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HEART RATE VARIABILITY PARAMETERS IN PATIENTS WITH ARTERIAL HYPERTENSION IN DEPENDENCE ON THE TYPE OF DAILY BLOOD PRESSURE PROFILE

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Violation of functioning of the autonomic nervous system is an important factor in the formation and progression of arterial hypertension (AH). Abnormal nocturnal blood pressure (BP) reduction is regarded as an independent prognostic factor for cardiovascular complications in patients with AH. One of the possible factors that determine the violation of BP circadian rhythm can be imbalance of different parts of autonomic nervous system.

The aim of our study was to study heart rate variability (HRV) in patients with AH, dependently of BP profile. 72 patients with AH were examined. Average age was 57 ± 11 years.

All patients underwent ambulatory BP (ABPM) and ECG monitoring. To define the daily profile the nocturnal BP dip was quantified and for HRV evaluation the frequency analysis method was used. HRV changes in patients with AH present with reduced total power and with a violation in the ratio of the powers of very low, low and high frequencies, enhanced sympathycotension and influence of humoral factors. Violations of systolic BP (SBP) daily profile was mainly characterized by an increase in the power of low frequency waves, which indicates an intensification of sympathetic and decreased parasympathetic influences. Violations of diastolic BP (DBP) daily profile were mainly characterized by a relative increase in the power of very low frequency waves. The obtained results showed that in the management of patients with AH it is important not only to control the circadian SBP and DBP profiles, but the evaluation of HRV also.

KEY WORDS: heart rate variability, arterial hypertension, ambulatory blood pressure monitoring, circadian blood pressure profile

ПОКАЗНИКИ ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ У ПАЦІЄНТІВ З ГІПЕРТОНІЧНОЮ ХВОРОБОЮ ЗАЛЕЖНО ВІД ТИПУ ДОБОВОГО ПРОФІЛЮ АРТЕРІАЛЬНОГО ТИСКУ

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Порушення функціонування вегетативної нервової системи є важливим фактором у формуванні та прогресуванні гіпертонічної хвороби (ГХ). Недостатнє або надмірне нічне зниження артеріального тиску (АТ) розглядається як незалежний прогностичний фактор серцево-судинних ускладнень у пацієнтів з ГХ. Одним з можливих чинників, які визначають порушення циркадного ритму АТ може бути дисбаланс вегетативної нервової системи. Ціллю нашого дослідження було вивчення особливостей показників варіабельності серцевого ритму (ВСР) у пацієнтів з ГХ. Обстежено 72 пацієнта з гіпертонічною хворобою. Середній вік 57 ± 11 років. Всім пацієнтам проводилося добове моніторування АТ і ЕКГ. Для визначення добових профілів систолічного АТ (САТ) та діастолічного АТ (ДАТ) розраховували ступінь нічного зниження АТ. Для оцінки ВСР використовувалися методи частотного аналізу. Зміни показників ВСР у пацієнтів з ГБ полягають у зниженні загальної потужності спектра з порушеннями в співвідношеннях потужностей дуже низьких, низьких та високих частот, посиленні симпатикотонии та впливу гуморальних факторів. Результати показали, що порушення добового профілю САД при зниженні загальної потужності спектра в основному характеризуються збільшенням потужності низьких частот ВСР, що свідчить про посилення симпатичних та зниження парасимпатичних впливів, а добового профілю ДАТ – у відносному збільшенні потужності дуже низьких частот ВСР, що свідчить про посилення гуморальних впливів. Результати показують важливість в діагностиці та контролі ГБ добових профілів не тільки САД, але і ДАТ, доповнюючи їх оцінкою показників ВСР.

