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Holter Monitoring Parameters in Assessment of Cardiovascular Risk in Patients with Hypertension and Obesity

S.V. Ivanchenko, O.M. Kovalyova and T.M. Pasiieshvili

Department of General Practice - Family Medicine and Internal Diseases of
Kharkov National Medical University
Address: 4 Nauki Avenue, Kharkiv, 61022, Ukraine

Abstract

The purpose of the study was to analyze the features of the Holter monitoring parameters and their significance in the evaluation of cardiovascular risk in patients with hypertension and obesity.

The Holter's was performed by 82 patients with hypertension aged 38 to 76 years (34 men and 48 women). The investigation was carried out on the diagnostic complex SDM 23 "X-TECHNO" in 24-hour. There were 4 groups of patients depending on the body mass index (BMI): 1st with normal body weight, 2nd - with overweight, 3rd - with obesity I degree, 4th - with obesity II-III degree.

Based on the results obtained, a combination of hypertension and overweight or obesity is characterized by changes in heart rate variability. This indicates a vegetative imbalance with a weakened activity of the parasympathetic part of the autonomic nervous system. These changes are manifested by a decrease in SDNN 24 and rMSSD, total spectrum power (TF) due to the HF component, an increase in the mean daily heart rate, and statistically significantly higher values of the vagosympathetic interaction index (LF/HF). Smoothing of the circadian rhythm of the heart in patients with hypertension depends on the presence and degree of obesity. The prolongation of the QT interval corrected for heart rate and the presence of ventricular rhythm disturbances of high grades recorded a statistically significantly larger number of individuals in the group of patients with obesity. These rhythm disturbances can be regarded as potentially malignant or malignant according to the risk stratification of J.T. Bigger.

Keywords: hypertension, obesity, cardiovascular risk, Holter monitoring, comorbidity

1. Introduction

The Holter monitoring is one of the most important methods for assessing the risk of sudden cardiac death and the development of life-threatening arrhythmias in patients at high cardiovascular risk groups. Hypertension, heart failure, heart attack, hypertrophic cardiomyopathy are the most common causes of life-threatening conditions development in cardiology [3]. However, in recent years, more and more data on the significance of other previously unknown factors, such as obesity, have appeared [6]. There is still no clear link between hypertension and the risk of sudden cardiac death. It has been established that hypertension is the most common cause of hypertrophy of the left ventricle (LV). Complex ventricular arrhythmias are more common in patients with hypertension and LV hypertrophy, which increases the risk of heart attack and sudden cardiac death [11]. At the same time, according to epidemiological observations, it has been shown that hypertension plays a disproportionate role in increasing the risk of sudden cardiac death. But, despite conducted randomized studies, there was no positive effect of decreasing blood pressure on the sudden cardiac death formation. This can be explained by a small number of patients and an insufficient risk of cardiac death [9]. That is, at present, this question, especially in the aspect of the comorbidity of hypertension, is not definitively defined and needs further study and refinement.

The purpose: to study the features of Holter monitoring parameters and their significance in cardiovascular risk assessment in patients with hypertension and obesity.

2. Materials and methods

Eighty-two patients (34 men and 48 women) with hypertension aged 38 to 76 years were examined. Verification of the diagnosis and determination of the degree of hypertension was carried out in accordance with the criteria (2013) recommended by the European Society for Hypertension (ESH)/European Society of Cardiology (ESC). The diagnosis of obesity was established according to the WHO classification (1998).

Patients were divided into 4 groups: 1st - 17 patients (9 men and 8 women) with normal body weight (average body mass index (BMI) was 22.75 (21,5;24,0) kg/m^2); 2nd - patients with excessive body weight (n = 26, 9 men and 17 women), BMI - 26.85 (25,84;27,60) kg/m^2; 3rd - 16 people with obesity I degree (6 men and 10 women), BMI – 32,44 (31,8;33,42) kg/m^2; 4th - patients with obesity II-III degree (n = 23, including 10 men and 13 women) with a BMI 39,51 (35,5;42,8) kg/m^2.

The Holter monitoring was carried out on the diagnostic complex SDM 23 "X-TECHNO" in 24-hour. The following parameters of Holter monitoring for the sudden cardiac death risk assessment were analyzed: heart rate variability (HRV) of the time domain is the average daily heart rate (heart rate, beats per minute); average RR interval, ms; SDNN (standard deviation of the average duration of all RR intervals, ms), SDANN (standard deviation of the average duration of RR intervals in 5-minute intervals, ms); SDNN index (average value of standard deviations of RR intervals, calculated on 5-minute intervals throughout the recording, ms); rMSSD (the square root of the sum of the squared values of successive pairs); pNN 50 (percentage of neighboring sinus intervals RR, which differ by more than 50 ms,%).

