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Abstract **УДК 616.12-008.331.1:613.25**

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THE DEPENDENCE OF THE PARAMETERS OF DAILY BLOOD PRESSURE MONITORING ON BODY MASS INDEX IN PATIENTS WITH ARTERIAL HYPERTENSION

In the XXI century, the problem of overweight and obesity affects the formation of cardiovascular risk becomes increasingly relevant. Arterial hypertension (AH) combined with common risk factors such as dyslipidemia, obesity, hypodynamia, smoking, diabetes mellitus (DM) causes at least 70–75% of stroke, 80–90% of myocardial infarctions, leading to premature disability and mortality of patients. The aim of the study was to study the relationship between the daily profile of blood pressure with BMI in patients with hypertension in stage 2.

Materials and methods. 120 persons with AH stage II were screened and divided into 2 groups according to body mass index (BMI). 60 patients with BMI 18–25 kg/m^2 belonged to the Ist group and 60 patients with BMI ≥ 25 kg/m^2 belonged to the IInd group. All patients had general-clinical, anthropometric studies with measurements of height, body weight, body mass index (BMI), daily blood pressure monitoring.

Results and discussion. According to the daily profile of blood pressure, among the patients of both groups revealed: "dippers" – 43 (35.8%), non-dippers – 71 (59.2%), "over-dippers" – 2 men (1.7 %), "night-payers" – 4 people (3.3%). In the group with BMI 18–25 kg/m^2, 53.3% of the patients had a physiological rhythm, 43.3% of patients had the phenomenon of "non-dippers". At the same time, among 80% of patients in the BMI group ≥ 25 kg/m^2 had an adverse profile of non-dippers (73.3%) and 6.7% had night-hypertension “night-peakers”. Determination of the time index of hypertension showed that, the average daily level of systolic blood pressure (SBP) in group II is 1.3 times as much as in group I ($p < 0.05$). It is important that the increase in the daily level of diastolic blood pressure (DBP) in group II was 1.6 times higher than that of group I, and also significantly exceeded the level of SBP in group II ($p < 0.05$). And it was also found that patients in group II had significantly increased the speed of morning rise of SBP and DBP in comparison with the Ist group of patients ($p < 0,05$). Conclusions. In patients with hypertension in stage 2 and BMI > 25 kg/m^2, 73.3% of non-dippers were found, and 6.7% of those with night-hypertension were night-peakers. This significantly exceeds the rates of patients with hypertension in stage 2 without excess weight. Patients with stage 2 of hypertension and obesity had significantly higher values of

systolic and diastolic blood pressure, the time index of blood pressure, and the onset of elevated blood pressure compared with those with BMI < 25 kg/m^2.

Keywords: hypertension, obesity, daily blood pressure profile, time index of blood pressure, morning rise of blood pressure.

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Резюме

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ЗАЛЕЖНІСТЬ ПОКАЗНИКІВ ДОБОВОГО МОНІТОРИНГУ АРТЕРІАЛЬНОГО ТИСКУ ВІД ІНДЕКСУ МАСИ ТІЛА У ХВОРИХ НА АРТЕРІАЛЬНУ ГІПЕРТЕНЗІЮ 2 СТАДІЇ

У XXI столітті все більш актуальною стає проблема впливу надмірної ваги та ожиріння на формування серцево-судинного ризику. Артеріальна гіпертензія (АГ) в поєднанні з поширеними чинниками ризику, таких як дисліпідемія, ожиріння, гіподинамія, паління, цукровий діабет (ЦД), стає причиною не менше ніж 70–75% інсультів, 80–90% інфарктів міокарда , що призводять до передчасної інвалідизації та смертності пацієнтів. Метою дослідження було вивчення взаємозв'язку показників добового профілю артеріального тиску (АТ) з індексом маси тіла (ІМТ) у хворих на АГ II стадії. Матеріали і методи. Обстежено 120 осіб з АГ II стадії, які були поділені на 2 групи за індексом маси тіла (ІМТ): I групу склали пацієнти із ІМТ 18–25 кг/м^2, II групу – пацієнти з ІМТ ≥ 25 кг/м^2. Усім пацієнтам проводили загальноклінічні, антропометричні дослідження з вимірюванням росту, маси тіла, обчисленням ІМТ, добове моніторування АТ.