КЛЮЧОВІ СЛОВА: варіабельність серцевого ритму, гіпертонічна хвороба, добове моніторування артеріального тиску, добовий профіль артеріального тиску

ПОКАЗАТЕЛИ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА У ПАЦИЕНТОВ С ГИПЕРТОНИЧЕСКОЙ БОЛЕЗНЬЮ В ЗАВИСИМОСТИ ОТ ТИПА СУТОЧНОГО ПРОФИЛЯ АРТЕРИАЛЬНОГО ДАВЛЕНИЯ

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Нарушение функционирования вегетативной нервной системы является важным фактором в формировании и прогрессировании гипертонической болезни (ГБ). Недостаточное или избыточное ночное снижение артериального давления (АД) рассматривается как независимый прогностический фактор сердечно-сосудистых осложнений у пациентов с ГБ. Одним из возможных факторов, которые определяют нарушение циркадного ритма АД, может быть дисбаланс вегетативной нервной системы. Целью нашего исследования было изучить особенности показателей вариабельности сердечного ритма (ВСР) у пациентов с ГБ. Обследовано 72 пациента с гипертонической болезнью. Средний возраст 57 ± 11 лет. Всем пациентам проводилось суточное мониторирование АД и ЭКГ. Для определения суточных профилей систолического АД (САД) и диастолического АД (ДАД) рассчитывали степень ночного снижения АД. Для оценки ВСР использовались методы частотного анализа. Изменения показателей ВСР у пациентов с ГБ состоят в снижении общей мощности спектра с нарушениями в соотношениях мощностей очень низких, низких и высоких частот, усиления симпатикотонии и усилении влияния гуморальных факторов. Результаты показали, что нарушения суточного профиля САД при снижении общей мощности спектра в основном характеризуются увеличением мощности низких частот ВСР, что свидетельствует об усилении симпатических и снижении парасимпатических влияний, и суточного профиля ДАД – в относительном увеличении мощности очень низких частот ВСР, что свидетельствует об усилении гуморальных влияний. Результаты показывают важность учитывания в диагностике и контроле ГБ суточных профилей не только САД, но и ДАД, дополняя их оценкой показателей ВСР.

КЛЮЧЕВЫЕ СЛОВА: вариабельность сердечного ритма, гипертоническая болезнь, суточное мониторирование артериального давления, суточный профиль артериального давления

INTRODUCTION

Arterial hypertension (AH) remains one of the most worldwide health and social problem due to its high prevalence, high risk of complications and the lack of adequate blood pressure (BP) control [1].

Autonomic dysfunction, along with heredity and endocrine-metabolic imbalance is an important factor in the formation and progression of the AH. Therefore, the study of autonomic regulation may be the key to understanding the clinical and pathogenetic features of hypertension.

At the present time to assess the state of the autonomic nervous system (ANS) is widely used study of heart rate variability (HRV) [2–3]. Studies in this area showed greater sympathetic drive in the early stages of AH, reduced HRV and increase very low frequency effects on the heart rhythm with the progression of the disease [4–5].

In accordance with the results of recent studies lack of adequate physiological nocturnal BP reduction or excessive BP lowering at night regarded as an independent prognostic factor for cardiovascular complications in patients with hypertension. One of the possible factors that determine the violation of BP circadian rhythm can be imbalance of different parts of autonomic nervous system.

OBJECTIVE

To study HRV particular qualities in patients with AH, dependently of BP profile.

MATERIALS AND METHODS

72 patients with AH were examined. The study involved 28 men (39 %) and 44 women (61 %). Average age was 57 ± 11 years.

AH of stage I was diagnosed in 15 % of patients, stage II – in 67 %, stage III – 18 %. AH of 1 grade was determined in 36 % of patients, grade 2 – 22 %, grade 3 – 14 %. Heart failure (HF) was diagnosed in 72% cases: HF stage I - 39%, HF stage IIA – 33 %, I functional class (FC) of HF was determined in 22 % of patients, II FC – 42 %, III FC – 8 %; coronary heart disease (CHD) – 76 % of cases: stable angina (I–III FC) – 27 %, postinfarction cardiosclerosis (PICS) – 3 %.

Exclusion criteria were secondary hypertension, hemodynamically significant valvular heart disease, cardiomyopathy of any

genesis, heart failure stage III, FC IV by NYHA, any acute condition (infection, trauma, surgery) within the previous 3 months, chronic diseases in stage of decompensation or exacerbation, cancer, as well as any circumstances that hinder the conduction of ABPM or Holter ECG monitoring.

