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ERECTILE DYSFUNCTION AND OBESITY IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND ARTERIAL HYPERTENSION

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SUMMARY

Objective: to study the relationship between erectile dysfunction and obesity parameters and the severity of obstructive sleep apnea in patients with arterial hypertension.

Material and methods: 71 patients with different severity of erectile dysfunction, overweight and obesity of grade 1, mild and severe obstructive sleep apnea and arterial hypertension were included in the study. The data of cardiorespiratory monitoring, anthropometric parameters of obesity were analyzed and the severity of erectile dysfunction was assessed by intracavernous pharmacodopplerography, the results were compared with the subjective opinion of patients on the degree of severity of erectile dysfunction according to the IIEF-5 questionnaire. All patients underwent psychosomatic status analysis according to the questionnaire scales: assessment of daytime drowsiness on the Epworth scale, severity of personal and situational anxiety on the Spielberger scale and depression level on the Beck scale.

Results: comparative analysis revealed statistically significant links between anthropometric data of obesity with OSA parameters (apnea/hypopnea index, desaturation index) ($p<0.05$), as well as the severity of erectile dysfunction (in terms of erection and dopplerography with evaluation of the of penile blood flow) ($p<0.05$). A statistically significant negative relationship between the quality of penile blood flow and the degree of arterial hypertension was revealed too ($p=0.02$). In a comparative analysis of the subjective state of erectile function and objective examination, no statistically significant association was revealed ($p=0.07$). As a result of the multifactorial linear regression, we have shown that with an increase of the waist circumference to the hip circumference ratio and a higher apnea/hypopnea index, the condition of penile arterial blood flow worsens, namely, a decrease in the peak systolic blood flow velocity ($\beta=-0.39$, $p=0.05$; $\beta=-0.44$, $p=0.03$, respectively). When assessing the psychosomatic state of patients, a significant correlation has been found between the severity of depression in the Beck scale and the level of personal and situational anxiety according to the Spielberger scale ($p<0.05$). The relationship between depression level on the Beck scale and the degree of situational anxiety with the severity of erectile dysfunction on the Juname scale has been also shown ($p<0.05$).

Conclusion: the combination of overweight or obesity with obstructive sleep apnea and arterial hypertension gives ground to suspect the presence of different severity of erectile dysfunction. The severity of ED is directly proportional to the level of anxiety and depression according to the questionnaire scales.

Keywords: *erectile dysfunction, obesity, obstructive sleep apnea, arterial hypertension.*

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AH – arterial hypertension,
AHI – apnea/hypopnea index,
DI – desaturation index,
BMI – body mass index,
RI – resistance index,
IIEF-5 – international index of erectile function,
EDBFV – end-diastolic blood flow velocity,
HC – hip circumference,
WC – waist circumference,
PSBFV – peak systolic blood flow velocity,
OSA – obstructive sleep apnea,
USDG – ultrasound Dopplerography,
ED – erectile dysfunction.

INTRODUCTION

The problem of gender medicine including an interdisciplinary approach to male health becomes more and more urgent today. A large-scale epidemiologic study, Massachusetts Male Aging Study (MMAS), revealed erectile dysfunction (ED) in 52% of males aged 40-70 years and 2/3 of them had signs of moderate or severe ED. According to the findings of the study performed by Feldman H.A. et al., more than 150 million males in the general population had erectile problems in 1995. As early as 1992 Laumann E.O. et al. analyzed more than 1,400 males aged 18-59 years and more than 30% of them had ED of different severity [1, 2].

According to the latest recommendations of the European Association of Urology, erectile dysfunction is a persistent condition characterized by the inability to achieve or maintain an erection adequate for satisfactory sexual activity [3].

Taking into account sensitivity of the issue, it is recommended to use an international index of erectile function, the modified questionnaire (IIEF-5), in order to assess erection quality [4]. This questionnaire is intended to assess the male sexual function associated with his ability to achieve and maintain erection adequate for normal sexual activity. But considering that initial signs of ED may be not manifested subjectively, especially in those cases when the matter concerns organic etiology of ED, objective diagnostics of ED should be performed [5, 6].