The spectral analysis was carried out to the following components of the HRV: High Frequency (HF, ms^2), Low Frequency (LF, ms^2), Very Low Frequency (VLF, ms^2), index of vagosympathetic interaction (LF/HF), and total power of the HRV spectrum (TF, ms^2).

The circadian index (CI) of the heart rate is calculated to estimate the daily dynamics of the heart rate in Holter monitoring. The presence and number of ventricular arrhythmias, the duration of the QT interval were analyzed.

Patients with oncological diseases, acute and chronic inflammatory processes, thyroid diseases, symptomatic hypertension and chronic heart failure of stage III were not involved in the study.

The statistical analysis of the data was carried out using the computer software package for the statistical information processing of Statistica 6.1 for Windows (Statsoft Inc., USA). The nonparametric Mann-Whitney statistical criterion and the Spearman rank correlation coefficient are used to compare independent samples. The quantitative characteristics are described by the median (Me), the values of the upper (UQ) and lower (LQ) quartiles of the sample. The critical level of significance in checking statistical hypotheses was $p<0,05$.

3. Results and discussion

The following indicators are used to assess the risk of sudden cardiac death in Holter monitoring: mean heart rate during the day, HRV, the presence, number and gradation of ventricular rhythm disturbances, and the duration of the QT interval. It has been shown that an increase in heart rate and low heart rate variability are independent risk factors for sudden cardiac death. The relationship between increased heart rate and sudden cardiac death was found in individuals with and without cardiovascular disease [9].

In our study, in assessing the average daily heart rate in patients with hypertension, a statistically significant increase in this parameter was observed in the groups with overweight and obesity: 78 (70;85) bpm. in patients with obesity II-III degree ($p = 0,004$) 77 (66;80) bpm. - with obesity of the I degree ($p = 0,01$) and 71 (67;76) bpm. in persons with excess body weight ($p = 0,04$), versus 67 (61;73) bpm. in patients with normal body weight. Intergroup analysis did not reveal any likely differences in overweight and obese groups. But the tendency to increase this indicator depending on the BMI was obvious, which is confirmed by the presence of a direct correlation between the mean daily heart rate and BMI ($r = 0,4$, $p < 0,05$).

The determination of average night and day heart rate values is an obligatory component of the protocol for the final conclusion of Holter monitoring. However, in view of the fact that the difference in the daytime and nighttime heart rate strongly depends on the initial values of heart rate (tendency to tachycardia or bradycardia), the heart CI is regarded as a more stable parameter as the ratio of average daily to average night heart rate [12]. So, according to Makarov L.M., in healthy subjects, the values of the heart CI do not have significant differences in gender and age, and range from 1,24 to 1,44. The circadian index reduction less than 1,2 is noted in diseases associated with autonomic "denervation" of the heart. This is associated with an unfavorable prognosis and a high risk of sudden death in patients at risk [5].

The most unfavorable values of the circadian index were determined in patients with hypertension and obesity of the 1st degree: 1,09 (1,0;1,17), which was significantly lower than in patients with normal body weight (1,19 (1,12;1,27), p = 0,03), overweight (1,16 (1,1;1,23), p = 0,04) and morbid obesity (1,15 (1,09;1,21), p = 0.03). It was found that all patients with obesity of the I degree had values of the heart rate below 1,2. This was significantly higher than in groups with normal body weight (64%, p = 0,003), overweight (69%, p = 0,004) and in obese patients of grade II-III (83%, p = 0,03).

Smoothing of the circadian heart rate profile in obese patients is considered a marker of the heart adaptive capacity depletion. This is clinically associated with an unfavorable prognosis and a high risk of arrhythmogenic syncopal conditions. Numerous studies have shown that changes in HRV parameters can be used as preclinical signs of cardiovascular diseases and development of cardiovascular complications [4]. Today's SDNN 24, SDANN 24 and SDNN index are the most informative in terms of cardiovascular risk assessment [10]. These are integral indicators of HRV, which depend on the activity of both departments of the autonomic nervous system and characterize the state of vegetative regulation in general. In turn, such HRV indices as rMSSD and pNN50 reflect the influence of the parasympathetic department of the autonomic nervous system and the severity of sinus arrhythmia.