Результати та їх обговорення. За добовим профілем АТ серед пацієнтів обох груп виявлено: «dippers» – 43 чоловік (35,8%) , «non-dippers» – 71 чоловік (59,2%), «over-dippers» – 2 чоловіка (1,7%), «night-peakers» – 4 чоловік (3,3%). У групі з ІМТ 18–25 кг/м^2 53,3 % хворих мали збережений фізіологічний ритм, 43,3 % хворих мали феномен «non-dippers», в той же час як серед 80 % пацієнтів групи ІМТ ≥ 25 кг/м^2 мали несприятливий профіль АТ – «non-dippers» (73,3%) та у 6,7% - реєструвалась нічна гіпертензія «night-peakers». Визначення індексу часу (ІЧ) гіпертензії показало, що у пацієнтів II групи середній добовий рівень систолічного артеріального тиску (САТ) у 1,3 рази більше порівняно з I групою ($p<0,05$). Звертає увагу, що підвищення добового рівня ДАТ у II групі в 1,6 рази перевищувало значення в I групі ($p < 0,05$). Також виявлено, що хворі II групи мали достовірно збільшену швидкість ранкового підйому САТ та ДАТ порівняно з I групою хворих ($p < 0,05$). Висновки. У пацієнтів з АГ II стадії та ІМТ > 25 кг/м2 виявлено 73,3% чоловік «non-dippers», та 6,7 % чоловік з нічною гіпертензією – «night-peakers», що значно перевищує показники хворих на АГ II стадії без надлишкової маси . Хворі на АГ II стадії та ожирінням мали достовірно вищі значення систолічного та діастолічного АТ, індексу часу АТ, вранішнього підйому АТ порівняно з хворими ІМТ < 25 кг/м^2.

Ключові слова: артеріальна гіпертензія, ожиріння, добовий профіль артеріального тиску, індекс часу АТ, вранішній підйом АТ.

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Introduction

Arterial hypertension (AH) is the most common cardiovascular disease (CVD) and belongs to "diseases of a civilization". CVD causes approximately 17 million deaths per year, nearly a third of the world's total deaths [1]. As of 01.01.2014, 12 153 040 patients with hypertension are registered in Ukraine, which is about a third of the adult population [2].When combined with common risk factors such as dyslipidemia, obesity, physical inactivity, smoking, diabetes mellitus (DM), AH is the cause of at least 70–75% of strokes, 80–90% of myocardial infarctions, which is the main risk factor for many cardiovascular complications that lead to premature disability and mortality of patients. AH significantly increases the risk of kidney damage, stroke, heart failure (HF), peripheral vascular disease and cardiovascular death [3; 4].

In the XXI century, the problem of excessive weight and obesity, as well as their impact on the formation of cardiovascular risk becomes more urgent. Obesity was recognized by the World Health Organization (WHO) as a new noninfectious "epidemic" of our time [3; 6]. According to WHO data, more than 30% of the world's population has excessive body weight (EBW), among them 16.8% are women and 14% are men. In Ukraine in 2011, 30% of the adult population and 10% of children had EBW (among them 50.5% were men, 56% were women), of which about 20% were obese. In 2014, 39% of people aged 18 and over had EBW and 13% were obese [3; 8]. European guidelines for CVD prevention, 2012, indicate that EBW and obesity are associated with the risk of death from CVD. There is a direct positive relationship between body mass index (BMI) and all-cause mortality, the lowest all-cause mortality rate is observed at a BMI of 20–25 kg/m^2, and further weight loss has no positive effect on the risk of CVD [9]. It was found that the incidence of AH in obesity is 75%, type 2 diabetes mellitus (DM) – 57%, coronary heart disease (CHD) – 20% [7]. The combination of AH, obesity and dyslipidemia causes early development of atherosclerosis and atherothrombosis, which increases overall and cardiovascular morbidity and mortality [10].

