ORIGINAL ARTICLE

CONTENTS

Interrelation of daily blood pressure profile with left ventricular myocardial hypertrophy in men of working age with hypertension

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ABSTRACT

Aim: To analyze the relationship between daily blood pressure biorhythms and left ventricular myocardial hypertrophy in working-age men with arterial hypertension.

Materials and Methods: Fifty-seven men with AH (mean age: 44.6±1.3 years) underwent Echo-CG and daily ABPM. Non-dipper and night-peaker patterns indicated BP biorhythm disturbances, while normal dipper and over-dipper patterns indicated undisturbed BP biorhythms. LVH was defined as LMMI > 115 g/m^2.

Results: About 60% of participants exhibited diurnal BP rhythm disorders, with a higher prevalence of LVH in this group compared to those with normal BP biorhythms (32% vs. 22%, p>0,05). Patients with normal daily BP biorhythms had significantly higher circadian indices of HR, systolic and diastolic BP, and double product compared to those with disturbed BP rhythms.

Conclusions: In young men with "non-dipper" and "night-peaker" patterns, LVH appears to be more pronounced than in those with normal daily BP biorhythms. This approach may optimize the timing of antihypertensive drug administration.

KEY WORDS: arterial hypertension, daily blood pressure profile, left ventricular hypertrophy

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INTRODUCTION

According to the WHO, the age-standardized mean prevalence of arterial hypertension (AH) among adults aged 30-79 years was 34% among men and 32% among women [1]. Hypertension increases the risk of cardiovascular complications, especially in young men, as they have a 99% higher risk of stroke compared to men with normal blood pressure, and a 10/5 mm Hg reduction in systolic and diastolic blood pressure, respectively, reduces the risk of cardiovascular events by 20% [2].

According to the results of the CARDIA subanalysis conducted in the United States, the presence of hypertension in young people increases the risk of cardiovascular disease by 8 times compared to people with normal blood pressure [3]. Daily blood pressure monitoring (DBP) in patients with arterial hypertension (AH) provides additional and important data, such as the state of nighttime BP reduction, the amount of morning rise, assess the circadian variability of BP and determine the daily BP profile. Identifying the relationship between the daily BP profile and target organ damage is important because each of the four markers of organ damage (left ventricular hypertrophy (LVH), microalbuminuria, increased pulse wave velocity, and carotid plaques) is an independent predictor of cardiovascular mortality [4].

ABPM has certain advantages over office BP measurement, namely, better reproducibility of average BP values over 24 hours, more accurate prediction of target organ damage, therapy outcomes, mortality, and the ability to identify white-coat hypertension (WCH) and masked hypertension. It is important for a doctor to identify patients with a disturbed daily blood pressure profile, namely non-dipper and night-peaker, which are considered pathological, because such patients are at a much higher risk of developing cardiovascular diseases and their complications.

AIM

The aim of the study was to identify and analyze the relationships between the parameters of daily blood

Table 1. The structure of the distribution of patients in groups without violations of daily blood pressure biorhythms and with violations of daily blood pressure biorhythms, depending on the presence of left ventricular hypertrophy

Total group, n=57			
Group without disturbances in the diurnal rhythm of blood pressure, n=23		**Group with disorders of the diurnal rhythm of blood pressure, n=34**	
Patients with left ventricular hypertrophy, n=5	Patients without left ventricular hypertrophy, n=18	Patients with left ventricular hypertrophy, n=11	Patients without left ventricular hypertrophy, n=23
8,8%	31,6%	19,3%	40,4%

Table 2. Proportion of patients with LVH in groups with normal and disturbed BP biorhythms

Group with normal daily BP biorhythms		Group with disturbed daily BP biorhythms	
Have a LVH – 21,7%	Do not have LVH – 78,3%	Have a LVH – 32,4%	Do not have LVH – 67,6%

pressure biorhythms and indicators of left ventricular myocardial hypertrophy in men of working age with hypertension who have different types of daily blood pressure profile.

MATERIALS AND METHODS

The subject of the study was 57 men of working age with arterial hypertension of I and II degree, the average age of which was 44.6 ± 1.3 years (M±m).

All patients underwent a general clinical examination, which included echocardiography and daily blood pressure monitoring. The blood pressure biorhythms were studied by means of daily ambulatory blood pressure monitoring, which was performed using blood pressure monitors VAT-41 (IMESK, Ukraine) and the ABP-Pro program. The following daily blood pressure patterns were considered to be disturbances of the daily blood pressure biorhythm: non-dipper and night-peaker. An undisturbed biorhythm was considered to be one that belonged to the categories of normal dipper and over-dipper. For heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP), and for the double product (HR*BP), their circadian indices (CI) were calculated as the ratio of the mean daytime to the mean nighttime value. Left ventricular myocardial hypertrophy (LVH) was assessed by the left ventricular myocardial mass index (LVMI), which was determined by echocardiography (Philips EPIQ Elite). The criterion for the presence of LVH was considered to be a value of LMMI > 115 g/m^2 [5].