All patients underwent ABPM and Holter ECG monitoring using a computer system «Kardiosens» (HAI Medica, Ukraine) with the oscillometric method of blood pressure measurement.

The monitoring was performed in the conditions of patient normal working day, the cuff was placed at the non-dominant arm using an appropriately sized cuff. According to Ambulatory Blood Pressure Monitoring International Recommendations 2013 [6], blood pressure was measured every 15 minutes during the day and 30 minutes at night. Daytime and night-time periods were defined based on a diary, in which participants were asked to record their activities and sleep times during the monitoring session. Editing ABPM, in accordance Ambulatory Blood Pressure Monitoring International Recommendations [6] if any value outside preset limits (see below) was detected during a recording, that measurement was rejected:

– Systolic blood pressure (SBP) > 250 or < 70 mm Hg,

– Diastolic blood pressure (DBP)> 150 or < 40 mm Hg,

– Pulse pressure (PP) > 150 or < 20 mm Hg,

– Heart rate (HR)> 200 or < 20 per minute.

Also ABPM data series were considered invalid for analysis in the following cases:

– Absence of ≥ 30 % of the scheduled measurements,

– Lack of data for > 2 consecutive hourly intervals,

– If patient maintained an irregular rest-activity schedule during consecutive 24-h periods of monitoring,

– If the nighttime sleep span was < 6 h or > 12 h [6].

To define the daily profile the nocturnal BP dip was quantified as the relative decline in mean BP from awake (daytime) to asleep (night-time) periods, and was calculated for SBP, DBP and PP separately using the following equation: ((mean awake BP – mean asleep BP) / mean awake BP) × 100 %. Depending on the value of this ration the following types of daily BP profile were defined: «dipper» – physiological decrease in BP during the night – sleep-time relative BP decline 10–20 %; «over dipper» – an excessive fall in BP at night, sleep-time relative BP decline > 20 %; «non dipper» – the lack of BP reduction at night, sleep-time relative BP decline < 10 %; «night-peaker» – night-time BP more than during daily activity, sleep-time relative BP decline < 0 [6].

HRV evaluation was carried out after exclusion of artifacts and arrhythmias. From the daily ECG record, 5-minute intervals were allocated, in the morning, during rest period, according to the patient diary. Frequency analysis method was used, and included the following parameters: total power (TP), low frequency (LF) (0.04–0.15 Hz), very low frequency (VLF) (0.003–0.04 Hz) and high frequency (HF) (0.15–0.4 Hz) components, the ratio LF/HF (index of the sympathovagal balance) [7]. Patients were divided into 4 groups according to the type of daily SBP profile and 4 groups – according to the type of daily DBP profile. For each group mean (M) and standard deviation (sd) were calculated. HRV parameters were compared in patients with pathological types of BP daily profile o – non dipper, night-picker and over dipper – with the physiological type – dipper – in accordance with the selected ABPM index, as well as in pairs in the groups of SBP and DBP profiles, and in healthy subjects. Software Statistical Package for Social Sciences (SPSS) was used for data analysis. For variables with asymmetric distribution in addition to M and sd median (Me) and 25^{th} and 74^{th} percentiles were reported. Statistical significance of the differences between the obtained results and recommended standards was calculated based on the t-test for the case of 2 different samples with known standard deviations (TP, HF, LF) and for the known population mean (LF/HF). Student's t-test was reported for variables having normal distribution (LF/HF), whereas Mann-Whitney's U-test was reported for variables having asymmetric distribution (TP, HF, LF, VLF).

RESULTS AND DISCUSSION

SBP profile of «dipper» type was set in 39 % of patients, «non dipper» – 43 %, «night-piker» – 10 %, «over dipper» – 8 %. DBP daily profile of «dipper» type was defined in 36 % of cases, «non dipper» – 29 %, «night-piker» – 4 %, «over dipper» – 31 %.