There is a direct relationship between body weight and BP: EBW is associated with a 2–6-fold increase in the AH risk [11;15]. It is known that increase of BP by 20/10 mm Hg increases the risk of cardiovascular events twofold, and epidemiological studies have shown a relationship between BMI and BP [12]. According to the Framingham study, AH in 80% of men and 61% of women is associated with EBW. More than 85% of patients with AH have BMI ≥ 25 kg/m^2. An increase of body weight by 4.5 kg is accompanied by elevated systolic blood pressure (SBP) in men by 4.4 mm Hg, in women by 4.2 mm Hg [13]. In people, suffering from obesity, the risk of AH increases by 5 times compared to slim people, and in 2/3 of patients, increased BP is a direct consequence of excessive weight [14;15]. At the same time, a high initial BMI serves as an increase in the "normal" BP range and is associated with high AH risk. Thus, a third of people with normal BP and obesity developed AH after an average of 14.5 years [14]. A 7 year study, which included more than 300 000 adults, showed that an increase in BMI by 1 was associated with a 9% difference in the CHD incidence [16].

BP is a physiological integrating indicator with a distinct circadian rhythm. Elevated blood pressure is an important, but not the only factor, determining the prognosis of cardiovascular complications. Informative indicators are the BP variability, especially circadian rhythm, daily index, time index and rate of morning BP increase. These characteristics are established during the daily blood pressure monitoring (DBPM) [17]. DBPM has several advantages over office measurement (WHO/MTAG, 1999): DBPM data more accurately reflects BP in the normal life conditions of the patients; average BP values, obtained with DBPM, are more closely associated with lesions of target organs than clinical measurement data; DBPM data before treatment may have prognostic value in the development of cardiovascular complications; regression of the lesion of target organ is closely associated with changes in the average daily BP values than with the level of clinical BP. DBPM is the most informative method in the study of chronobiological changes in indicators, the assessment of which is necessary for the accurate interpretation of various clinical manifestations of the disease and determination of the effectiveness of prescribed treatment [17].

The objective of this study was to determine the dependence of the daily BP profile from BMI in patients with stage II AH.

Materials and methods.

The study involved 120 people with stage II AH aged from 26 to 75 years (average age is 51 years), of which 38.3% were men and 61.7% were women. Depending on BMI all patients were divided into 2 groups: Group I consisted of 60 people with a BMI of 23.1 ± 1.80 kg/m^2, group II consisted of 60 people with a BMI ≥ 31.5 ± 3.96 kg/m^2 ($p < 0.05$).

In total, there were 1.6 times more women, 45% were patients from 51 to 59 years old. Gender equality was observed in this age group. In the group of patients with BMI 18–25 kg/m^2, there were 60% men and 40% women, and in the group with BMI ≥ 25 kg/m^2 there were 2 times more women (68.3%). The gender structure of patients, obtained by us, coincides with epidemiological studies on EBW and obesity in Ukraine [3; 8].

Verification of the diagnosis, determination of the stage and degree of AH was conducted in accordance with the criteria of unified clinical protocol of primary, secondary (specialized) and tertiary (highly specialized) medical care No. 564 of the MOH of Ukraine (dated 13.06.2016) [2].

The exclusion criteria were patients with symptomatic AH, myocardial infarction or unstable angina, effort angina of the II–IV functional class, obesity in endocrinological diseases, diabetes mellitus, acute infectious diseases, exacerbation of chronic infectious diseases, neoplasms, mental disorders and diseases of the nervous system, systemic connective tissue diseases, acute cerebrovascular accidents, refusal to participate in the study.