Statistical processing of the data was performed using the SPSS-21.0 program. The mean group values (M) and their errors (m) were calculated. The analysis of the reliability of differences between the mean group values was performed using Student's T-test for independent samples. The reliability of differences between proportions within groups was assessed using Student's T-test (the reliability of differences between the mean values of binary variables in two groups was assessed) and Pearson's Chi-square test. To confirm the hypothesis about the difference in proportions, the level of reliability of the values of the criteria used was chosen at the level of $p<0.05$. Linear (Pearson's linear correlation coefficient, R) and rank correlation (Spearman's rank correlation coefficient, R_{sp}) were used to study the relationship between the indicators.

RESULTS

THE STRUCTURE OF THE DISTRIBUTION OF PERSONS IN GROUPS

To investigate the association between BP biorhythm disturbances and left ventricular myocardial hypertrophy (LVH), the total group was divided, according to the indicators of daily monitoring, on a binary basis, into those with BP biorhythm disturbances and those without them. After the first binary division, a second binary division was performed in each of the obtained subgroups (with unimpaired and impaired BP biorhythms) based on the presence or absence of LVH (according to echo-CG). The result of the division is shown in Table 1.

Individuals with diurnal BP rhythm disorders accounted for about 60% of the total sample, and those without diurnal BP rhythm disorders accounted for about 40%.

The next step in analyzing the internal structure of the groups was to determine the proportion of patients with left ventricular hypertrophy within each of the two groups, with normal and disturbed daily BP biorhythms (Table 2, Fig. 1, Fig. 2).

The proportion of patients with LVH in the group with disturbed diurnal BP rhythm was almost 1.5 times higher (32 vs. 22%) than in patients with normal BP biorhythm, however, these differences were not sig-

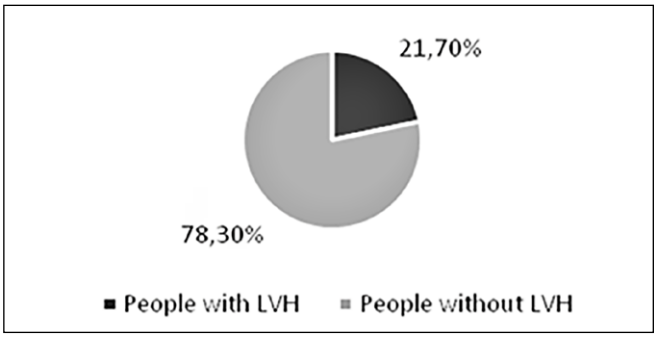

Fig. 1. Specific proportion of people with LVH in the group with preserved daily BP biorhythms.

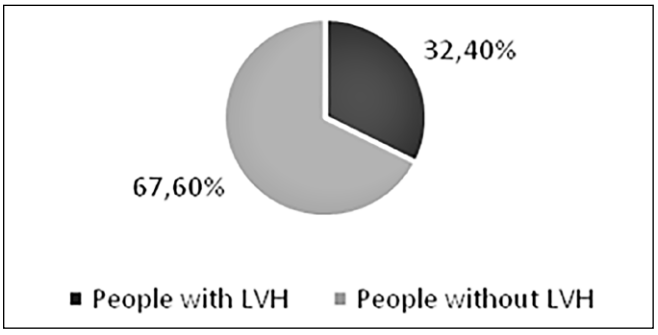

Fig. 2. Specific proportion of people with LVH in the group with disturbed daily BP biorhythms.

nificant (Student's t test = - 0.865; p = 0.391; Pearson's Chi-square test = 0.765; p = 0.382), which may indicate only a trend. Such a lack of distinct differences in the structure of the groups may be due to the fact that our study involved men of relatively young age, with a short history of hypertension, when LVH had not yet significantly formed. Thus, the observed tendency to increase the proportion of patients with LVH in the group with disturbed daily BP biorhythms is in favor of the negative impact of these BP rhythm disturbances on the development of structural heart disease.

AVERAGE GROUP INDICATORS

Analyzing the mean group values of anthropometry, daily blood pressure monitoring and echo-CG in groups of patients with normal and disturbed blood pressure biorhythms (Table 3), the following can be noted.