The total power of the HRV (TP) was lower than the recommended values in all groups of BP profile, except the group of non-dippers, in

which TP slightly exceeded the normal values in both subgroups – SBP-non-dipper and DBP-non-dipper (Table). Statistically significant differences were found in comparison with the recommended standards in all investigated HRV domains. In all BP daily profile subgroups, the power of the high-frequency and low-frequency components were significantly lower than the normal values. The lowest values of HF and LF were observed in the group of SBP-night-pickers (Table). VLF values in all groups were higher than normal, in subgroups of SBP-dippers, SBP- and DBP-non dippers, DBP-over dippers these differences were statistically significant at the level of $p < 0.05$ (Table). The index of the sympathovagal balance exceeded the recommended standards also. Differences were found to be statistically significant in all groups, except for DBP-night-pickers and DBP-over diapers (Table).

Table

HRV parameters in patients with AH dependently of BP daily profile, M ± sd

		TP	*HF*	*LF*	*VLF*	*LF/ HF*
SBP	dipper	2612 ± 3728	118 ± 140*	448 ± 480*	1145 ± 1104*	4,47 ± 2,31*
	non dipper	3794±3244	300±476*	684±788*	1551±1501*	3,19±1,68*
	night-picker	2110±2436	92±61*	356±330*	950±1130	3,5±1,38*
	over dipper	2560±2466	292±383*	448±321*	864±575	3,56±2,26*
DBP	dipper	3240±4201	212±344*	612±772*	1263±11774	3,52±1,45*
	non dipper	3724±3300	277±479*	579±660*	1540±1644*	3,48±1,82*
	night-picker	2508±1619	147±73*	432±286*	1036±618	3,03±2,05
	over dipper	2396±2127	161±231*	443±368*	1092±985*	4,3±2,73
recommended standards		3466 ± 1018	975 ± 203	1170 ± 416	765± 410	1.5 – 2.0

When comparing HRV parameters in pairs in the subgroups of BP daily profile types there were no statistically significant differences in TP. When comparing the physiological type of BP daily profile – dipper – with pathological ones, the TP in the subgroup of SBP-non dippers was statistically significantly higher than that in the subgroup of SBP-dippers (Figure 1).

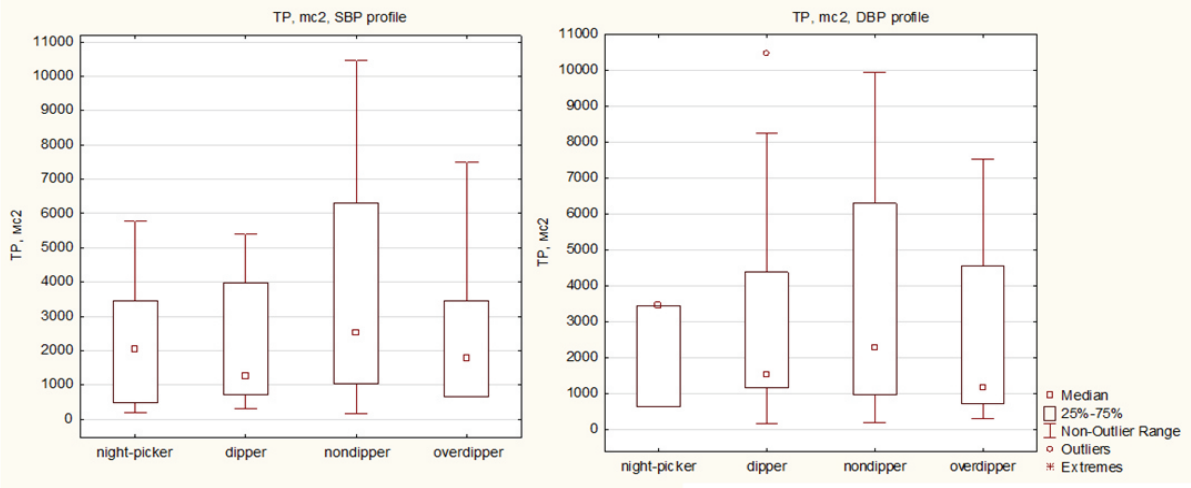

Fig. 1. The total power (TP) of the HRV, depending on the type of daily profiles of SBP and DBP

When comparing HF in pairs in subgroups of BP daily profile types, no significant differences were found. When comparing the pathological types of BP daily profile with the dipper type in the groups of non-dippers and over dippers a greater degree of scattering was noted, and the HF value in the subgroup of SBP-non dippers was significantly higher than that in the subgroup of SBP-dippers at a level of $p < 0.05$ (Fig. 2).