According to the results of our study, the BMI increase in patients with hypertension was significantly associated with a decrease in the values of SDNN 24 and rMSSD and an increase in the average daily heart rate. This indicated a vegetative imbalance with a weakened activity of the parasympathetic part of the autonomic nervous system (Table 1).

Table 1.
Average values of HRV parameters of the temporary area in patients with hypertension depending on the presence and degree of obesity

Parameters	Hypertension	Hypertension and excess body weight	Hypertension and obesity grade I	Hypertension and obesity II-III degree
Average daily heart rate, bpm	66 (61;73)	75* (66;80)	72* (67;76)	80* (70;85)
Average interval RR, ms	873 (837;915)	825 (746;938)	821 (792;859)	764 (722;808)*
SDNN 24, ms	134,82 (116,7;156,1)	114,06* (88,4;136,0)	109,16* (86;131,1)	111,18* (93;128,4)
SDANN 24, ms	115,93 (90,5;147,26)	100,7 (75,4;117,93)	94,9 (66,76;115,6)	92,06 (83,4;115,94)
SDNN index	56,4 (44,46;67,16)	50,6 (41,8;56,72)	52,12 (47,1;55,42)	47,6 (42,8;51,8)
rMSDD, ms	30,32 (22,4;36,5)	26,75* (14,74;27,0)	24,47* (19,24;27,9)	19,8* (16,85;23,68)
pNN50, %	5,55 (2,52;13,5)	1,98 (0,7;3,25)	3,42 (1,63;7,6)	1,5* (1,0;3,0)

Note: *p<0,05 - compared to patients with normal body weight.

The obtained results are confirmed by the data of HRV parameters analysis of the frequency domain (Table 2). Thus, patients with hypertension with overweight and obesity had significantly lower values of the TF spectrum total power indicator due to the HF component. This indicator mainly reflects the activity of the parasympathetic part of the autonomic nervous system and high values of the index of vagosympathetic interaction (LF/HF).

Table 2
The average values of the HRV frequency index for patients with hypertension, depending on the presence and degree of obesity

Parameters	Hypertension	Hypertension and excess body weight	Hypertension and obesity grade I	Hypertensio n and obesity II-III degree
TF, ms^2	6498 (3697;9548)	4681* (2755;6191)	4216* (3225;4444)	4376* (3317;4831)
HF, ms^2	485,4 (227,7;679,55)	272,16* (102,3;351,03)	205,56* (130,1;298,81)	198,04* (192;325,5)

Table 2 (Continued):
The average values of the HRV frequency index for patients with hypertension, depending on the presence and degree of obesity

LF, ms^2	1053 (396,04;1670,8)	884 (504,7;1168,1)	880,05 (535,7;1137,8)	689,9 (510,4;814, 9)
VLF, ms^2	4926 (2859;7296)	3494 (2147;3936)	3311 (2377;4233)	3467 (2516;4363)
LF/HF, units	2,14 (1,4;2,6)	4,3* (1,8;5,2)	4,08* (1,9;6,0)	3,8* (2,2;5,4)

Note: p* - compared to patients with normal body weight

Holter monitoring is the main method of diagnosis of extrasystole, assessment of the degree of premature ventricular or supraventricular contractions detected during the electrocardiogram registration. It is proved that the prognostic value of extrasystoles, above all, depends on the organic heart disease presence or absence and its severity, rather than on the characteristics of the extrasystoles themselves. The risk of developing flashing arrhythmia is a criterion for malignancy in supraventricular extrasystoles. Ventricular rhythm disorders are associated with the likelihood of fatal arrhythmias, that is, they are considered as a risk factor for sudden cardiac death [8]. According to the literature, the normal amount of extrasystoles in Holter monitoring is approximately up to 200 supraventricular and up to 200 ventricular extrasystoles (VE) per day. Increasing the VE amount more than 700 per day is considered as "pathological" and is one of the indications for antiarrhythmic therapy [8,9].