Noninvasive intracavernous pharmacodopplerography is a golden standard for ED verification today. This method is based on the assessment of erection quality and its duration using the international Juname scale after a bolus injection of prostaglandin E1. The result is considered satisfactory if normal erection develops within 5-10 min and lasts for 30-60 min. Delayed development of erection within 20-25 minutes may be evidence of arterial blood flow insufficiency of the penis. Rapid tumescence loss is the evidence of venous insufficiency. Absence of tumescence or development of incomplete tumescence after injection of the drug may be evidence of cavernous tissue sclerosis and decompensated arterial and/or venous insufficiency. The erection degree is assessed using a six-point scale where ER0 means non-response to injection of prostaglandin; ER1 – insignificant tumescence (penis elongation); ER2 – incomplete tumescence (penile diameter increase); ER3 – complete tumescence (maximum diameter increase with maximum possible penis length); ER4 – semi-rigid penis condition and ER5 – normal erection. Color Ultrasound Dopplerography (USDG) of the penile vessels is performed subsequently; it is necessary for diagnostics of organic ED. USDG of the penile vessels is the most informative when it is performed at rest and after pharmacologically induced erection. When performing USDG of the penile vessels it is extremely important to assess blood flow velocity parameters, namely, peak systolic blood flow velocity (PSBFV), end-diastolic blood flow velocity (EDBFV), and resistance index (RI). Decreased PSBFV is observed in arteriogenic ED, increased EDBFV is seen in venous occlusive ED and decreased RI may be revealed in both cases and also in patients with mixed genesis of ED. Isolated decrease of RI is often a sign of compensated organic ED [7].

According to the World Health Organization (WHO), adult body mass index (BMI) of more than 25 kg/m^2 is considered as overweight and BMI of more than 30 kg/m^2 is assessed as obesity. According to the latest data, approximately 70% of the population are overweight and 30% of the population suffers from obesity of different severity. As recent studies show, 150 minutes of moderate aerobic physical activity per week lower the risk of coronary heart disease (CHD) and diabetes mellitus (DM) by 30 and 27%, respectively [8].

It is common to distinguish overweight (BMI of 25-29.9 kg/m2), obesity of grade 1, 2 and 3 or morbid obesity (BMI of 30-34.9; 35-39.9; 40-44.9, respectively) [9].

About one third of the whole adult population of the Earth experience such sound phenomenon as snore. Snore is one of the main symptoms of obstructive sleep apnea (OSA). The definition of OSA was formulated by C. Guilleminault in 1973: Obstructive sleep apnea is a condition characterized by presence of snore, periodically repeating partial or complete breathing interruption during sleep which is long enough to result in decreased blood oxygen level, rough sleep fragmentation and excessive daytime drowsiness. In order to diagnose OSA, apnea episodes should last for not less than 10 s and occur not rarer than 5 times per hour [10]. The prevalence rate of OSA in adult population is 5-7% and in this situation 1-2% of people suffer from severe forms of the disease [11].

The patients with severe degree of OSA may have more than 500 breathing interruptions during sleep with the total duration of up to 3-4 hours that results in acute and chronic hypoxemia, that, in its turn, increases significantly the risk of cardiovascular diseases such as arterial hypertension, cardiac rhythm and conduction disturbances, myocardial infarction, stroke and sudden cardiac death [12, 13].

Arterial hypertension (AH) takes the first place by the prevalence rate among all cardiovascular diseases and it is also one of the main reasons causing morbidity and mortality of the population. According to WHO, the prevalence rate of AH is 20-30% among the world population. In Russia approximately 40% of adult population has arterial hypertension [14]. According to the American Heart

Association data concerning prevention, diagnostics and treatment of arterial hypertension, OSA was assessed as the first one among all causes of secondary AH and also among all causes for its refractory form [15].

As it is known, overweight and obesity are predisposing causes of OSA [16]. Approximately 25% of patients with BMI of 25-28 kg/m^2 suffers at least from mild degree of OSA with apnea/hypopnea index (AHI) of less than 15 events/hour [17].