While heart rate, blood pressure, double product, area under the graph of both systolic and diastolic pressure, as well as the AASI vascular stiffness index, echocardiographic parameters did not differ significantly between the groups of patients with normal and disturbed daily blood pressure biorhythm, circadian indices, on the other hand, revealed significant differences. Thus, in patients with a normal daily BP biorhythm, circadian indices of heart rate, systolic and diastolic pressure, and double product were significantly higher than in the group of patients with a disturbed BP rhythm. In cardiology practice, at present, the indicators of cardiovascular functioning biorhythms in people with hypertension cover only circadian changes in systolic and diastolic blood pressure. At the same time, clinical classifications do not take into account the circadian fluctuations of heart rate and the calculated index – the double product, which is an approximate equivalent of the mechanical work of the heart [6]. It is interesting to note that in the group of individuals with disturbed daily biorhythms, calculated using circadian systolic and diastolic pressures, significantly lower values of circadian indices of heart rate and double product are additionally noted. This highlights the importance of taking into account in the clinical assessment of hypertension biorhythms not only the mechanical component of the heart, which is associated with overcoming vascular resistance and is expressed in blood pressure, but also the circadian biorhythm of the chronotropic function of the sinus node, assessed by the instantaneous heart rate.

The correlation analysis between age, daily blood pressure monitoring, anthropometry, and echo-CG revealed the following. In the group of patients with disturbed diurnal BP biorhythm and absence of LVH, a significant positive correlation between mean daily heart rate and LVMI was found ($R_{Sp.}$ = 0,417; p = 0,048). In the group of patients with disturbed diurnal blood pressure biorhythm and the presence of LVH several strong correlations were found. In particular, there was a negative relationship between age and left ventricular ejection fraction (R = -0,705; p = 0,015; $R_{Sp.}$ = -0,703; p = 0,016). A positive correlation of body mass index was noted simultaneously with several Echo-CG parameters characterizing LVH - with the left ventricular myocardial mass index (R = 0,686; p = 0,020), with the thickness of the interventricular septum ($R_{Sp.}$ = 0,690; p = 0,019), with the thickness of the left ventricular posterior wall ($R_{Sp.}$ = 0,636; p = 0,036). The circadian indices of systolic and diastolic pressure revealed strong significant negative correlations with the indicators characterizing left ventricular hypertrophy. Thus, the circadian index of systolic pressure was negatively correlated with the index of left ventricular myocardial mass ($R_{Sp.}$ =-0,673; p = 0,023). And the circadian diastolic pressure index had strong negative correlations with the thickness of the interventricular septum ($R_{Sp.}$ =-0,731; p = 0,011) and the thickness of the left ventricular posterior wall ($R_{Sp.}$ =-0,636; p = 0,036).

DISCUSSION

We found that, according to the data of daily blood pressure monitoring, 60% of men of working age with

Table 3. Average group values of indicators

Indicator	Persons with a normal blood pressure biorhythm	Persons with disturbed blood pressure biorhythm
Age, yrs.	42,1 ± 3,5	40,0 ± 2,1
Body mass index (BMI)	28,03 ± 1,12	29,80 ± 0,89
HR per 24h, /min	76,40 ± 1,91	78,96 ± 1,90
HR per day, /min	83,60 ± 2,07	84,26 ± 2,12
HR per night, /min	62,93 ± 2,11	68,87 ± 1,91
Circadian heart rate index	1,34 ± 0,04	1,23 ± 0,03 *
Systolic blood pressure per 24h, mmHg	127,9 ± 2,6	126,6 ± 2,8
Systolic blood pressure per day, mmHg	134,3 ± 2,8	129,2 ± 2,7
Systolic blood pressure per night, mmHg	115,7 ± 2,5	121,4 ± 2,9
Circadian index of systolic blood pressure	1,16 ± 0,01	1,07 ± 0,01 **
Diastolic blood pressure per 24h, mmHg	79,7 ± 2,3	78,2 ± 2,3
Diastolic blood pressure per day, mmHg	85,5 ± 2,4	81,3 ± 2,2
Diastolic blood pressure per night, mmHg	68,9 ± 2,0	72,4 ± 2,5
Circadian index of diastolic blood pressure	1,24 ± 0,02	1,13 ± 0,02 **
Double product per 24h	9801 ± 362	10015 ± 358
Double product per day	11263 ± 432	10880 ± 351
Double product per night	7296 ± 313	8424 ± 379
Circadian index of the double product	1,56 ± 0,05	1,31 ± 0,03 **
Systolic blood pressure area per day	5,81 ± 1,50	4,38 ± 1,44
Systolic blood pressure area per night	3,58 ± 1,22	7,13 ± 2,07
Diastolic blood pressure area per day	6,00 ± 1,28	4,33 ± 1,04
Diastolic blood pressure area per night	3,75 ± 1,09	7,23 ± 1,72
Systolic blood pressure area per 24h	5,05 ± 1,37	5,32 ± 1,64
Diastolic blood pressure area per 24h	5,23 ± 1,19	5,31 ± 1,24
AASI	0,36 ± 0,04	0,36 ± 0,03
Max daytime systolic blood pressure, mmHg	171,5 ± 6,3	161,9 ± 4,0
Max daytime diastolic blood pressure, mmHg	113,0 ± 3,5	109,5 ± 2,6
Max nighttime systolic blood pressure, mmHg	135,5 ± 3,2	148,2 ± 7,9
Max nighttime diastolic blood pressure, mmHg	85,3 ± 2,4	99,1 ± 8,4
left ventricular ejection fraction, %.	60,7 ± 1,4	60,7 ± 0,9
stroke volume, ml	68,1 ± 3,5	72,4 ± 1,8
minute volume, l/min	4,9 ± 0,5	5,4 ± 0,2
thickness of the interventricular septum, cm	1,23 ± 0,07	1,25 ± 0,03
left ventricular posterior wall thickness, cm	1,09 ± 0,04	1,12 ± 0,02
mass of the left ventricular myocardium, g	219,9 ± 16,5	228,4 ± 8,9
left ventricular myocardial mass index (LVMI), g/m^2	103,2 ± 6,4	104,5 ± 3,3