All patients underwent general clinical, anthropometric examinations with measurement of height, body weight, calculation of BMI according to the Quetelet formula. The criteria for the distribution of patients according to BMI were in line with WHO recommendations (2009): BMI from 18.5 to 24.9 kg/m^2 was regarded as normal body weight, BMI from 25.0 to 29.9 kg/m^2 – as an excessive weight, BMI greater than 30.0 kg/m^2 – as obesity (I degree obesity – 30.0–34.9 kg/m^2, II degree – 35.0–39.9 kg/m^2, III degree obesity – more than 40 kg/m^2) [20]. DBPM was performed using the MAVRM 04 apparatus (MeditechLtd., Hungary), according to the standard protocol. BP was measured every 15 minutes during the day from 7 to 23 o'clock and every 30 minutes during the night, from 23 to 7 o'clock [17; 18]. The obtained data were subjected to computer analysis using a special program. Average values of daily systolic (SBP) and diastolic (DBP) BP; time index (TI) for SBP and DBP for active and passive periods (% of time during which the PB values exceed the critical level – 140/90 mm Hg for the daytime and 120/80 mm Hg for the nighttime BP); daily index (DI) were determined. The morning increase value (MIV) of SBP and DBP (from 5 to 10 o'clock) was calculated by the formula: BPMIV = BPmax – BPmin during this time interval [18]. BP DI was characterized as follows : patients with a 10–20% decrease in SBP during the nighttime were classified as "dippers", with a 10% decrease as "non-dippers", with a > 20% decrease as "over-dipper". In the presence of nocturnal hypertension (BP > 125/75 mm Hg) patients were referred to as "night-peakers" [17; 19]. Most researchers believe that investigation and changes in blood pressure at nighttime are more important and informative than BP in the daytime, for the prediction of fatal events and cardiovascular complications, namely left ventricular hypertrophy, microalbuminuria. And the presence of a persistent BP increase leads to the involvement of target organs in the pathological process [20].

The Statistica for Windows 6.0 software package was used for statistical data processing. At the first stage of calculation, descriptive statistics for the indicators, measured on a quantitative scale, were obtained. The probability of differences for comparison of mean values was determined using Student's t-test (p). The values of the studied parameters are given in the form of M ± m, where M is the arithmetic mean, m is the standard error. The differences were considered statistically significant at $p < 0.05$.

Study results and discussion

According to the daily BP profile in patients of both groups were revealed: "dippers" – 43 patients (35.8%), "non-dippers" – 71 patient (59.2%), "over-dippers" – 2 patients (1.7%), "night-peakers" – 4 patients (3.3%). Obtained data indicates that only one third (35.8%) of patients with AH retain the most favorable type of daily BP profile – "dippers".

Among group I patients (with BMI < 25 kg/m^2) the preserved physiological rhythm of "dippers" was revealed, 43.3% showed "non-dippers" profile, and 3.3% showed an excessive BP decrease at nighttime – "over-dippers", there were no patients with nocturnal hypertension. Among group II patients (with BMI > 25 kg/m^2) there were only 20% of patients with daily "dipper" rhythm, and there were 1.7 times more "non-dippers" (73.3%) compared to group I ($p < 0.05$). Nocturnal hypertension – "night-peakers" was observed in 6.7% of group II patients (Figure 1). Thus, in group I, with BMI within the normal range, more than half of the patients had a preserved physiological rhythm, and the vast majority (80 %) of group II patients (BMI > 25 kg/m^2) had an unfavorable BP profile – "non-dippers" (73.3%) and 6.7% showed nocturnal hypertension ($p < 0.05$).

Further analysis of the DBPM parameters related to SBP/DBP TI and the morning increase value of BP (MIV SBP/DBP). The results of these studies are shown in Table 1.

Table 1 – Indicators of daily monitoring in patients with stage II AH (M ± m)

Indicator		Group I (n= 60)	Group II (n= 60)	p
HR, bpm		76.2 ± 1.41	75.4 ± 2.49*	p >0.05
BP	SBP mm Hg	138.2 ± 3.24	147.6 ± 4.25*	p <0.05
	DBP mm Hg	88.4 ± 2.63	103.8 ± 3.64*	p <0.05
Time index	SBP day, %	53.4 ± 1.12	61.8 ± 1.28*	p <0.05
	DBP day, %	49.9 ± 1.62	57.06 ± 1.40*	p <0.05
Morning increase value, mm Hg	SBP mm Hg/h	54.4 ± 2.32	60.48 ± 1.26*	p <0.05
	DBP mm Hg/h	41.4 ± 2.23	46.2 ± 0.87*	p <0.05