It should be mentioned that an interrelationship between OSA and ED is evidenced by the fact that the standard methods for treatment of ED are insufficiently effective in patients with OSA of severe degree and vice versa breathing recovery during sleep is accompanied with potency recover in most males [18, 19].

ED is more often revealed in the group of males with insufficient night decrease of blood pressure (BP) level, in whom more significant diastolic dysfunction, increased lipid, glucose and uric acid levels in the blood plasma were found later [20]. At present it is generally recognized that most cases of ED are a precursory symptom of peripheral atherosclerosis, which, in its turn, is associated with a wide range of cardiovascular complications [21]. It is proven that AH favors vascular wall remodeling, decreased elasticity and decreased lumen of blood vessels supplying blood during erection, that, in its turn, results in development of organic ED [22, 23].

Taking into account the indisputable role of OSA in the development of ED, it seems urgent to assess the presence and degree of organic ED and to reveal the relationship with obesity in males capable of working suffering from arterial hypertension.

MATERIALS AND METHODS

Characteristics of the patients included in the study

71 patients with different severity of ED, overweight and obesity of grade 1, mild and severe OSA and AH were included in the study. All patients underwent the investigation on outpatient basis or were investigated and treated at the Department of Hypertension of the National Medical Research Center of Cardiology of the Ministry of Health of Russia from October, 2016 to October, 2017.

Table 1. Initial characteristics of the patients

Parameter	Median
Age, years	47,9 [32; 64]
Weight, kg	99,2 [75; 127]
BMI, kg/m2	30,8 [25,1; 34,9]
SBP, mm Hg	147,4 [120; 180]
DBP, mm Hg	87,9 [70; 110]
Duration of AH, years	8,5 [4; 13]
Degree of AH, degree	1,4 [1; 3]
AHI, events/h	25,4 [5,5; 88,5]
DI, events/h	22,2 [2,6; 102,4]
Min. SpO2, %	79,2 [45; 89]
Epworth scale	8,6 [0; 24]
IIEF-5, score	16,9 [5; 20]
Personal anxiety	42,7 [26; 62]
Situational anxiety	38,8 [21; 74]
Depression level	9,4 [0; 38]

Note: BMI – body mass index; SBP – systolic blood pressure; DBP – diastolic blood pressure; AHI – apnea /hypopnea index; DI – desaturation index; min. SpO2 – minimum saturation; IIEF-5 – international index of erectile function.

Table 2. Initial levels of erectile function (n=21)

Parameter	Median
IIEF-5, score	16, [5; 20]
ER0-5	3,6 [2; 5]
PSBFV, cm/s	38,6 [18,8; 62,3]
EDBFV, cm/s	9,2 [4,3; 18,7]
RI	0,79 [0,52; 1,0]

Note: IIEF – international index of erectile function; ED 1-5 – erection degree according to the Juname scale; PSBFV – peak systolic blood flow velocity; EDBFV – end-diastolic blood flow velocity; RI – resistance index.

Table 3. Assessment of erectile function parameters

Correlations	r	p
PSBFV/EDBFV	0.678	0.000
EDBFV/RI	-0.586	0.001
ED 1-5/RI	0.618	0.003

Note: PSBFV – peak systolic blood flow velocity; EDBFV – end-diastolic blood flow velocity; RI – resistance index; ED 1-5 – erection degree according to the Juname scale.

Inclusion and exclusion criteria

The study inclusion criteria were: male sex, age of 30-64 years, overweight or obesity of grade 1 (BMI of 25-34.9 kg/m^2), mild and severe obstructive sleep apnea

(5 events/h >AHI <15 events/h or >30 events/h), availability of findings indicative of erectile dysfunction (according to IIEF-5 questionnaire), arterial hypertension, signature of informed consent form.

The patients with coronary heart disease, diabetes mellitus, cardiac rhythm disturbances, any other condition requiring administration of beta-blockingdrugs , obesity of grade 2-3 (BMI≥35 kg/m^2), moderate obstructive sleep apnea

(AHI of 15-29.9 events/h), significant renal and hepatic impairment were excluded from the study.