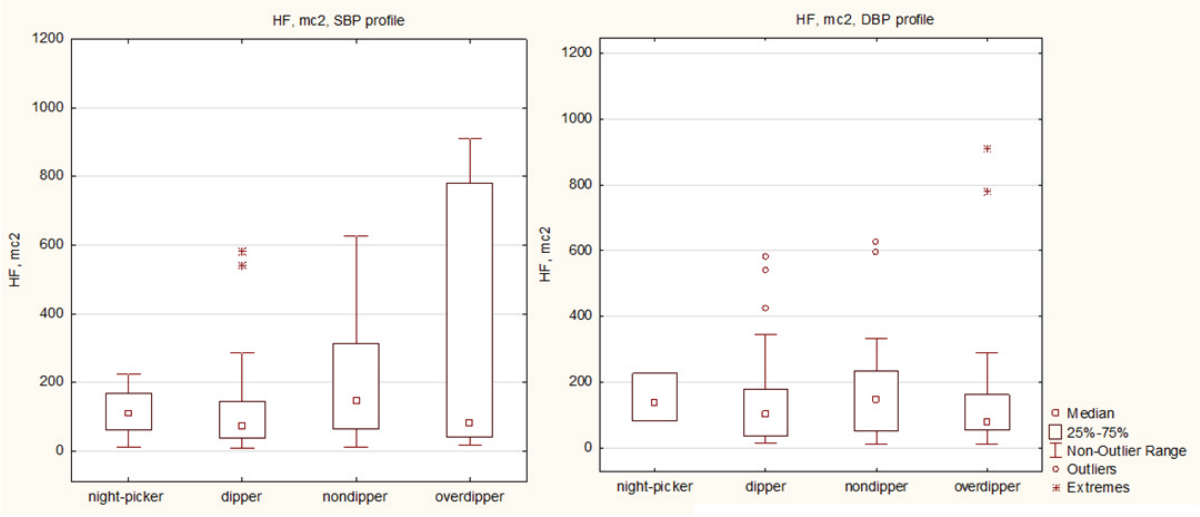

Fig. 2. The high-frequency component (HF) of the HRV, depending on the type of daily profiles of SBP and DBP

When comparing the powers of LF and VLF in pairs in the subgroups of BP daily profile types, and comparing the values of these parameters of pathological types of BP daily profile with the type dipper, no significant differences were found (Fig. 3, 4).