Conducting a quantitative analysis of ventricular extrasystole in our study did not reveal differences in the number of patients with a number of VE greater than the statistical norm. So, in a group with a normal body weight, 28.6% of patients had more than 200 VE per day. In the group with an overweight, this indicator was 20%, with I degree obesity - 36%, and in the group with obesity of the II-III degree - 30%. However, it should be noted that all patients with hypertension and a pathological number of VE (> 700) per day belonged to the group with obesity II-III degree ($p = 0,0001$). The qualitative analysis revealed a higher number of individuals with ventricular rhythm disorders by type of trigeminis: 4th grade by B. Lown, M. Wolf, or class 5 - in the modification of M. Ryan in the group with obesity II-III degree, compared with patients with normal BMI and overweight ($p = 0,03$). The comorbidity of hypertension and high-grade obesity also was significantly higher than the proportion of individuals with paired monomorphic VE: a 4-A class according to B. Lown, M. Wolf and in M. Ryan's modification ($p = 0.04$), the frequency of ventricular extrasystole ($p = 0,04$) and the number of single polymorphic VE of the 3rd class according to B. Lown, M. Wolf and in M. Ryan's modification ($p = 0,03$). Correlation analysis showed a direct correlation between BMI and the frequency of ventricular extrasystole ($r = 0,4$; $p < 0.05$), BMI and ventricular rhythm disturbances by type of trigeminia (r = 0,43; p < 0.05), total number of VE and age of patients (r = 0,34; p < 0,05).

The extension of the QT interval is currently considered one of the proven predictors of sudden cardiac death [1,13]. The existence of a relationship between the extension of the QT interval and the frequency of fatal ventricular arrhythmias, in particular polymorphic ventricular tachycardia of the type "pirouettes" has been proven by a number of studies.

In our study, the duration of the QT interval corrected for the heart rate (QTc) was not significantly different in patients of different groups and was 418 (412;427) ms in patients with normal body weight, 427 (418;435) ms - with overweight, 423 (409;447) ms - with obesity of I degree and 422 (418;446) ms - with obesity of II-III degree, although the tendency to increase this parameter for obesity was noted.

In-group analysis of patients with prolonged QTc (> 0.43 s in males and > 0,45 s in females) revealed no change in this parameter in patients with normal body weight. The elongation QTc was determined in 18% of cases (p = 0.05) in the group with an overweight, group with I degree obesity - in 27.4% (p = 0,02), with II-III degree obesity in - 26.6% of the examined (p = 0,04).

As a possible predictive parameter, the dispersion of the QT interval (ΔQT) is also discussed - the difference between the highest and the smallest duration of the interval QT, which is normally 20-50 ms [2]. In the opinion of several authors, the predictor of ventricular tachyarrhythmias is ΔQT more than 45 ms. Other researchers suggest that the upper limit of the norm is ΔQT 70 ms and even 125 ms [7]. Increasing the dispersion of the QT interval may indicate the presence of electrical non-myogenicity of the myocardium, increasing the heterogeneity of the repolarization, and the tendency to develop high-grade VE, especially in combination with other markers of arrhythmogenesis.

According to our study, all examined had ΔQT values within the average statistical norm: 20 (12;30) ms in patients with normal body weight, 26 (16;40) ms - overweight, 31 (22;48) ms - with obesity I degree; 22 (12;27) ms - with II-III degree obesity. There were no significant differences in this indicator in different groups.

The presence of obesity greatly complicates the course of circulatory system diseases and increases the risk of cardiovascular complications. Conducting a comprehensive survey using the Holter monitoring technique and evaluating parameters corresponding to the high risk of cardiovascular disasters allows us to identify patients at risk in time and develop a personalized approach to treatment.

Conclusion

1. Changes in heart rate variability are determined in patients with hypertension and excess body weight or obesity. This indicates the presence of a vegetative imbalance with a weakening of the parasympathetic activity of the autonomic nervous system.

2. The increase in body mass index in patients with hypertension is significantly associated with a decrease in SDNN24 and rMSSD, total spectrum power (TF) due to the HF component, an increase in the average daily rate, and statistically significant high values of the vagosympathetic interaction index (LF/HF).
3. Rigidity of circadian heart rhythm is typical for patients with hypertension. It depends on the presence and degree of obesity and is most pronounced in the case of obesity of the I degree.
4. Hypertension with obesity is characterized by a significantly higher number of patients with ventricular violations of the rhythm of high gradations that can be considered as potentially malignant or malignant according to the risk stratification of J.T. Bigger.
5. The presence of obesity or overweight in patients with hypertension was associated with a significantly higher proportion of individuals with a prolonged QT interval corrected for the heart rate.

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Conflicts of interest. Not declared

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