Laboratory and instrumental methods of investigation

The anthropometrical data was obtained by measuring the height (h), weight, waist circumference (WC), hip circumference (HC) and then WC/HC and WC/h ratios were calculated. At present the standard practice is to consider the values of less than 1.0 and 0.5 for WC/HC and WC/h, respectively, as normal [24]. Body mass index (BMI) was calculated using Quetelet formula: body weight (kg)/squared height (m) (kg/m^2). The patients with overweight and obesity of grade 1 were included in the study irrespective of the WC/HC and WC/h ratios. The initial characteristics of the patients are shown in table 4.

In order to assess the severity of OSA we performed cardiorespiratory monitoring using the devices Somte/Compumedics (Australia), Grass Technologies (USA), Incart/Cardiotekhnika (Russia) or respiratory monitoring using the device Somnocheck micro/Weinmann (Germany). The diagnosis of mild or severe OSA was made in patients with 5 events/h >AHI <15 events/h or >30 events/h, respectively.

The presence and degree of ED were assessed preliminarily by completing the IIEF-5 questionnaire. Presence of ED was supposed in patients with score of less than 21; the mild, moderate and

Table 4. Initial anthropometrical data

Parameter	Mean/Median
Weight, kg	99,2 [75; 127]
BMI, kg/m2	30,8 [25,1; 34,9]
WC, cm	105,2 [88; 127]
HC, cm	102,7 [111;120]
WC/HC	1,14 [0,83; 1,91]
WC/h	0,55 [0,45; 0,65]

Note: BMI – body mass index; WC – waist circumference; HC – hip circumference; WC/HC – ratio of waist circumference to hip circumference; WC/h – ratio of waist circumference to height.

Table 5. Assessment of correlation between obesity and OSA

OSA parameters	AHI r, p	DI r, p	Min. SpO_2 r, p
Weight	r=0.272, p=0.022	r=0.263, p=0.03	нд
BMI	r=0.359, p=0.002	r=0.401, p=0.001	r=-0.332, p=0.005
WC/h	r=0.330, p=0.005	r=0.353, p=0.003	r=-0.313, p=0.008
WC	r=0.491, p<0.000	r=0.527, p=0.000	r=-0.298, p=0.01
WC/HC	r=0.362, p=0.002	r=0.377, p=0.001	нд

Note: BMI – body mass index; WC/h – ratio of waist circumference to height; WC – waist circumference; WC/HC – ratio of waist circumference to hip circumference; AHI – apnea/hypopnea index; DI – desaturation index; min. SpO2 – minimum saturation.

severe degree were supposed in patients with score of 16-20, 11-15 and 5-10, respectively. 21patients out of 71 underwent pharmacodopplerography of penile vessels with intracavernous injection of prostaglandin E1 (bolus injection of 10 μg of Alprostadil) with subsequent assessment of erection intensity and duration using the Juname scale (from 0 to 5) and assessment of blood flow velocity parameters by means of color Dopplerography such as peak systolic blood flow velocity (PSBFV), end-diastolic blood flow velocity (EDBFV) and resistance index (RI) calculated using formula: (PSBFV – EDBFV)/PSBFV. This investigation was performed on outpatient basis after completing the questionnaires, at the National Medical Research Center of Obstetrics, Gynecology and Perinatology named after V.I. Kulakov of the Ministry of Health of Russia The presence of arteriogenic ED was evidenced by decreased PSBFV (to less than 35 cm/s), venous occlusive ED was confirmed by increased EDBFV (to more than 5 cm/s); decreased RI (to less than 0.85) (may be revealed in both cases and also in patients with mixed genesis of ED. Isolated decrease of RI is often a sign of compensated organic ED.

The clinical blood pressure level was measured using Korotkov's method. The AH duration was elucidated by obtaining the anamnestic survey and basing on the data of the medical documents submitted by the patients.