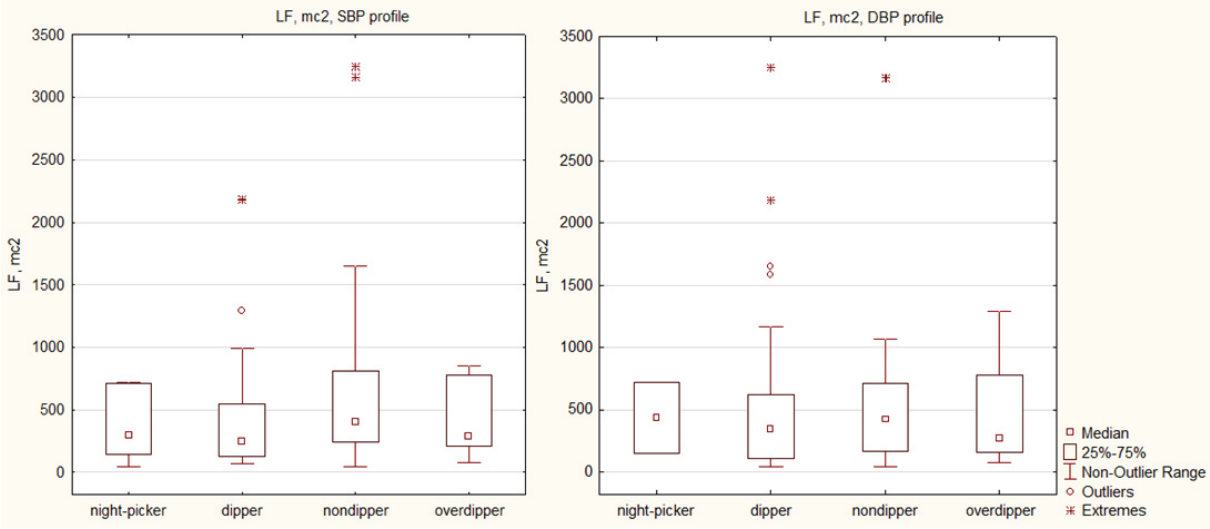

Fig. 3. The low-frequency component (LF) of the HRV, depending on the type of daily profiles of SBP and DBP

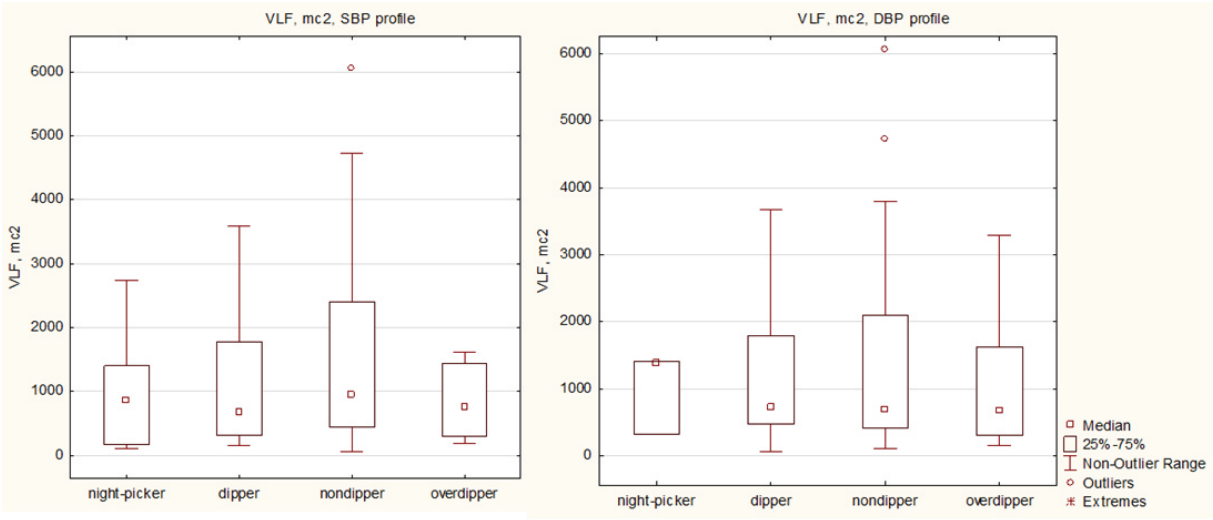

Fig.4. The very low-frequency component (VLF) of the HRV, depending on the type of daily profiles of SBP and DBP

The obtained results in general do not differ from those presented by other authors [8–9]. The analysis of our data confirms that in patients with AH the total power of the HRV decreases, primarily due to the HF component. However, there appears to be no data on HRV particular qualities in patients with AH, dependently of BP profile. The differences we found in HRV parameters in patients with AH in groups of BP daily profile types can be explained by the predominance of the sympathetic branch of regulation in the formation of pathological types of SBP and humoral factors predominance in the formation of pathological types of DBP.

CONCLUSIONS

1. Changes in HRV in patients with AH present with decreased total power with a violation in the ratio of the very low, low and high frequency components, enhanced sympathetic tone and influence of humoral factors.

2. Disorders of SBP daily profile are mainly characterized by increased low frequency component, which indicates an increase in sympathetic and a decrease in parasympathetic influences. Disorders of DBP daily profile present with a relative increase in the power of very low frequency component, which indicates an increased humoral influences.

PROSPECTS FOR FUTURE STUDIES

It seems appropriate to study the HRV changes in hypertensive patients with different types of daily BP profile with the use of antihypertensive drugs of different pharmacological groups.

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