Note: *– p<0.05 compared to group I patients with stage II AH with EBW

The result of determination of hypertension TI showed that in group II patients the average daily SBP and DBP level is significantly higher compared to group I patients ($p < 0.05$). It is noteworthy that the increase in the daily SBP level in group II was 1.2 times higher than in group I, namely, hypertension TI in group I was 53.4 ± 1.12, and in group II – 61.8 ± 1.28 ($p < 0.05$). Hypertension TI characterizes hyperbaric loads of target organs more accurately than average BP values and can be used to predict the personal risk of cardiovascular events in patients with stage II AH [20].

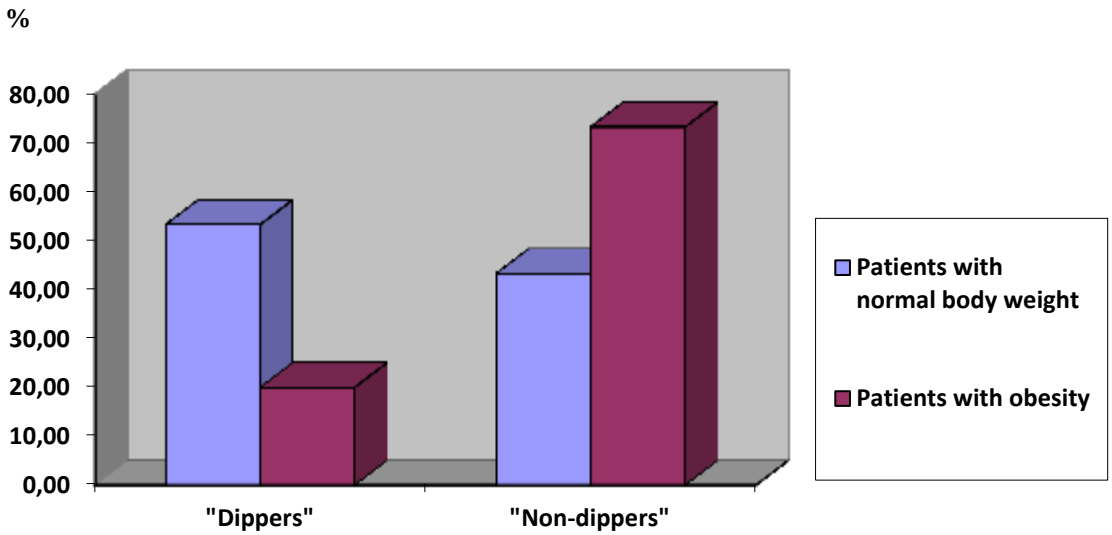

Figure 1 – Types of daily BP profile depending on BMI

It was also revealed that group II patients had significantly higher rate of morning SBP and DBP increase in comparison with group I patients ($p < 0.05$). The rate of morning SBP increase in group I is (54.4 ± 2.32) mm Hg vs (60.48 ± 1.26) mm Hg in group II and DBP is (41.4 ± 2.23) mm Hg vs (46.2 ± 0.87) mm Hg, respectively. It is known that the morning period is considered to be the time of "cardiovascular disasters", which is associated with the physiological activation of sympathoadrenal and renin-angiotensin-aldosterone systems and leads to increased vascular tone, decreased fibrinolytic properties of blood and activation of platelet aggregation properties, which leads to the development of myocardial infarction, sudden death, stroke in the morning, so increase of BP rate in the period from 4 to 10 am is considered as a starting mechanism for the development of complications [20].

Conclusions

1. In patients with stage II AH and obesity, 80% of patients with an unfavorable daily profile in terms of cardiovascular complications were identified, namely: 73.3% of patients with insufficient BP reduction at nighttime – "non-dippers", and 6.7% of men with night hypertension – "night-peakers", which significantly exceeds these figures among patients with AH with normal body weight.

2. Patients with stage II AH and BMI > 25 kg/m^2 had significantly higher values of systolic and diastolic BP, BP time index, morning BP increase compared to patients with normal body weight.

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