All patients were offered to complete the questionnaires in order to assess their psychosomatic status at the stage of inclusion in the study. When assessing the daytime drowsiness using the Epworth scale, we considered the total score of more than 8 as presence of drowsiness and the score of more than 10 as significant daytime drowsiness. The Spielberger scale was used for revealing the severity of personal and situational anxiety, and depression level was assessed with the help of the Beck scale. The anxiety and depression degrees are assessed as mild, moderate and severe depending on the score. The Spielberger scale assesses mild anxiety as a score of less than 30, the score of 31-44 indicates moderate degree and the score of more than 45 means severe anxiety. When assessing depression level using the Beck scale, the score of 10-15 means mild depression, the score of 16-19 indicates moderate depression, the score 20-29 shows significant depression and the score of more than 30 evidences severe depression.

The statistical data processing was carried out using the software Statistica 10, Stata 15.0. The parameter distribution normality was determined using Shapiro-Wilk test and visually by the graph of distribution. The mean and standard deviation are presented for parameters with normal distribution. The median with interquartile range is provided for parameters with non-normal distribution. The Spearman nonparametric method was used to reveal and assess the relationship between two rows of compared data. The statistical significance level of statistical tests used was considered as less than 0.05.

RESULTS

The average age of the patients included in the study was 47.9±9.2 years. According to findings of the IIEF-5, mild ED was observed in 51 (71.8%) patients, while moderate and severe degree was found only in 20 (28.2%) patients. The duration of arterial hypertension was on average 8.5 years; the patients did not differ in the stage of essential hypertension.

According to findings of the IIEF-5 questionnaire, average score was 16.9 which corresponded to mild ED. But while performing the pharmacological test and assessing the erection degree according to the Juname scale after the drug administration, the erection degree was 3.6 which corresponded to moderate ED. Thus, less than 30% of the patients assessed the severity of erectile dysfunction adequately.

Taking into account the wide use of the international questionnaire for subjective assessment of erectile function, IIEF-5, we made a decision that is was necessary to estimate the prognostic significance and pre-test probability of presence and severity of ED basing on the data of the questionnaire as compared to objective findings of ED assessment. Therefore, we performed correlation analysis of the patients' answers to the questions of the questionnaire with erection degree and duration according to the Juname scale and intracavernous bolus injection of prostaglandin.

The correlation analysis reveals a trend to correlation between the score of IIEF-5 questionnaire and findings of Dopplerography (r=0.42; p=0.07) but probability of error is high because of small number of the patients under study.

Subsequently, the correlation analysis using the Spearman method found a statistically significant correlation between PSBFV and EDBFV (r=0.678; p=0.000), EDBFV and RI (r=-0.586; p=0.001) and also erection degree according to the Juname scale (ER0-5) and RI (r=0.618; p=0.003) (Table 3).

In order to determine the grade of abdominal obesity we assessed such anthropometrical parameters as height, weight, body mass index (BMI=kg/m2), measured waist and hip circumference and calculated the ratio of waist circumference to the height (WC/h) and waist circumference to hip circumference (WC/HC).

Table 6. Assessment of correlation between OSA and ED parameters

Parameters	AHI r, p	DI r, p	Min. SpO_2 r, p
ED 1-5	r=-0.501, p=0.02	no data	no data
PSBFV	r=-0.502, p=0.02	r=-0.608, p=0.003	no data
EDBFV	no data	no data	no data
RI	r=-0.668, p<0.001	r=-0.603, p=0.004	r=0.443, p=0.04

Note: PSBFV – peak systolic blood flow velocity; EDBFV – end-diastolic blood flow velocity; RI – resistance index; ED 1-5 – erection degree according to the Juname scale; AHI – apnea/hypopnea index; DI – desaturation index; min. SpO_2 – minimum saturation.

Table 7. Results of multifactorial logistic regression analysis which included parameters of apnea and obesity

	PSBFV
Apnea/hypopnea index	β =-0.443, p= 0.03
WC/HC	β =-0.379,p = 0.05

Note: WC/HC – ratio of waist circumference to hip circumference.

According to the literature, there exists an undisputable correlation between obesity and ED [25]. In spite of small number of the patients under study (n=21) we revealed a statistically significant correlation between the WC/HC ratio and peak systolic blood flow velocity (PSBFV) as a sign of arteriogenic ED (β=-0.38, p=0.05, basing on the data of multifactorial logistic analysis).

