01$, clinic diastolic BP: 95 ± 10 vs 89 ± 11; $p = 0.008$, clinic HR: 82 ± 13 vs 74 ± 11; $p = 0.04$) as well as ambulatory measurements (systolic BP24: 137 ± 11 vs 119 ± 7; $p < 0.001$, diastolic BP24: 87 ± 7 vs 73 ± 5; $p < 0.001$, HR24: 79 ± 9 vs 71 ± 10; $p < 0.01$) compared to normotensives. Moreover, the analysis revealed an increased interoceptive awareness in hypertensives as compared to normotensives. A comparison within the hypertensive group between subjects with and without interoceptive awareness revealed that subjects with increased interoceptive awareness had higher office systolic and diastolic blood pressure values, as well as mean ambulatory HR.
Conclusion: These findings give credence to the idea that interoceptive awareness may represent an enhanced cardiovascular reactivity involved in essential hypertension, even in its early stages. The cross-sectional nature of this study precludes causal inference, but provides valuable directions for future prospective investigations.

1. Introduction

Interoception, the ability of perceiving bodily changes, involves a concept based on William James theory, who first postulated the presence of a viscero-afferent feed-back closely linked to emotional experience (James, 1883; Pollatos et al., 2007a,b,c). Interoceptive awareness provides the organism with a homeostatic mechanism in order to adapt to moment-to-moment fluctuations of afferent information travelling from the body to the nervous system (Cameron, 2001). Until now, known factors influencing cardiovascular interoception include male gender, younger age, body composition, fitness, physical activity, postural changes and symptom proneness (Cameron, 2001; Vaitl, 1996). According to Pollatos et al. (2007b), specific structures including insula, dorsal singulate gyrus and the dorsomedial prefrontal cortex are involved in processing cardiac sensations, whereas the right hemisphere seems to play a central role in cerebral regulation of cardiac functions (Leopold and Schandry, 2006).

Interoception has been proposed as a possible model in order to understand and to explain a psychosomatic process underlying essential hypertension (Cameron, 2001; Vaitl, 1996), but the results remain contradictory. On the one hand, a body of evidence suggests that elevated blood pressure levels are associated with reduced ability to perceive cardiac activity and explain their findings based on the baroreceptor hypothesis and on observed differences concerning nociception in hypertension and normotention (Elbert et al., 1988; Blumenthal et al., 1993; Kollenbaum et al., 1996). On the other hand, a number of researchers suggest that elevated blood pressure facilitates

Abbreviation: ABPM, ambulatory blood pressure monitoring; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; BMI, body mass index; SNS, sympathetic nervous system.

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doi:10.1016/j.ijpsycho.2010.07.003

the perception of cardiac activity (O'Brien et al., 1998; Schandry and Montoya, 1996; Schandry et al., 1993; Greenstadt et al., 1986).

The assumption that psychological factors contribute to the development of essential hypertension and affect blood pressure regulation dates at least back to the early 20th century (Alexander, 1939; Pickering and Gerin, 1990; Rutledge and Hogan, 2002). During the last decades a convincing body of studies proposed possible mechanisms and models including increased sympathetic nervous system activity, cardiovascular reactivity to stress, neurohormonal models, psychological characteristics and behavioral dispositions (Rutledge and Hogan, 2002), as well as interoceptive awareness (Cameron, 2001; Vaitl, 1996), in order to explain the potential relationship between essential hypertension and psychological parameters. However, it is of great importance to determine whether elevated blood pressure is related with an increased cardiac awareness because of: Firstly, hypertension, according data from the National Health and Nutrition Examination Survey (NAHANES), affects 50 million or more Americans and is overall the major risk factor for the development of cardiovascular disease, the main cause of mortality (JNC 7, 2003). Secondly, hypertension has often been considered a "silent" disease (Greenstadt et al., 1986). For several reasons, understanding the degree to which cardiac awareness is present across the essential hypertension is of particular interest. For instance, a clearer understanding of the role of cardiac awareness in essential hypertension would inform unifying theories concerning the two entities, as well as introducing therapeutic interventions such as biofeedback training which seems to be needed to assure effective treatment of hypertension (Brener, 1977; Greenstadt et al., 1986).

Ambulatory blood pressure monitoring (ABPM) provides a useful tool in the detection and evaluation of hypertension (O'Brien et al., 2003). It offers unique opportunities in the assessment of the impact of lifestyle habits on blood pressure in subjects going their normal activities (Beilin, 2002). Moreover, ABPM offers information about the influence of behavioral effects on blood pressure elevations (Pickering et al., 1995). Ambulatory measurements provide greater statistical power and seem to correlate better than office measurements with acute and sustained effects of lifestyle (Palatini, 1997).