Notes: * – significance of differences in mean group values at the level of $p < 0.05$; ** – significance of differences in mean group values at the level of $p < 0,01$.

hypertension had pathological blood pressure profiles of the "non-dipper" and "night-peaker" types. The relationship between disturbed blood pressure biorhythms and myocardial hypertrophy revealed in the study was manifested in a 1.5-fold increase in the proportion of patients with LVH in the group with disturbed daily blood pressure biorhythms compared with the group with normal blood pressure biorhythms.

In addition, in the group of patients with a combined disorder of the daily blood pressure biorhythm with LVH, this relationship was manifested by a strong negative correlation of circadian blood pressure indices with indicators of left ventricular myocardial hypertrophy. In patients with concomitant disturbance of daily BP biorhythms with LVH, a negative correlation of age with LVEF is also noted, which may indirectly indicate

accelerated functional aging of the cardiovascular system. The presence of positive correlations of body mass index with LV wall thickness and LVMI may indicate its prognostic value in relation to the development of structural heart lesions in hypertension.

Based on our experimental data, there is reason to believe that circadian indices of heart rate, systolic and diastolic blood pressure, and the double product are sensitive markers of the prognosis of left ventricular myocardial hypertrophy. And this sensitivity is especially high in patients with a combination of disturbances in the daily BP biorhythm with LVH. Further studies are needed to clarify the prognostic significance of the above circadian hemodynamic indices in relation to the progression of LVH and the course of hypertension.

According to the results of scientific studies, the daily blood pressure profiles of "non-dipper" and "night-peaker" are associated with a significant number of negative factors, including damage to target organs – left ventricular hypertrophy, thickening of the intima-media complex, progressive decrease in renal function, cognitive impairment, and increased risk of all-cause and cardiovascular mortality [10]. And the detection of signs of LV remodeling and, in particular, LVH in patients with hypertension is associated with a higher incidence of angina pectoris, myocardial infarction (MI), ventricular arrhythmias, heart failure and a decrease in LVEF, aortic root dilatation, peripheral arterial disease, cerebrovascular and renal complications, cardiovascular and sudden cardiac death (SCD).

The increased risk of complications depends not only on the level of blood pressure (BP), but is associated with the degree of LV hypertrophy [7-10]. The correlation between LV mass and blood pressure, especially office blood pressure, is usually weak. The average daily pressure fluctuations are more correlated with LV mass (Rosei E., Muiesan M., 2017). The presence of LVH is one of the risk factors for resistant hypertension. In people with LVH, cardiovascular complications occur 2-4 times more often than in people without LVH, regardless of other risk factors [11, 12].

The analysis of the degree of heart damage in young and middle-aged men with hypertension performed in our study confirms the results of those studies that indicate the importance of changes in the circadian rhythm of blood pressure on the damage to target organs already at the initial stages of this disease.

CONCLUSIONS

Thus, young men with hypertension should be examined with ABPM to determine the daily BP profile. According to the results of the study, we have reason to believe that in young men with pathological daily BP profile ("non-dipper" and "night-peaker"), heart damage in the form of left ventricular myocardial hypertrophy tends to be more pronounced than in individuals with normal daily BP biorhythms. The proposed diagnostic approach, which takes into account the factor of the presence of disturbances in the daily rhythm of blood pressure and heart rate, allows to obtain additional information on the prognosis of the disease and to optimize the choice of the time schedule for the administration of antihypertensive drugs. The presence of LVH and pathological blood pressure profile are important criteria for a high risk of cardiovascular complications in patients with hypertension and indicate the feasibility of more aggressive treatment of such patients.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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