The logistic correlation analysis showed that probability of ED increased as the WC/HC ratio reflecting the degree of abdominal obesity grew (regression coefficient = -19.7; p=0.02).

Thus, in the patients with initially satisfactory erection (ER5), increased WC/HC ratio enhances probability of erection worsening and, vice versa, in the patients with initially lowered erectile function (ER2) increased WC/HC ratio lowers the probability of erection improvement and favors its further progression.

Taking into account that obesity is an independent predictor of OSA, we assessed the correlation between different obesity parameters and OSA severity by apnea/hypopnea index, desaturation index and minimum saturation level. In this case the correlation analysis using Spearman method allowed to reveal a statistically significant correlation between OSA severity (by the basic parameters AHI, DI and min. SpO2) and obesity parameters (weight, BMI, WC, WC/h, WC/HC) (p<0.05) (Table 5).

When performing the correlation analysis using Spearman test we revealed a negative correlation between apnea/hypopnea index (AHI) and blood flow velocity parameters of the penile arteries such as PSBFV (r=-0.502; p=0.02) and RI (r=-0.668; p<0.001) and also erection degree according to the Juname scale (r=-0.501; p=0.02). The similar data was obtained when comparing PSBFV and RI with desaturation index (DI) (r=-0.608; p=0.003 and r=-0.603; p=0.004, respectively) (Table 6).

Taking into account the revealed statistically significant correlations between OSA, obesity and ED parameters we assessed the relationships between OSA severity and obesity parameters associated independently with ED severity in the patients with AH.

Table 8. Results of multifactorial logistic regression analysis which included the systolic blood pressure level and WC/HC

	PSBFV
SBP	β =-0.478, p = 0.02
WC/HC	β =-0.377, p = 0.05

Note: SBP – systolic blood pressure; WC/HC – ratio of waist circumference to hip circumference.

The multifactorial linear regression showed that increased values of WC/HC ratio (β=-0.379, p=0.05) and higher AHI values (β=-0.443, p = 0.03) were independently associated with worsened condition of the penile arterial blood flow, namely, peak systolic blood flow velocity.

A multifactorial logistic regression model, which included apnea/hypopnea index and WC/HC ratio, revealed correlation with ED severity (Table 7).

The multifactorial linear regression showed that increased values of WC/HC ratio (β=-0.377, p=0.05) and higher SBP values (β=-0.478, p=0.02) were independently associated with worsened quality of the penile arterial blood flow, namely, peak systolic blood flow velocity (PSBFV).

A multifactorial logistic regression model, which included the systolic blood pressure level and WC/HC ratio, revealed correlation with ED severity (Table 8).

In order to assess the psychosomatic status of the patients with ED and OSA, we performed analysis using the Spearman method after completing the questionnaire to reveal a correlation between ED and OSA degree and anxiety and depression parameters. The assessment of the effect exerted by ED on the anxiety and depression level revealed statistically significant correlation between ED severity (erection degree by the Juname scale) and the level of situational anxiety according to the Spielberger scale and depression according to the Beck scale (p<0.05).

The correlation analysis also found a positive correlation between the daytime drowsiness level according to the Epworth scale in patients with OSA and depression level according to the Beck scale (p<0.05) (Table 9).

CONCLUSION AND DISCUSSION

It is known than increased body weight is one of the main factors resulting in progression of OSA symptoms. As a large-scale study, Wisconsin Sleep Cohort Study, has shown, up to 18 million people capable of working suffer from OSA. When 690 patients were followed up for 4 years, their mean body weight increased from 85 to 88 kg and mean AHI grew from 4.1 to 5.5 events per hour. Subsequent statistical processing showed that the increase of the body weight only by 10% favored the development of moderate or severe OSA (AHI >15 events/h) in persons with initial AHI of less than 15 events per hour. It was also shown that the increase or decrease of AHI by 3% in the patients with OSA was associated with the increase or decrease of the body weight by 1%, respectively [26]. The prevalence rate of OSA in males is approximately 2 times as high as in females and OSA is diagnosed in every 5-6th male in the male group aged 40-60 years [27].