To date, the psychosomatic process of hypertension remains unclear; still, there are indications that it may be influenced by the capability of perceiving bodily changes, especially in cardiac activity.

The purpose of this study was to investigate the relation between essential hypertension in newly diagnosed untreated hypertensives, by means of ambulatory blood pressure monitoring (ABPM) and the ability of heartbeat detection, as an index of cardiac interoceptive awareness. To our knowledge, this is the first study examining the relation between heartbeat detectability and parameters of ambulatory blood pressure monitoring in untreated essential hypertensives at the time of diagnosis.

In the present study, it was hypothesized that: a) newly diagnosed essential hypertensives are better heartbeat detectors than normotensives and b) in the group of hypertensives, individuals with higher levels of blood pressure and heart rate present increased cardiac interoceptive awareness.

2. Methods

2.1. Study population

The study population consisted of 50 newly diagnosed untreated hypertensives, referred to the hypertensive center of the Department of Clinical Therapeutics (Athens University, Greece), and of 31 normotensives volunteers. All subjects fulfilled the following inclusion criteria: 1) absence of clinical evidence of hypertension related complications (coronary artery disease, heart failure, cerebrovascular disease, renal insufficiency or peripheral artery disease), psychiatric disorders and any other systematic disease; 2) no clinical signs or laboratory evidence of secondary causes of arterial hypertension; 3) at least three valid BP measurements per hour over 24-hour ABPM (75% successful measurements). Exclusion criterion was the use of any medication, including antihypertensive agents and psychiatric treatment.

The above cohort of patients was evaluated by means of 24-hour ABPM. The study population was divided into two groups in terms of the ambulatory blood pressure levels. Normotensives were considered those with 24-hour ambulatory BP $<$130/80 mmHg. Hypertensives were defined as those with 24-hour ambulatory BP $\geq$130/80 mmHg. All participants were ambulatory and the two groups were matched for sex, age and body mass index. Subjects were given their informed consent for entering the study. The protocol was approved by the institutional review committee of the hospital and the procedures followed were in accordance with the institutional guidelines.

2.2. Clinic blood pressure measurements

Clinic blood pressure measurements were obtained by a mercury sphygmomanometer three consecutive times at the same day. The first measurement was taken at the beginning of the visit, 5 min after sitting down. The second one was taken 10 min later and the third immediately before application of the ABPM equipment. The mean of the three systolic values and the mean of the three diastolic values of the same patient were the clinic systolic and clinic diastolic blood pressure, respectively. In addition, heart rate measurements were taken after the blood pressure measurements and were expressed as clinic heart rate. Study participants remained seated with the arm comfortably placed at heart level, whereas blood pressure and heart rate measurements were obtained for each one by the same doctor, who was blinded to the study hypotheses. Subjects were not informed about their blood pressure and heart rate levels during the procedure.

2.3. Ambulatory blood pressure monitoring (ABPM)

All subjects underwent ABPM for 24 h with a Spacelabs 90207 ambulatory blood pressure monitor. The participants were measured in a working day and were instructed to perform as usually. The cuff was fixed to the non-dominant arm with tape. Automatic blood pressure readings were taken at 15-minute intervals and at least three valid BP measurements per hour over 24 h were needed for the purpose of the study. None of the study participants were bedridden or hospitalized during ABPM. The accuracy of the ABPM devices was checked monthly by means of 10 automatic and 10 oscillatory BP readings taken simultaneously from the same arm via a Y-tube. In all instances the values did not differ by $>$5 mmHg.

2.4. Assessment of interoceptive awareness

Cardiac interoception was assessed by a heartbeat detection task. We used a heartbeat discrimination task based on the method of constant stimuli (MCS) as it has been proposed by Schneider et al. (1998) and Brener et al. (1993). The task measures individual's ability to discriminate among external (auditory) stimuli those signals that most closely coincide in time with their own heartbeats. Subjects who can discriminate from an array of repeated presentations the signals which are synchronous or asynchronous with their own heartbeats are classified as heartbeat detectors and present an increased cardiac interoception.

2.4.1. Apparatus and procedure

Participants were seated in a comfortable chair at the clinic office. After subjects were seated electrodes of the ECG and headphones were attached. The output of the ECG was fed into an amplifier in which the participant's headphones were connected as well. The system was