According to Andersen M.L. et al., the worsened sleep quality resulted in the decreased circulating androgen level in healthy patients under study which confirmed the biological significance of sleep in regulation of testosterone production which has circadian rhythm [28]. It is known than 80% of the patients with sleep apnea

Table 9. Assessment of correlation between OSA, ED and anxiety and depression level

Parameters	SA according to Spielberger scale r, p	PA according to Spielberger scale r, p	Depression according to Beck scale r, p
ED 1-5	r=0.32 p<0.05	no data	r=0.24; p<0.05
Epworth scale	no data	no data	r=0.33; p<0.05
SA according to Spielberger scale	-	r=0,68; p<0.05	r=0,33; p<0.05

Note: ED 1-5 – erection degree according to the Juname scale; Epworth scale – scale of daytime drowsiness; SA according to Spielberger scale – situational anxiety according to the Spielberger scale; PA according to Spielberger scale – personal anxiety according to the Spielberger scale.

have erectile dysfunction which is accompanied by decreased potency, shortened erection phase in terms of time and degree, absence of spontaneous erection during sleep. And vice versa almost 45% of males with erectile dysfunction have AHI of more than 5 events per hour. The severity of ED is directly proportional to OSA severity [29]. Our study has shown a statistically significant correlation between OSA parameters and decreased efficiency of the penile blood flow and, as a consequence, lowered degree and shortened duration of erection according to the Juname scale.

A vicious circle is formed in males with OSA, obesity and ED: obesity leads to onset and progression of OSA; testosterone deficit observed in males with OSA results in decreased lipolysis and metabolic rate what predisposes to obesity; and adipose cells inhibit testosterone production which favors progression of ED [18]. This study was not aimed at the assessment of the correlation between hormone disorder and ED degree. But the assessment of anthropometric obesity parameters and their relationship with ED showed that abdominal obesity and increase of such parameter as the ratio of the waist circumference to hip circumference are associated with decreased blood flow velocity in the penile arteries and, correspondingly, more severe ED. Besides that, the probability of ED aggravation grows as WC/HC ratio increases.

The IIEF-5 questionnaire is actively used all around the world to assess the severity of ED [4]. But this questionnaire has a subjective nature and is based exclusively on the patient's sensations. The high score according to this scale corresponds to normal erectile function what should be confirmed by objective methods of investigation. In contrast to this fact, the data in both home and foreign literature shows inconsistence between the questionnaire scores and objective findings [5, 30]. Our study revealed results which are similar to the literary data. In spite of the revealed trend to the statistically significant correlation between IIEF-5 and objective data, these results should be made more precise after completion of patient enrollment and final analysis.

More than 150 million males in the whole world suffer from erectile dysfunction. This pathology is often observed in the patients with OSA, obesity and arterial hypertension [31]. Modern studies show that obesity and OSA are associated with both arteriogenic ED and decreased bioavailable testosterone level. It is quite possible that hypogonadism associated with obesity and the increased cardiovascular risk may partially explain higher prevalence rate of ED in persons with overweight and obesity [32]. As several studies show, obesity, ED and OSA are often associated with increased anxiety and depressive disorders [33,34]. Our study revealed a relationship between anxiety level, drowsiness degree and ED severity in the patients with OSA.

Many researchers agree in opinion that ED should be considered as a predictor of cardiovascular diseases [35, 36]. ED observed in the patients with AH and OSA, in its turn, is considered as the earliest manifestation of atherosclerosis and as a predictor of cardiovascular disorders.

From practical viewpoint, basing on the findings of our work we can recommend the patients with AH (especially, of degrees 2 and 3), overweight and OSA (especially, of moderate and severe degree) not to neglect a consultation of an uroandrologist even if there are no complaints of worsened erection quality. And, vice versa, if a patient has ED in combination with overweight or obesity, he should undergo a detailed investigation by a physician-cardiologist for early revealing and correction of the cardiovascular pathology [37] and also any investigation method in order to rule out sleep breathing disturbances..

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